

Road To Zero - The Microgrid Management Game

Generated by Doxygen 1.9.1

1 Hierarchical Index	1
1.1 Class Hierarchy	1
2 Class Index	3
2.1 Class List	3
3 File Index	5
3.1 File List	5
4 Class Documentation	7
4.1 AssetsManager Class Reference	7
4.1.1 Detailed Description	8
4.1.2 Constructor & Destructor Documentation	8
4.1.2.1 AssetsManager()	8
4.1.2.2 ~AssetsManager()	9
4.1.3 Member Function Documentation	9
4.1.3.1 __loadSoundBuffer()	9
4.1.3.2 clear()	10
4.1.3.3 getCurrentTrackKey()	11
4.1.3.4 getFont()	11
4.1.3.5 getSound()	12
4.1.3.6 getSoundBuffer()	12
4.1.3.7 getTexture()	13
4.1.3.8 getTrackStatus()	13
4.1.3.9 loadFont()	14
4.1.3.10 loadSound()	14
4.1.3.11 loadTexture()	15
4.1.3.12 loadTrack()	16
4.1.3.13 nextTrack()	17
4.1.3.14 pauseTrack()	17
4.1.3.15 playTrack()	17
4.1.3.16 previousTrack()	17
4.1.3.17 stopTrack()	18
4.1.4 Member Data Documentation	18
4.1.4.1 current_track	18
4.1.4.2 font_map	18
4.1.4.3 sound_map	18
4.1.4.4 soundbuffer_map	18
4.1.4.5 texture_map	19
4.1.4.6 track_map	19
4.2 ContextMenu Class Reference	19
4.2.1 Detailed Description	21
4.2.2 Constructor & Destructor Documentation	21

4.2.2.1 ContextMenu()	21
4.2.2.2 ~ContextMenu()	22
4.2.3 Member Function Documentation	22
4.2.3.1 __drawConsoleScreenFrame()	22
4.2.3.2 __drawConsoleText()	23
4.2.3.3 __drawVisualScreenFrame()	24
4.2.3.4 __handleKeyPressEvents()	24
4.2.3.5 __handleMouseButtonEvents()	25
4.2.3.6 __sendQuitGameMessage()	25
4.2.3.7 __sendRestartGameMessage()	26
4.2.3.8 __setConsoleState()	26
4.2.3.9 __setConsoleString()	26
4.2.3.10 __setUpConsoleScreen()	27
4.2.3.11 __setUpConsoleScreenFrame()	27
4.2.3.12 __setUpMenuFrame()	29
4.2.3.13 __setUpVisualScreen()	30
4.2.3.14 __setUpVisualScreenFrame()	30
4.2.3.15 draw()	32
4.2.3.16 processEvent()	32
4.2.3.17 processMessage()	32
4.2.4 Member Data Documentation	33
4.2.4.1 assets_manager_ptr	33
4.2.4.2 console_screen	33
4.2.4.3 console_screen_frame_bottom	34
4.2.4.4 console_screen_frame_left	34
4.2.4.5 console_screen_frame_right	34
4.2.4.6 console_screen_frame_top	34
4.2.4.7 console_state	34
4.2.4.8 console_string	34
4.2.4.9 console_string_changed	35
4.2.4.10 console_substring_idx	35
4.2.4.11 event_ptr	35
4.2.4.12 frame	35
4.2.4.13 game_menu_up	35
4.2.4.14 menu_frame	35
4.2.4.15 message_hub_ptr	36
4.2.4.16 position_x	36
4.2.4.17 position_y	36
4.2.4.18 render_window_ptr	36
4.2.4.19 visual_screen	36
4.2.4.20 visual_screen_frame_bottom	36
4.2.4.21 visual_screen_frame_left	37

4.2.4.22 visual_screen_frame_right	37
4.2.4.23 visual_screen_frame_top	37
4.3 DieselGenerator Class Reference	37
4.3.1 Detailed Description	39
4.3.2 Constructor & Destructor Documentation	39
4.3.2.1 DieselGenerator()	40
4.3.2.2 ~DieselGenerator()	41
4.3.3 Member Function Documentation	41
4.3.3.1 __breakdown()	41
4.3.3.2 __computeProductionCosts()	41
4.3.3.3 __drawProductionMenu()	42
4.3.3.4 __handleKeyPressEvents()	42
4.3.3.5 __handleMouseButtonEvents()	43
4.3.3.6 __repair()	44
4.3.3.7 __sendImprovementStateMessage()	44
4.3.3.8 __setUpTileImprovementSpriteAnimated()	45
4.3.3.9 __upgrade()	45
4.3.3.10 advanceTurn()	46
4.3.3.11 draw()	46
4.3.3.12 getTileOptionsSubstring()	48
4.3.3.13 processEvent()	49
4.3.3.14 processMessage()	50
4.3.3.15 setIsSelected()	50
4.3.4 Member Data Documentation	50
4.3.4.1 capacity_kW	50
4.3.4.2 emissions_tonnes_CO2e	50
4.3.4.3 fuel_cost	51
4.3.4.4 max_production_MWh	51
4.3.4.5 production_MWh	51
4.3.4.6 smoke_da	51
4.3.4.7 smoke_dx	51
4.3.4.8 smoke_dy	51
4.3.4.9 smoke_prob	52
4.3.4.10 smoke_sprite_list	52
4.4 EnergyStorageSystem Class Reference	52
4.4.1 Detailed Description	54
4.4.2 Constructor & Destructor Documentation	54
4.4.2.1 EnergyStorageSystem()	54
4.4.2.2 ~EnergyStorageSystem()	55
4.4.3 Member Function Documentation	55
4.4.3.1 __handleKeyPressEvents()	55
4.4.3.2 __handleMouseButtonEvents()	56

4.4.3.3 __setUpProductionMenu()	56
4.4.3.4 __setUpTileImprovementSpriteStatic()	57
4.4.3.5 __upgrade()	57
4.4.3.6 draw()	58
4.4.3.7 getTileOptionsSubstring()	58
4.4.3.8 processEvent()	59
4.4.3.9 processMessage()	59
4.4.3.10 setIsSelected()	59
4.4.4 Member Data Documentation	60
4.4.4.1 capacity_MWh	60
4.4.4.2 charge_MWh	60
4.5 Game Class Reference	60
4.5.1 Detailed Description	64
4.5.2 Constructor & Destructor Documentation	64
4.5.2.1 Game()	64
4.5.2.2 ~Game()	66
4.5.3 Member Function Documentation	66
4.5.3.1 __advanceTurn()	66
4.5.3.2 __checkTerminatingConditions()	67
4.5.3.3 __computeCurrentDemand()	67
4.5.3.4 __decrementTutorial()	68
4.5.3.5 __draw()	68
4.5.3.6 __drawFrameClockOverlay()	69
4.5.3.7 __drawHUD()	69
4.5.3.8 __drawLossCredits()	71
4.5.3.9 __drawLossDemand()	72
4.5.3.10 __drawLossEmissions()	73
4.5.3.11 __drawTurnAdvanceBanner()	73
4.5.3.12 __drawTurnSummary()	74
4.5.3.13 __drawTutorial()	75
4.5.3.14 __drawVictory()	75
4.5.3.15 __handleImprovementStateMessage()	76
4.5.3.16 __handleKeyPressEvents()	77
4.5.3.17 __handleMouseButtonEvents()	77
4.5.3.18 __incrementTutorial()	78
4.5.3.19 __insufficientCreditsAlarm()	78
4.5.3.20 __processEvent()	79
4.5.3.21 __processMessage()	80
4.5.3.22 __sendCreditsEarnedMessage()	81
4.5.3.23 __sendGameStateMessage()	82
4.5.3.24 __sendTurnAdvanceMessage()	83
4.5.3.25 __summarizeTurn()	83

4.5.3.26 __toggleFrameClockOverlay()	84
4.5.3.27 __toggleTutorial()	85
4.5.3.28 __updatePopulation()	85
4.5.3.29 run()	85
4.5.4 Member Data Documentation	87
4.5.4.1 assets_manager_ptr	87
4.5.4.2 check_terminating_conditions	87
4.5.4.3 clock	87
4.5.4.4 consecutive_zero_emissions_months	87
4.5.4.5 context_menu_ptr	88
4.5.4.6 credits	88
4.5.4.7 cumulative_emissions_tonnes	88
4.5.4.8 demand_MWh	88
4.5.4.9 demand_remaining_MWh	88
4.5.4.10 demand_served_MWh	88
4.5.4.11 demand_vec_MWh	89
4.5.4.12 dispatch_income	89
4.5.4.13 draw_turn_advance_banner	89
4.5.4.14 event	89
4.5.4.15 fade_rectangle	89
4.5.4.16 frame	89
4.5.4.17 game_loop_broken	90
4.5.4.18 game_phase	90
4.5.4.19 hex_map_ptr	90
4.5.4.20 increase_turn_advance_alpha	90
4.5.4.21 message_deadlock	90
4.5.4.22 message_deadlock_frame	90
4.5.4.23 message_hub	91
4.5.4.24 month	91
4.5.4.25 net_credit_flow	91
4.5.4.26 overproduction_MWh	91
4.5.4.27 overproduction_penalty	91
4.5.4.28 past_demand_MWh	91
4.5.4.29 population	92
4.5.4.30 quit_game	92
4.5.4.31 render_window_ptr	92
4.5.4.32 show_frame_clock_overlay	92
4.5.4.33 show_tutorial	92
4.5.4.34 substring_idx	92
4.5.4.35 time_since_start_s	93
4.5.4.36 transition_from_title	93
4.5.4.37 turn	93

4.5.4.38 turn_advance_alpha	93
4.5.4.39 turn_emissions_tonnes	93
4.5.4.40 turn_end	93
4.5.4.41 turn_fuel_cost	94
4.5.4.42 turn_operation_maintenance_cost	94
4.5.4.43 turn_summary_string	94
4.5.4.44 turn_summary_text	94
4.5.4.45 tutorial_page	94
4.5.4.46 tutorial_string	94
4.5.4.47 tutorial_text	95
4.5.4.48 year	95
4.6 HexMap Class Reference	95
4.6.1 Detailed Description	98
4.6.2 Constructor & Destructor Documentation	98
4.6.2.1 HexMap()	98
4.6.2.2 ~HexMap()	99
4.6.3 Member Function Documentation	99
4.6.3.1 __assembleHexMap()	100
4.6.3.2 __assessNeighbours()	100
4.6.3.3 __buildDrawOrderVector()	100
4.6.3.4 __drawTotalDispatch()	101
4.6.3.5 __enforceOceanContinuity()	103
4.6.3.6 __getMajorityTileType()	103
4.6.3.7 __getNeighboursVector()	104
4.6.3.8 __getNoise()	105
4.6.3.9 __getSelectedTile()	106
4.6.3.10 __getValidMapIndexPositions()	107
4.6.3.11 __handleInitialDraw()	108
4.6.3.12 __handleKeyPressEvents()	109
4.6.3.13 __handleMouseButtonEvents()	109
4.6.3.14 __isLakeTouchingOcean()	110
4.6.3.15 __layTiles()	110
4.6.3.16 __logSettlementPosition()	112
4.6.3.17 __procedurallyGenerateTileResources()	113
4.6.3.18 __procedurallyGenerateTileTypes()	113
4.6.3.19 __sendNoTileSelectedMessage()	114
4.6.3.20 __setUpGlassScreen()	114
4.6.3.21 __setUpInitialDraw()	115
4.6.3.22 __smoothTileTypes()	115
4.6.3.23 assess()	115
4.6.3.24 clear()	116
4.6.3.25 draw()	116

4.6.3.26 processEvent()	117
4.6.3.27 processMessage()	118
4.6.3.28 reroll()	118
4.6.3.29 toggleResourceOverlay()	119
4.6.4 Member Data Documentation	119
4.6.4.1 assets_manager_ptr	119
4.6.4.2 border_tiles_vec	119
4.6.4.3 dalpha	119
4.6.4.4 demand_MWh	120
4.6.4.5 event_ptr	120
4.6.4.6 frame	120
4.6.4.7 glass_screen	120
4.6.4.8 hex_draw_order_vec	120
4.6.4.9 hex_map	120
4.6.4.10 initial_draw_tile_idx	121
4.6.4.11 just_constructed	121
4.6.4.12 message_hub_ptr	121
4.6.4.13 n_layers	121
4.6.4.14 n_tiles	121
4.6.4.15 position_x	121
4.6.4.16 position_y	122
4.6.4.17 render_window_ptr	122
4.6.4.18 settlement_position_logged	122
4.6.4.19 settlement_position_x	122
4.6.4.20 settlement_position_y	122
4.6.4.21 show_resource	122
4.6.4.22 tile_position_x_vec	123
4.6.4.23 tile_position_y_vec	123
4.6.4.24 tile_selected	123
4.7 HexTile Class Reference	123
4.7.1 Detailed Description	128
4.7.2 Constructor & Destructor Documentation	128
4.7.2.1 HexTile()	128
4.7.2.2 ~HexTile()	129
4.7.3 Member Function Documentation	129
4.7.3.1 __buildDieselGenerator()	129
4.7.3.2 __buildEnergyStorage()	130
4.7.3.3 __buildSettlement()	130
4.7.3.4 __buildSolarPV()	131
4.7.3.5 __buildTidalTurbine()	132
4.7.3.6 __buildWaveEnergyConverter()	132
4.7.3.7 __buildWindTurbine()	133

4.7.3.8 __clearDecoration()	134
4.7.3.9 __closeBuildMenu()	134
4.7.3.10 __getTileCoordsSubstring()	134
4.7.3.11 __getTileImprovementSubstring()	135
4.7.3.12 __getTileOptionsSubstring()	135
4.7.3.13 __getTileResourceSubstring()	136
4.7.3.14 __getTileTypeSubstring()	137
4.7.3.15 __handleKeyPressEvents()	138
4.7.3.16 __handleKeyReleaseEvents()	142
4.7.3.17 __handleMouseButtonEvents()	143
4.7.3.18 __isClicked()	143
4.7.3.19 __openBuildMenu()	144
4.7.3.20 __scrapImprovement()	144
4.7.3.21 __sendAssessNeighboursMessage()	145
4.7.3.22 __sendCreditsSpentMessage()	145
4.7.3.23 __sendGameStateRequest()	146
4.7.3.24 __sendInsufficientCreditsMessage()	146
4.7.3.25 __sendTileSelectedMessage()	147
4.7.3.26 __sendTileStateMessage()	147
4.7.3.27 __sendUpdateGamePhaseMessage()	147
4.7.3.28 __setIsSelected()	148
4.7.3.29 __setResourceText()	148
4.7.3.30 __setUpBuildMenu()	149
4.7.3.31 __setUpBuildOption()	150
4.7.3.32 __setUpDieselGeneratorBuildOption()	151
4.7.3.33 __setUpEnergyStorageSystemBuildOption()	152
4.7.3.34 __setUpMagnifyingGlassSprite()	152
4.7.3.35 __setUpNodeSprite()	153
4.7.3.36 __setUpResourceChipSprite()	153
4.7.3.37 __setUpSelectOutlineSprite()	153
4.7.3.38 __setUpSolarPVBuildOption()	154
4.7.3.39 __setUpTidalTurbineBuildOption()	154
4.7.3.40 __setUpTileExplosionReel()	155
4.7.3.41 __setUpTileSprite()	155
4.7.3.42 __setUpWaveEnergyConverterBuildOption()	155
4.7.3.43 __setUpWindTurbineBuildOption()	156
4.7.3.44 assess()	157
4.7.3.45 decorateTile()	157
4.7.3.46 draw()	158
4.7.3.47 processEvent()	159
4.7.3.48 processMessage()	160
4.7.3.49 setTileResource() [1/2]	161

4.7.3.50 setTileResource() [2/2]	161
4.7.3.51 setTileType() [1/2]	162
4.7.3.52 setTileType() [2/2]	162
4.7.3.53 toggleResourceOverlay()	163
4.7.4 Member Data Documentation	163
4.7.4.1 assets_manager_ptr	163
4.7.4.2 build_menu_backing	164
4.7.4.3 build_menu_backing_text	164
4.7.4.4 build_menu_open	164
4.7.4.5 build_menu_options_text_vec	164
4.7.4.6 build_menu_options_vec	164
4.7.4.7 credits	164
4.7.4.8 decoration_cleared	165
4.7.4.9 draw_explosion	165
4.7.4.10 event_ptr	165
4.7.4.11 explosion_frame	165
4.7.4.12 explosion_sprite_reel	165
4.7.4.13 frame	165
4.7.4.14 game_phase	166
4.7.4.15 has_improvement	166
4.7.4.16 is_selected	166
4.7.4.17 magnifying_glass_sprite	166
4.7.4.18 major_radius	166
4.7.4.19 message_hub_ptr	166
4.7.4.20 minor_radius	167
4.7.4.21 node_sprite	167
4.7.4.22 position_x	167
4.7.4.23 position_y	167
4.7.4.24 render_window_ptr	167
4.7.4.25 resource_assessed	167
4.7.4.26 resource_assessment	168
4.7.4.27 resource_chip_sprite	168
4.7.4.28 resource_text	168
4.7.4.29 scrap_improvement_frame	168
4.7.4.30 select_outline_sprite	168
4.7.4.31 show_node	168
4.7.4.32 show_resource	169
4.7.4.33 tile_decoration_sprite	169
4.7.4.34 tile_improvement_ptr	169
4.7.4.35 tile_resource	169
4.7.4.36 tile_sprite	169
4.7.4.37 tile_type	169

4.8 Message Struct Reference	170
4.8.1 Detailed Description	170
4.8.2 Member Data Documentation	170
4.8.2.1 bool_payload	170
4.8.2.2 channel	170
4.8.2.3 double_payload	171
4.8.2.4 int_payload	171
4.8.2.5 number_of_reads	171
4.8.2.6 string_payload	171
4.8.2.7 subject	171
4.8.2.8 vector_payload	171
4.9 MessageHub Class Reference	172
4.9.1 Detailed Description	172
4.9.2 Constructor & Destructor Documentation	173
4.9.2.1 MessageHub()	173
4.9.2.2 ~MessageHub()	173
4.9.3 Member Function Documentation	173
4.9.3.1 addChannel()	173
4.9.3.2 clear()	174
4.9.3.3 clearMessages()	174
4.9.3.4 hasTraffic()	174
4.9.3.5 incrementMessageRead()	175
4.9.3.6 isEmpty()	175
4.9.3.7 popMessage()	176
4.9.3.8 printState()	176
4.9.3.9 receiveMessage()	177
4.9.3.10 removeChannel()	178
4.9.3.11 sendMessage()	178
4.9.4 Member Data Documentation	179
4.9.4.1 message_map	179
4.10 Settlement Class Reference	179
4.10.1 Detailed Description	181
4.10.2 Constructor & Destructor Documentation	181
4.10.2.1 Settlement()	181
4.10.2.2 ~Settlement()	182
4.10.3 Member Function Documentation	182
4.10.3.1 __handleKeyPressEvents()	182
4.10.3.2 __handleMouseButtonEvents()	183
4.10.3.3 __setUpCoinSprite()	183
4.10.3.4 __setUpTileImprovementSpriteStatic()	184
4.10.3.5 draw()	184
4.10.3.6 getTileOptionsSubstring()	185

4.10.3.7 processEvent()	186
4.10.3.8 processMessage()	186
4.10.3.9 setIsSelected()	186
4.10.4 Member Data Documentation	187
4.10.4.1 coin_sprite	187
4.10.4.2 draw_coin	187
4.10.4.3 smoke_da	187
4.10.4.4 smoke_dx	187
4.10.4.5 smoke_dy	187
4.10.4.6 smoke_prob	188
4.10.4.7 smoke_sprite_list	188
4.11 SolarPV Class Reference	188
4.11.1 Detailed Description	190
4.11.2 Constructor & Destructor Documentation	191
4.11.2.1 SolarPV()	191
4.11.2.2 ~SolarPV()	192
4.11.3 Member Function Documentation	192
4.11.3.1 __breakdown()	192
4.11.3.2 __computeCapacityFactors()	193
4.11.3.3 __computeDispatch()	193
4.11.3.4 __computeProduction()	194
4.11.3.5 __computeProductionCosts()	195
4.11.3.6 __drawProductionMenu()	195
4.11.3.7 __drawUpgradeOptions()	196
4.11.3.8 __handleKeyPressEvents()	197
4.11.3.9 __handleMouseButtonEvents()	198
4.11.3.10 __repair()	198
4.11.3.11 __sendImprovementStateMessage()	199
4.11.3.12 __setUpTileImprovementSpriteStatic()	199
4.11.3.13 __upgradePowerCapacity()	200
4.11.3.14 advanceTurn()	200
4.11.3.15 draw()	201
4.11.3.16 getTileOptionsSubstring()	202
4.11.3.17 processEvent()	203
4.11.3.18 processMessage()	203
4.11.3.19 setIsSelected()	204
4.11.3.20 update()	204
4.11.4 Member Data Documentation	204
4.11.4.1 capacity_factor_vec	204
4.11.4.2 capacity_kW	205
4.11.4.3 dispatch_MWh	205
4.11.4.4 dispatch_vec_MWh	205

4.11.4.5 dispatchable_MWh	205
4.11.4.6 max_daily_production_MWh	205
4.11.4.7 production_MWh	205
4.11.4.8 production_vec_MWh	206
4.12 TidalTurbine Class Reference	206
4.12.1 Detailed Description	208
4.12.2 Constructor & Destructor Documentation	208
4.12.2.1 TidalTurbine()	208
4.12.2.2 ~TidalTurbine()	209
4.12.3 Member Function Documentation	210
4.12.3.1 __breakdown()	210
4.12.3.2 __computeCapacityFactors()	210
4.12.3.3 __computeDispatch()	210
4.12.3.4 __computeProduction()	211
4.12.3.5 __computeProductionCosts()	212
4.12.3.6 __drawProductionMenu()	212
4.12.3.7 __drawUpgradeOptions()	213
4.12.3.8 __handleKeyPressEvents()	214
4.12.3.9 __handleMouseButtonEvents()	215
4.12.3.10 __repair()	216
4.12.3.11 __sendImprovementStateMessage()	216
4.12.3.12 __setUpTileImprovementSpriteAnimated()	216
4.12.3.13 __upgradePowerCapacity()	217
4.12.3.14 advanceTurn()	217
4.12.3.15 draw()	218
4.12.3.16 getTileOptionsSubstring()	220
4.12.3.17 processEvent()	221
4.12.3.18 processMessage()	221
4.12.3.19 setIsSelected()	221
4.12.3.20 update()	222
4.12.4 Member Data Documentation	222
4.12.4.1 bobbing_y	222
4.12.4.2 capacity_factor_vec	222
4.12.4.3 capacity_kW	222
4.12.4.4 dispatch_MWh	223
4.12.4.5 dispatch_vec_MWh	223
4.12.4.6 dispatchable_MWh	223
4.12.4.7 max_daily_production_MWh	223
4.12.4.8 production_MWh	223
4.12.4.9 production_vec_MWh	223
4.12.4.10 rotor_drotation	224
4.13 TileImprovement Class Reference	224

4.13.1 Detailed Description	228
4.13.2 Constructor & Destructor Documentation	228
4.13.2.1 TileImprovement()	228
4.13.2.2 ~TileImprovement()	229
4.13.3 Member Function Documentation	230
4.13.3.1 __breakdown()	230
4.13.3.2 __closeProductionMenu()	230
4.13.3.3 __closeUpgradeMenu()	230
4.13.3.4 __drawDispatch()	231
4.13.3.5 __handleKeyPressEvents()	231
4.13.3.6 __handleMouseButtonEvents()	232
4.13.3.7 __openProductionMenu()	232
4.13.3.8 __openUpgradeMenu()	233
4.13.3.9 __repair()	233
4.13.3.10 __sendCreditsSpentMessage()	233
4.13.3.11 __sendGameStateRequest()	234
4.13.3.12 __sendInsufficientCreditsMessage()	234
4.13.3.13 __sendTileStateRequest()	234
4.13.3.14 __setUpDispatchIllustration()	235
4.13.3.15 __setUpProductionMenu()	235
4.13.3.16 __setUpUpgradeMenu()	236
4.13.3.17 __upgradeStorageCapacity()	236
4.13.3.18 advanceTurn()	237
4.13.3.19 draw()	237
4.13.3.20 getTileOptionsSubstring()	239
4.13.3.21 processEvent()	239
4.13.3.22 processMessage()	240
4.13.3.23 setIsSelected()	240
4.13.3.24 update()	240
4.13.4 Member Data Documentation	241
4.13.4.1 assets_manager_ptr	241
4.13.4.2 credits	241
4.13.4.3 demand_MWh	241
4.13.4.4 demand_vec_MWh	241
4.13.4.5 dispatch_backing	241
4.13.4.6 dispatch_text	242
4.13.4.7 event_ptr	242
4.13.4.8 frame	242
4.13.4.9 game_phase	242
4.13.4.10 health	242
4.13.4.11 is_broken	242
4.13.4.12 is_running	243

4.13.4.13 is_selected	243
4.13.4.14 just_built	243
4.13.4.15 just_upgraded	243
4.13.4.16 message_hub_ptr	243
4.13.4.17 month	243
4.13.4.18 operation_maintenance_cost	244
4.13.4.19 position_x	244
4.13.4.20 position_y	244
4.13.4.21 production_menu_backing	244
4.13.4.22 production_menu_backing_text	244
4.13.4.23 production_menu_open	244
4.13.4.24 render_window_ptr	245
4.13.4.25 storage_kWh	245
4.13.4.26 storage_level	245
4.13.4.27 storage_upgrade_sprite	245
4.13.4.28 storage_upgrade_sprite_vec	245
4.13.4.29 tile_improvement_sprite_animated	245
4.13.4.30 tile_improvement_sprite_static	246
4.13.4.31 tile_improvement_string	246
4.13.4.32 tile_improvement_type	246
4.13.4.33 tile_resource	246
4.13.4.34 tile_resource_scalar	246
4.13.4.35 upgrade_arrow_sprite	246
4.13.4.36 upgrade_frame	247
4.13.4.37 upgrade_level	247
4.13.4.38 upgrade_menu_backing	247
4.13.4.39 upgrade_menu_backing_text	247
4.13.4.40 upgrade_menu_open	247
4.13.4.41 upgrade_plus_sprite	247
4.14 WaveEnergyConverter Class Reference	248
4.14.1 Detailed Description	250
4.14.2 Constructor & Destructor Documentation	250
4.14.2.1 WaveEnergyConverter()	250
4.14.2.2 ~WaveEnergyConverter()	251
4.14.3 Member Function Documentation	251
4.14.3.1 __breakdown()	252
4.14.3.2 __computeCapacityFactors()	252
4.14.3.3 __computeDispatch()	252
4.14.3.4 __computeProduction()	253
4.14.3.5 __computeProductionCosts()	254
4.14.3.6 __drawProductionMenu()	254
4.14.3.7 __drawUpgradeOptions()	255

4.14.3.8	__handleKeyPressEvents()	256
4.14.3.9	__handleMouseButtonEvents()	257
4.14.3.10	__repair()	258
4.14.3.11	__sendImprovementStateMessage()	258
4.14.3.12	__setUpTileImprovementSpriteAnimated()	259
4.14.3.13	__upgradePowerCapacity()	259
4.14.3.14	advanceTurn()	260
4.14.3.15	draw()	260
4.14.3.16	getTileOptionsSubstring()	262
4.14.3.17	processEvent()	263
4.14.3.18	processMessage()	263
4.14.3.19	setIsSelected()	263
4.14.3.20	update()	264
4.14.4	Member Data Documentation	264
4.14.4.1	bobbing_y	264
4.14.4.2	capacity_factor_vec	264
4.14.4.3	capacity_kW	265
4.14.4.4	dispatch_MWh	265
4.14.4.5	dispatch_vec_MWh	265
4.14.4.6	dispatchable_MWh	265
4.14.4.7	max_daily_production_MWh	265
4.14.4.8	production_MWh	265
4.14.4.9	production_vec_MWh	266
4.15	WindTurbine Class Reference	266
4.15.1	Detailed Description	268
4.15.2	Constructor & Destructor Documentation	268
4.15.2.1	WindTurbine()	268
4.15.2.2	~WindTurbine()	269
4.15.3	Member Function Documentation	270
4.15.3.1	__breakdown()	270
4.15.3.2	__computeCapacityFactors()	270
4.15.3.3	__computeDispatch()	271
4.15.3.4	__computeProduction()	272
4.15.3.5	__computeProductionCosts()	272
4.15.3.6	__drawProductionMenu()	272
4.15.3.7	__drawUpgradeOptions()	273
4.15.3.8	__handleKeyPressEvents()	274
4.15.3.9	__handleMouseButtonEvents()	275
4.15.3.10	__repair()	276
4.15.3.11	__sendImprovementStateMessage()	276
4.15.3.12	__setUpTileImprovementSpriteAnimated()	277
4.15.3.13	__upgradePowerCapacity()	277

4.15.3.14	advanceTurn()	278
4.15.3.15	draw()	278
4.15.3.16	getTileOptionsSubstring()	280
4.15.3.17	processEvent()	281
4.15.3.18	processMessage()	281
4.15.3.19	setIsSelected()	281
4.15.3.20	update()	282
4.15.4	Member Data Documentation	282
4.15.4.1	capacity_factor_vec	282
4.15.4.2	capacity_kW	282
4.15.4.3	dispatch_MWh	282
4.15.4.4	dispatch_vec_MWh	283
4.15.4.5	dispatchable_MWh	283
4.15.4.6	max_daily_production_MWh	283
4.15.4.7	production_MWh	283
4.15.4.8	production_vec_MWh	283
4.15.4.9	rotor_drotation	283
5	File Documentation	285
5.1	header/ContextMenu.h File Reference	285
5.1.1	Detailed Description	286
5.1.2	Enumeration Type Documentation	286
5.1.2.1	ConsoleState	286
5.2	header/DieselGenerator.h File Reference	286
5.2.1	Detailed Description	287
5.3	header/EnergyStorageSystem.h File Reference	287
5.3.1	Detailed Description	288
5.4	header/ESC_core/AssetsManager.h File Reference	288
5.4.1	Detailed Description	289
5.5	header/ESC_core/constants.h File Reference	289
5.5.1	Detailed Description	293
5.5.2	Function Documentation	293
5.5.2.1	FOREST_GREEN()	293
5.5.2.2	LAKE_BLUE()	293
5.5.2.3	MENU_FRAME_GREY()	293
5.5.2.4	MONOCHROME_SCREEN_BACKGROUND()	293
5.5.2.5	MONOCHROME_TEXT_AMBER()	294
5.5.2.6	MONOCHROME_TEXT_GREEN()	294
5.5.2.7	MONOCHROME_TEXT_RED()	294
5.5.2.8	MOUNTAINS_GREY()	294
5.5.2.9	OCEAN_BLUE()	294
5.5.2.10	PLAINS_YELLOW()	295

5.5.2.11 RESOURCE_CHIP_GREY()	295
5.5.2.12 VISUAL_SCREEN_FRAME_GREY()	295
5.5.3 Variable Documentation	295
5.5.3.1 BREAKDOWN_PROBABILITY_INCREMENT	295
5.5.3.2 BUILD_SETTLEMENT_COST	295
5.5.3.3 CLEAR_FOREST_COST	296
5.5.3.4 CLEAR_MOUNTAINS_COST	296
5.5.3.5 CLEAR_PLAINS_COST	296
5.5.3.6 COST_PER_LITRE_DIESEL	296
5.5.3.7 CREDITS_PER_MWH_SERVED	296
5.5.3.8 DAILY_TIDAL_CAPACITY_FACTOR	296
5.5.3.9 DIESEL_GENERATOR_BUILD_COST	297
5.5.3.10 DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION	297
5.5.3.11 EMISSIONS_LIFETIME_LIMIT_TONNES	297
5.5.3.12 ENERGY_STORAGE_SYSTEM_BUILD_COST	297
5.5.3.13 FLOAT_TOLERANCE	297
5.5.3.14 FRAMES_PER_SECOND	297
5.5.3.15 GAME_CHANNEL	298
5.5.3.16 GAME_HEIGHT	298
5.5.3.17 GAME_STATE_CHANNEL	298
5.5.3.18 GAME_WIDTH	298
5.5.3.19 HEX_MAP_CHANNEL	298
5.5.3.20 KG_CO2E_PER_LITRE_DIESEL	298
5.5.3.21 LITRES_DIESEL_PER_MWH_PRODUCTION	299
5.5.3.22 MAX_STORAGE_LEVELS	299
5.5.3.23 MAX_UPGRADE_LEVELS	299
5.5.3.24 MAXIMUM_DAILY_DEMAND_PER_CAPITA	299
5.5.3.25 MEAN_DAILY_DEMAND_RATIOS	299
5.5.3.26 MEAN_DAILY_SOLAR_CAPACITY_FACTORS	300
5.5.3.27 MEAN_DAILY_WAVE_CAPACITY_FACTORS	300
5.5.3.28 MEAN_DAILY_WIND_CAPACITY_FACTORS	300
5.5.3.29 MEAN_POPULATION_GROWTH_RATE	300
5.5.3.30 NO_TILE_SELECTED_CHANNEL	301
5.5.3.31 RESOURCE_ASSESSMENT_COST	301
5.5.3.32 SCRAP_COST	301
5.5.3.33 SECONDS_PER_FRAME	301
5.5.3.34 SECONDS_PER_MONTH	301
5.5.3.35 SECONDS_PER_YEAR	301
5.5.3.36 SETTLEMENT_CHANNEL	302
5.5.3.37 SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION	302
5.5.3.38 SOLAR_PV_BUILD_COST	302
5.5.3.39 SOLAR_PV_WATER_BUILD_MULTIPLIER	302

5.5.3.40 STARTING_CREDITS	302
5.5.3.41 STARTING_POPULATION	302
5.5.3.42 STDEV_DAILY_DEMAND_RATIOS	303
5.5.3.43 STDEV_DAILY_SOLAR_CAPACITY_FACTORS	303
5.5.3.44 STDEV_DAILY_WAVE_CAPACITY_FACTORS	303
5.5.3.45 STDEV_DAILY_WIND_CAPACITY_FACTORS	304
5.5.3.46 STDEV_POPULATION_GROWTH_RATE	304
5.5.3.47 TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION	304
5.5.3.48 TIDAL_TURBINE_BUILD_COST	304
5.5.3.49 TILE_RESOURCE_CUMULATIVE_PROBABILITIES	304
5.5.3.50 TILE_SELECTED_CHANNEL	305
5.5.3.51 TILE_STATE_CHANNEL	305
5.5.3.52 TILE_TYPE_CUMULATIVE_PROBABILITIES	305
5.5.3.53 TUTORIAL_PAGES	305
5.5.3.54 WAVE_ENERGY_CONVERTER_BUILD_COST	305
5.5.3.55 WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION	305
5.5.3.56 WIND_OP_MAINT_COST_PER_MWH_PRODUCTION	306
5.5.3.57 WIND_TURBINE_BUILD_COST	306
5.5.3.58 WIND_TURBINE_WATER_BUILD_MULTIPLIER	306
5.6 header/ESC_core/doxygen_cite.h File Reference	306
5.6.1 Detailed Description	306
5.7 header/ESC_core/includes.h File Reference	307
5.7.1 Detailed Description	307
5.8 header/ESC_core/MessageHub.h File Reference	308
5.8.1 Detailed Description	308
5.9 header/ESC_core/testing_utils.h File Reference	308
5.9.1 Detailed Description	309
5.9.2 Function Documentation	309
5.9.2.1 expectedErrorNotDetected()	310
5.9.2.2 printGold()	310
5.9.2.3 printGreen()	310
5.9.2.4 printRed()	311
5.9.2.5 testFloatEquals()	311
5.9.2.6 testGreaterThan()	312
5.9.2.7 testGreaterThanOrEqualTo()	312
5.9.2.8 testLessThan()	313
5.9.2.9 testLessThanOrEqualTo()	314
5.9.2.10 testTruth()	314
5.10 header/Game.h File Reference	315
5.10.1 Enumeration Type Documentation	316
5.10.1.1 GamePhase	316
5.11 header/HexMap.h File Reference	316

5.11.1 Detailed Description	317
5.12 header/HexTile.h File Reference	317
5.12.1 Detailed Description	318
5.12.2 Enumeration Type Documentation	318
5.12.2.1 TileResource	318
5.12.2.2 TileType	319
5.13 header/Settlement.h File Reference	319
5.13.1 Detailed Description	320
5.14 header/SolarPV.h File Reference	320
5.14.1 Detailed Description	321
5.15 header/TidalTurbine.h File Reference	321
5.15.1 Detailed Description	322
5.16 header/TileImprovement.h File Reference	322
5.16.1 Detailed Description	323
5.16.2 Enumeration Type Documentation	323
5.16.2.1 TileImprovementType	323
5.17 header/WaveEnergyConverter.h File Reference	324
5.17.1 Detailed Description	325
5.18 header/WindTurbine.h File Reference	325
5.18.1 Detailed Description	326
5.19 source/ContextMenu.cpp File Reference	326
5.19.1 Detailed Description	326
5.20 source/DieselGenerator.cpp File Reference	326
5.20.1 Detailed Description	326
5.21 source/EnergyStorageSystem.cpp File Reference	327
5.21.1 Detailed Description	327
5.22 source/ESC_core/AssetsManager.cpp File Reference	327
5.22.1 Detailed Description	327
5.23 source/ESC_core/MessageHub.cpp File Reference	327
5.23.1 Detailed Description	328
5.24 source/ESC_core/testing_utils.cpp File Reference	328
5.24.1 Detailed Description	328
5.24.2 Function Documentation	329
5.24.2.1 expectedErrorNotDetected()	329
5.24.2.2 printGold()	329
5.24.2.3 printGreen()	329
5.24.2.4 printRed()	330
5.24.2.5 testFloatEquals()	330
5.24.2.6 testGreaterThan()	331
5.24.2.7 testGreaterThanOrEqualTo()	331
5.24.2.8 testLessThan()	332
5.24.2.9 testLessThanOrEqualTo()	333

5.24.2.10 testTruth()	333
5.25 source/Game.cpp File Reference	334
5.25.1 Detailed Description	334
5.26 source/HexMap.cpp File Reference	334
5.26.1 Detailed Description	335
5.27 source/HexTile.cpp File Reference	335
5.27.1 Detailed Description	335
5.28 source/main.cpp File Reference	335
5.28.1 Detailed Description	336
5.28.2 Function Documentation	336
5.28.2.1 constructRenderWindow()	336
5.28.2.2 loadAssets()	337
5.28.2.3 main()	340
5.28.2.4 playBrandAnimation()	341
5.28.2.5 showTitleScreen()	344
5.29 source/Settlement.cpp File Reference	348
5.29.1 Detailed Description	348
5.30 source/SolarPV.cpp File Reference	348
5.30.1 Detailed Description	348
5.31 source/TidalTurbine.cpp File Reference	348
5.31.1 Detailed Description	349
5.32 source/TileImprovement.cpp File Reference	349
5.32.1 Detailed Description	349
5.33 source/WaveEnergyConverter.cpp File Reference	349
5.33.1 Detailed Description	349
5.34 source/WindTurbine.cpp File Reference	350
5.34.1 Detailed Description	350
Bibliography	351
Index	353

Chapter 1

Hierarchical Index

1.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

AssetsManager	7
ContextMenu	19
Game	60
HexMap	95
HexTile	123
Message	170
MessageHub	172
TileImprovement	224
DieselGenerator	37
EnergyStorageSystem	52
Settlement	179
SolarPV	188
TidalTurbine	206
WaveEnergyConverter	248
WindTurbine	266

Chapter 2

Class Index

2.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

AssetsManager	A class which manages visual and sound assets	7
ContextMenu	A class which defines a context menu for the game	19
DieselGenerator	A settlement class (child class of TileImprovement)	37
EnergyStorageSystem	A settlement class (child class of TileImprovement)	52
Game	A class which acts as the central class for the game, by containing all other classes and implementing the game loop	60
HexMap	A class which defines a hex map of hex tiles	95
HexTile	A class which defines a hex tile of the hex map	123
Message	A structure which defines a standard message format	170
MessageHub	A class which acts as a central hub for inter-object message traffic	172
Settlement	A settlement class (child class of TileImprovement)	179
SolarPV	A settlement class (child class of TileImprovement)	188
TidalTurbine	A settlement class (child class of TileImprovement)	206
TileImprovement	A base class for the tile improvement hierarchy	224
WaveEnergyConverter	A settlement class (child class of TileImprovement)	248
WindTurbine	A settlement class (child class of TileImprovement)	266

Chapter 3

File Index

3.1 File List

Here is a list of all files with brief descriptions:

header/ ContextMenu.h	
Header file for the ContextMenu class	285
header/ DieselGenerator.h	
Header file for the DieselGenerator class	286
header/ EnergyStorageSystem.h	
Header file for the EnergyStorageSystem class. DEPRECATED / NOT USED	287
header/ Game.h	315
header/ HexMap.h	
Header file for the HexMap class	316
header/ HexTile.h	
Header file for the Game class	317
header/ Settlement.h	
Header file for the Settlement class	319
header/ SolarPV.h	
Header file for the SolarPV class	320
header/ TidalTurbine.h	
Header file for the TidalTurbine class	321
header/ TileImprovement.h	
Header file for the TileImprovement class	322
header/ WaveEnergyConverter.h	
Header file for the WaveEnergyConverter class	324
header/ WindTurbine.h	
Header file for the WindTurbine class	325
header/ESC_core/ AssetsManager.h	
Header file for the AssetsManager class	288
header/ESC_core/ constants.h	
Header file for various constants	289
header/ESC_core/ doxygen_cite.h	
Header file which simply cites the doxygen tool	306
header/ESC_core/ includes.h	
Header file for various includes	307
header/ESC_core/ MessageHub.h	
Header file for the MessageHub class	308
header/ESC_core/ testing_utils.h	
Header file for various testing utilities	308

source/ ContextMenu.cpp	Implementation file for the ContextMenu class	326
source/ DieselGenerator.cpp	Implementation file for the DieselGenerator class	326
source/ EnergyStorageSystem.cpp	Implementation file for the EnergyStorageSystem class. DEPRECATED / NOT USED	327
source/ Game.cpp	Implementation file for the Game class	334
source/ HexMap.cpp	Implementation file for the HexMap class	334
source/ HexTile.cpp	Implementation file for the HexTile class	335
source/ main.cpp	Implementation file for main() for Road To Zero	335
source/ Settlement.cpp	Implementation file for the Settlement class	348
source/ SolarPV.cpp	Implementation file for the SolarPV class	348
source/ TidalTurbine.cpp	Implementation file for the TidalTurbine class	348
source/ TileImprovement.cpp	Implementation file for the TileImprovement class	349
source/ WaveEnergyConverter.cpp	Implementation file for the WaveEnergyConverter class	349
source/ WindTurbine.cpp	Implementation file for the WindTurbine class	350
source/ESC_core/ AssetsManager.cpp	Implementation file for the AssetsManager class	327
source/ESC_core/ MessageHub.cpp	Implementation file for the MessageHub class	327
source/ESC_core/ testing_utils.cpp	Implementation file for various testing utilities	328

Chapter 4

Class Documentation

4.1 AssetsManager Class Reference

A class which manages visual and sound assets.

```
#include <AssetsManager.h>
```

Public Member Functions

- [AssetsManager](#) (void)
Constructor for the [AssetsManager](#) class.
- void [loadFont](#) (std::string, std::string)
Method to load a font and insert it into the font map.
- void [loadTexture](#) (std::string, std::string)
Method to load a texture and insert it into the texture map.
- void [loadSound](#) (std::string, std::string)
Method to load a sound and insert it into the sound map. Automatically creates a corresponding sf::SoundBuffer.
- void [loadTrack](#) (std::string, std::string)
Method to load a track (sf::Music) and insert it into the track map.
- sf::Font * [getFont](#) (std::string)
Method to get font associated with given font key.
- sf::Texture * [getTexture](#) (std::string)
Method to get texture associated with given texture key.
- sf::SoundBuffer * [getSoundBuffer](#) (std::string)
Method to get soundbuffer associated with given sound key.
- sf::Sound * [getSound](#) (std::string)
Method to get sound associated with given sound key.
- void [playTrack](#) (void)
Method to play the current track.
- void [pauseTrack](#) (void)
Method to pause the current track.
- void [stopTrack](#) (void)
Method to stop the current track.
- void [nextTrack](#) (void)
Method to advance to the next track. Wraps around if the end of the track map is reached.

- void [previousTrack](#) (void)
Method to return to the previous track. Wraps around if the beginning of the track map is reached.
- std::string [getCurrentTrackKey](#) (void)
Method to get track key for current track.
- sf::SoundSource::Status [getTrackStatus](#) (void)
Method to get the status of the current track.
- void [clear](#) (void)
Method to clear all loaded assets.
- [~AssetsManager](#) (void)
Destructor for the [AssetsManager](#) class.

Public Attributes

- std::map< std::string, sf::Font * > [font_map](#)
A map of pointers to loaded fonts.
- std::map< std::string, sf::Texture * > [texture_map](#)
A map of pointers to loaded textures.
- std::map< std::string, sf::SoundBuffer * > [soundbuffer_map](#)
A map of pointers to sound buffers.
- std::map< std::string, sf::Sound * > [sound_map](#)
A map of pointers to loaded sounds.
- std::map< std::string, sf::Music * >::iterator [current_track](#)
A map iterator which corresponds to the current track (i.e., the track currently being played).
- std::map< std::string, sf::Music * > [track_map](#)
A map of pointers to opened tracks (i.e. sf::Music).

Private Member Functions

- void [__loadSoundBuffer](#) (std::string, std::string)
Helper method to load a soundbuffer and insert it into the soundbuffer map. Should only be called by [loadSound\(\)](#), to create an sf::SoundBuffer corresponding to the loaded sf::Sound.

4.1.1 Detailed Description

A class which manages visual and sound assets.

4.1.2 Constructor & Destructor Documentation

4.1.2.1 AssetsManager()

```
AssetsManager::AssetsManager (
    void )
```

Constructor for the [AssetsManager](#) class.

```
142 {
143     //...
144
145     std::cout << "AssetsManager constructed at " << this << std::endl;
146
147     return;
148 } /* AssetsManager() */
```

4.1.2.2 ~AssetsManager()

```
AssetsManager::~AssetsManager (
    void )
```

Destructor for the [AssetsManager](#) class.

```
771 {
772     this->clear();
773
774     std::cout << "AssetsManager at " << this << " destroyed" << std::endl;
775
776     return;
777 } /* ~AssetsManager() */
```

4.1.3 Member Function Documentation

4.1.3.1 __loadSoundBuffer()

```
void AssetsManager::__loadSoundBuffer (
    std::string path_2_sound,
    std::string sound_key ) [private]
```

Helper method to load a soundbuffer and insert it into the soundbuffer map. Should only be called by [loadSound\(\)](#), to create an `sf::SoundBuffer` corresponding to the loaded `sf::Sound`.

Parameters

<i>path_2_sound</i>	A path (either relative or absolute) to the sound file.
<i>sound_key</i>	A key associated with the sound (for indexing into the soundbuffer map).

```
79 {
80     // 1. check key, throw error if already in use
81     if (this->soundbuffer_map.count(sound_key) > 0) {
82         std::string error_str = "ERROR AssetsManager::__loadSoundBuffer() sound key ";
83         error_str += sound_key;
84         error_str += " is already in use";
85
86         this->clear();
87
88         #ifdef _WIN32
89             std::cout << error_str << std::endl;
90         #endif /* _WIN32 */
91
92         throw std::runtime_error(error_str);
93     }
94
95
96     // 2. load from file, throw error on fail
97     sf::SoundBuffer* soundbuffer_ptr = new sf::SoundBuffer();
98
99     if (not soundbuffer_ptr->loadFromFile(path_2_sound)) {
100         std::string error_str = "ERROR AssetsManager::__loadSoundBuffer() could not load ";
101         error_str += "soundbuffer at ";
102         error_str += path_2_sound;
103
104         this->clear();
105
106         #ifdef _WIN32
107             std::cout << error_str << std::endl;
108         #endif /* _WIN32 */
109
110         throw std::runtime_error(error_str);
111     }
112
113 }
```

```

114 // 3. insert into soundbuffer map
115 this->soundbuffer_map.insert(
116     std::pair<std::string, sf::SoundBuffer*>(sound_key, soundbuffer_ptr)
117 );
118
119 std::cout << "SoundBuffer " << sound_key << " inserted into soundbuffer map" <<
120     std::endl;
121
122 return;
123 } /* __loadSoundBuffer() */

```

4.1.3.2 clear()

```

void AssetsManager::clear (
    void )

```

Method to clear all loaded assets.

```

678 {
679     // 1. clear fonts
680     std::map<std::string, sf::Font*>::iterator font_iter;
681     for (
682         font_iter = this->font_map.begin();
683         font_iter != this->font_map.end();
684         font_iter++
685     ) {
686         delete font_iter->second;
687
688         std::cout << "Font " << font_iter->first << " deleted from font map" <<
689             std::endl;
690     }
691     this->font_map.clear();
692
693     // 2. clear textures
694     std::map<std::string, sf::Texture*>::iterator texture_iter;
695     for (
696         texture_iter = this->texture_map.begin();
697         texture_iter != this->texture_map.end();
698         texture_iter++
699     ) {
700         delete texture_iter->second;
701
702         std::cout << "Texture " << texture_iter->first << " deleted from texture map" <<
703             std::endl;
704     }
705     this->texture_map.clear();
706
707     // 3. clear sound buffers
708     std::map<std::string, sf::SoundBuffer*>::iterator soundbuffer_iter;
709     for (
710         soundbuffer_iter = this->soundbuffer_map.begin();
711         soundbuffer_iter != this->soundbuffer_map.end();
712         soundbuffer_iter++
713     ) {
714         delete soundbuffer_iter->second;
715
716         std::cout << "SoundBuffer " << soundbuffer_iter->first <<
717             " deleted from soundbuffer map" << std::endl;
718     }
719     this->soundbuffer_map.clear();
720
721     // 4. clear sounds
722     std::map<std::string, sf::Sound*>::iterator sound_iter;
723     for (
724         sound_iter = this->sound_map.begin();
725         sound_iter != this->sound_map.end();
726         sound_iter++
727     ) {
728         sound_iter->second->stop();
729         delete sound_iter->second;
730
731         std::cout << "Sound " << sound_iter->first << " deleted from sound map" <<
732             std::endl;
733     }
734     this->sound_map.clear();
735
736 }
737
738

```



```

739
740 // 5. clear tracks
741 std::map<std::string, sf::Music*>::iterator track_iter;
742 for (
743     track_iter = this->track_map.begin();
744     track_iter != this->track_map.end();
745     track_iter++)
746 {
747     track_iter->second->stop();
748     delete track_iter->second;
749
750     std::cout << "Track " << track_iter->first << " deleted from track map" <<
751         std::endl;
752 }
753 this->track_map.clear();
754
755 return;
756 } /* clear() */

```

4.1.3.3 getCurrentTrackKey()

```

std::string AssetsManager::getCurrentTrackKey (
    void )

```

Method to get track key for current track.

Returns

The track key for the current track.

```

642 {
643     return this->current_track->first;
644 } /* getCurrentTrackKey() */

```

4.1.3.4 getFont()

```

sf::Font * AssetsManager::getFont (
    std::string font_key )

```

Method to get font associated with given font key.

Parameters

<i>font_key</i>	A key associated with the font (for indexing into the font map).
-----------------	--

Returns

A pointer to the corresponding font.

```

383 {
384     // 1. check key, throw error if not found
385     if (this->font_map.count(font_key) <= 0) {
386         std::string error_str = "ERROR AssetsManager::getFont() font key ";
387         error_str += font_key;
388         error_str += " is not contained in font map";
389
390         this->clear();
391
392         #ifdef _WIN32

```

```

393         std::cout << error_str << std::endl;
394     #endif /* _WIN32 */
395
396     throw std::runtime_error(error_str);
397 }
398
399 return this->font_map[font_key];
400 } /* getFont() */

```

4.1.3.5 getSound()

```

sf::Sound * AssetsManager::getSound (
    std::string sound_key )

```

Method to get sound associated with given sound key.

Parameters

<i>sound_key</i>	A key associated with the sound (for indexing into the sound map).
------------------	--

Returns

A pointer to the corresponding sound.

```

493 {
494     // 1. check key, throw error if not found
495     if (this->sound_map.count(sound_key) <= 0) {
496         std::string error_str = "ERROR AssetsManager::getSound() sound key ";
497         error_str += sound_key;
498         error_str += " is not contained in sound map";
499
500         this->clear();
501
502         #ifdef _WIN32
503             std::cout << error_str << std::endl;
504         #endif /* _WIN32 */
505
506         throw std::runtime_error(error_str);
507     }
508
509     return this->sound_map[sound_key];
510 } /* getSound() */

```

4.1.3.6 getSoundBuffer()

```

sf::SoundBuffer * AssetsManager::getSoundBuffer (
    std::string sound_key )

```

Method to get soundbuffer associated with given sound key.

Parameters

<i>sound_key</i>	A key associated with the soundbuffer (for indexing into the soundbuffer map).
------------------	--

Returns

A pointer to the corresponding soundbuffer.

```

457 {
458     // 1. check key, throw error if not found
459     if (this->soundbuffer_map.count(sound_key) <= 0) {
460         std::string error_str = "ERROR AssetsManager::getSoundBuffer() sound key ";
461         error_str += sound_key;
462         error_str += " is not contained in soundbuffer map";
463
464         this->clear();
465
466         #ifdef _WIN32
467             std::cout << error_str << std::endl;
468         #endif /* _WIN32 */
469
470         throw std::runtime_error(error_str);
471     }
472
473     return this->soundbuffer_map[sound_key];
474 } /* getSoundBuffer() */

```

4.1.3.7 getTexture()

```

sf::Texture * AssetsManager::getTexture (
    std::string texture_key )

```

Method to get texture associated with given texture key.

Parameters

<i>texture_key</i>	A key associated with the texture (for indexing into the texture map).
--------------------	--

Returns

A pointer to the corresponding texture.

```

420 {
421     // 1. check key, throw error if not found
422     if (this->texture_map.count(texture_key) <= 0) {
423         std::string error_str = "ERROR AssetsManager::getTexture() texture key ";
424         error_str += texture_key;
425         error_str += " is not contained in texture map";
426
427         this->clear();
428
429         #ifdef _WIN32
430             std::cout << error_str << std::endl;
431         #endif /* _WIN32 */
432
433         throw std::runtime_error(error_str);
434     }
435
436     return this->texture_map[texture_key];
437 } /* getTexture() */

```

4.1.3.8 getTrackStatus()

```

sf::SoundSource::Status AssetsManager::getTrackStatus (
    void )

```

Method to get the status of the current track.

Returns

The status of the current track.

```

661 {
662     return this->current_track->second->getStatus();
663 } /* getTrackStatus */

```

4.1.3.9 loadFont()

```

void AssetsManager::loadFont (
    std::string path_2_font,
    std::string font_key )

```

Method to load a font and insert it into the font map.

Parameters

<i>path_2_font</i>	A path (either relative or absolute) to the font file.
<i>font_key</i>	A key associated with the font (for indexing into the font map).

```

167 {
168     // 1. check key, throw error if already in use
169     if (this->font_map.count(font_key) > 0) {
170         std::string error_str = "ERROR AssetsManager::loadFont() font key ";
171         error_str += font_key;
172         error_str += " is already in use";
173
174         this->clear();
175
176         #ifdef _WIN32
177             std::cout << error_str << std::endl;
178         #endif /* _WIN32 */
179
180         throw std::runtime_error(error_str);
181     }
182
183
184     // 2. load from file, throw error on fail
185     sf::Font* font_ptr = new sf::Font();
186
187     if (not font_ptr->loadFromFile(path_2_font)) {
188         std::string error_str = "ERROR AssetsManager::loadFont() could not load ";
189         error_str += "font at ";
190         error_str += path_2_font;
191
192         this->clear();
193
194         #ifdef _WIN32
195             std::cout << error_str << std::endl;
196         #endif /* _WIN32 */
197
198         throw std::runtime_error(error_str);
199     }
200
201
202     // 3. insert into font map
203     this->font_map.insert(std::pair<std::string, sf::Font*>(font_key, font_ptr));
204
205     std::cout << "Font " << font_key << " inserted into font map" << std::endl;
206
207     return;
208 } /* loadFont() */

```

4.1.3.10 loadSound()

```

void AssetsManager::loadSound (

```

```
std::string path_2_sound,
std::string sound_key )
```

Method to load a sound and insert it into the sound map. Automatically creates a corresponding sf::SoundBuffer.

Parameters

<i>path_2_sound</i>	A path (either relative or absolute) to the sound file.
<i>sound_key</i>	A key associated with the sound (for indexing into the sound map).

```
291 {
292     // 1. create an associated sf::SoundBuffer
293     this->__loadSoundBuffer(path_2_sound, sound_key);
294
295     // 2. associate sf::Sound with sf::SoundBuffer
296     sf::Sound* sound_ptr = new sf::Sound();
297     sound_ptr->setBuffer(*(this->soundbuffer_map[sound_key]));
298
299     // 3. insert into sound map
300     this->sound_map.insert(std::pair<std::string, sf::Sound*>(sound_key, sound_ptr));
301
302     std::cout << "Sound " << sound_key << " inserted into sound map" << std::endl;
303
304     return;
305 } /* loadSound() */
```

4.1.3.11 loadTexture()

```
void AssetsManager::loadTexture (
    std::string path_2_texture,
    std::string texture_key )
```

Method to load a texture and insert it into the texture map.

Parameters

<i>path_2_texture</i>	A path (either relative or absolute) to the texture file.
<i>texture_key</i>	A key associated with the texture (for indexing into the texture map).

```
228 {
229     // 1. check key, throw error if already in use
230     if (this->texture_map.count(texture_key) > 0) {
231         std::string error_str = "ERROR AssetsManager::loadTexture() texture key ";
232         error_str += texture_key;
233         error_str += " is already in use";
234
235         this->clear();
236
237         #ifdef _WIN32
238             std::cout << error_str << std::endl;
239         #endif /* _WIN32 */
240
241         throw std::runtime_error(error_str);
242     }
243
244     // 2. load from file, throw error on fail
245     sf::Texture* texture_ptr = new sf::Texture();
246
247     if (not texture_ptr->loadFromFile(path_2_texture)) {
248         std::string error_str = "ERROR AssetsManager::loadTexture() could not load ";
249         error_str += "texture at ";
250         error_str += path_2_texture;
251
252         this->clear();
253
254         #ifdef _WIN32
255             std::cout << error_str << std::endl;
256         #endif
```

```

257         #endif /* _WIN32 */
258
259         throw std::runtime_error(error_str);
260     }
261
262
263     // 3. insert into texture map
264     this->texture_map.insert(
265         std::pair<std::string, sf::Texture*>(texture_key, texture_ptr)
266     );
267
268     std::cout << "Texture " << texture_key << " inserted into texture map" << std::endl;
269
270     return;
271 } /* loadTexture() */

```

4.1.3.12 loadTrack()

```

void AssetsManager::loadTrack (
    std::string path_2_track,
    std::string track_key )

```

Method to load a track (sf::Music) and insert it into the track map.

Parameters

<i>path_2_track</i>	A path (either relative or absolute) to the track file.
<i>track_key</i>	A key associated with the track (for indexing into the track map).

```

324 {
325     // 1. check key, throw error if already in use
326     if (this->track_map.count(track_key) > 0) {
327         std::string error_str = "ERROR AssetsManager::loadTrack() track key ";
328         error_str += track_key;
329         error_str += " is already in use";
330
331         this->clear();
332
333         #ifdef _WIN32
334             std::cout << error_str << std::endl;
335         #endif /* _WIN32 */
336
337         throw std::runtime_error(error_str);
338     }
339
340     // 2. open from file, throw error on fail
341     sf::Music* track_ptr = new sf::Music();
342
343     if (not track_ptr->openFromFile(path_2_track)) {
344         std::string error_str = "ERROR AssetsManager::loadTrack() could not open ";
345         error_str += "track at ";
346         error_str += path_2_track;
347
348         this->clear();
349
350         #ifdef _WIN32
351             std::cout << error_str << std::endl;
352         #endif /* _WIN32 */
353
354         throw std::runtime_error(error_str);
355     }
356
357     // 3. insert into track map
358     this->track_map.insert(std::pair<std::string, sf::Music*>(track_key, track_ptr));
359     this->current_track = this->track_map.begin();
360
361     std::cout << "Track " << track_key << " inserted into track map" << std::endl;
362
363     return;
364 } /* loadTrack() */

```

4.1.3.13 nextTrack()

```
void AssetsManager::nextTrack (
    void )
```

Method to advance to the next track. Wraps around if the end of the track map is reached.

```
583 {
584     // 1. stop current track
585     this->stopTrack();
586
587     // 2. increment current track
588     this->current_track++;
589
590     // 3. handle wrap around
591     if (this->current_track == this->track_map.end()) {
592         this->current_track = this->track_map.begin();
593     }
594
595     return;
596 } /* nextTrack() */
```

4.1.3.14 pauseTrack()

```
void AssetsManager::pauseTrack (
    void )
```

Method to pause the current track.

```
544 {
545     this->current_track->second->pause();
546
547     return;
548 } /* pauseTrack() */
```

4.1.3.15 playTrack()

```
void AssetsManager::playTrack (
    void )
```

Method to play the current track.

```
525 {
526     this->current_track->second->play();
527
528     return;
529 } /* playTrack() */
```

4.1.3.16 previousTrack()

```
void AssetsManager::previousTrack (
    void )
```

Method to return to the previous track. Wraps around if the beginning of the track map is reached.

```
612 {
613     // 1. stop current track
614     this->stopTrack();
615
616     // 2. handle wrap around
617     if (this->current_track == this->track_map.begin()) {
618         this->current_track = this->track_map.end();
619     }
620
621     // 3. decrement current track
622     this->current_track--;
623
624     return;
625 } /* previousTrack() */
```

4.1.3.17 stopTrack()

```
void AssetsManager::stopTrack (
    void )
```

Method to stop the current track.

```
563 {
564     this->current_track->second->stop();
565
566     return;
567 } /* stopTrack() */
```

4.1.4 Member Data Documentation

4.1.4.1 current_track

```
std::map<std::string, sf::Music*>::iterator AssetsManager::current_track
```

A map iterator which corresponds to the current track (i.e., the track currently being played).

4.1.4.2 font_map

```
std::map<std::string, sf::Font*> AssetsManager::font_map
```

A map of pointers to loaded fonts.

4.1.4.3 sound_map

```
std::map<std::string, sf::Sound*> AssetsManager::sound_map
```

A map of pointers to loaded sounds.

4.1.4.4 soundbuffer_map

```
std::map<std::string, sf::SoundBuffer*> AssetsManager::soundbuffer_map
```

A map of pointers to sound buffers.

4.1.4.5 texture_map

```
std::map<std::string, sf::Texture*> AssetsManager::texture_map
```

A map of pointers to loaded textures.

4.1.4.6 track_map

```
std::map<std::string, sf::Music*> AssetsManager::track_map
```

A map of pointers to opened tracks (i.e. sf::Music).

The documentation for this class was generated from the following files:

- header/ESC_core/[AssetsManager.h](#)
- source/ESC_core/[AssetsManager.cpp](#)

4.2 ContextMenu Class Reference

A class which defines a context menu for the game.

```
#include <ContextMenu.h>
```

Collaboration diagram for ContextMenu:



Public Member Functions

- [ContextMenu](#) (sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [ContextMenu](#) class.
- void [processEvent](#) (void)
Method to processEvent [ContextMenu](#). To be called once per event.
- void [processMessage](#) (void)
Method to processMessage [ContextMenu](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- [~ContextMenu](#) (void)
Destructor for the [ContextMenu](#) class.

Public Attributes

- [ConsoleState console_state](#)
The current state of the console screen.
- bool [console_string_changed](#)
Boolean which indicates if console string just changed.
- bool [game_menu_up](#)
Indicates whether or not the game menu is up.
- size_t [console_substring_idx](#)
The current final index of the console string draw.
- unsigned long long int [frame](#)
The current frame of this object.
- double [position_x](#)
The position of the object.
- double [position_y](#)
The position of the object.
- std::string [console_string](#)
The string to be printed to the console screen.
- sf::RectangleShape [menu_frame](#)
The frame of the context menu.
- sf::RectangleShape [visual_screen](#)
The context menu screen for visuals.
- sf::ConvexShape [visual_screen_frame_top](#)
The top framing of the visual screen.
- sf::ConvexShape [visual_screen_frame_left](#)
The left framing of the visual screen.
- sf::ConvexShape [visual_screen_frame_bottom](#)
The bottom framing of the visual screen.
- sf::ConvexShape [visual_screen_frame_right](#)
The right framing of the visual screen.
- sf::RectangleShape [console_screen](#)
The context menu console screen (for animated text output).
- sf::ConvexShape [console_screen_frame_top](#)
The top framing of the console screen.
- sf::ConvexShape [console_screen_frame_left](#)
The left framing of the console screen.
- sf::ConvexShape [console_screen_frame_bottom](#)
The bottom framing of the console screen.
- sf::ConvexShape [console_screen_frame_right](#)
The right framing of the console screen.

Private Member Functions

- void [__setUpMenuFrame](#) (void)
Helper method to set up context menu frame (drawable).
- void [__setUpVisualScreen](#) (void)
Helper method to set up context menu visual screen (drawable).
- void [__setUpVisualScreenFrame](#) (void)
Helper method to set up framing for context menu visual screen (drawable).
- void [__drawVisualScreenFrame](#) (void)

- Helper method to draw visual screen frame.*
- void [__setUpConsoleScreen](#) (void)
- Helper method to set up context menu console screen (drawable).*
- void [__setUpConsoleScreenFrame](#) (void)
- Helper method to set up framing for context menu console screen (drawable).*
- void [__drawConsoleScreenFrame](#) (void)
- Helper method to draw console screen frame.*
- void [__setConsoleState](#) (ConsoleState)
- Helper method to set state of console screen and update string if necessary.*
- void [__setConsoleString](#) (void)
- Helper method to set console string depending on console state.*
- void [__drawConsoleText](#) (void)
- Helper method to draw animated text to context menu console screen.*
- void [__handleKeyPressEvents](#) (void)
- Helper method to handle key press events.*
- void [__handleMouseButtonEvents](#) (void)
- Helper method to handle mouse button events.*
- void [__sendQuitGameMessage](#) (void)
- Helper method to format and send a quit game message.*
- void [__sendRestartGameMessage](#) (void)
- Helper method to format and send a restart game message.*

Private Attributes

- sf::Event * [event_ptr](#)
- A pointer to the event class.*
- sf::RenderWindow * [render_window_ptr](#)
- A pointer to the render window.*
- [AssetsManager](#) * [assets_manager_ptr](#)
- A pointer to the assets manager.*
- [MessageHub](#) * [message_hub_ptr](#)
- A pointer to the message hub.*

4.2.1 Detailed Description

A class which defines a context menu for the game.

4.2.2 Constructor & Destructor Documentation

4.2.2.1 ContextMenu()

```
ContextMenu::ContextMenu (
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [ContextMenu](#) class.

Parameters

<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```

849 {
850     // 1. set attributes
851
852     // 1.1. private
853     this->event_ptr = event_ptr;
854     this->render_window_ptr = render_window_ptr;
855
856     this->assets_manager_ptr = assets_manager_ptr;
857     this->message_hub_ptr = message_hub_ptr;
858
859     // 1.2. public
860     this->console_state = ConsoleState :: NONE_STATE;
861     this->__setConsoleState(ConsoleState :: READY);
862
863     this->console_string_changed = true;
864     this->game_menu_up = false;
865
866     this->frame = 0;
867
868     this->position_x = GAME_WIDTH;
869     this->position_y = 0;
870
871     // 2. set up and position drawable attributes
872     this->__setUpMenuFrame();
873     this->__setUpVisualScreen();
874     this->__setUpVisualScreenFrame();
875     this->__setUpConsoleScreen();
876     this->__setUpConsoleScreenFrame();
877
878     std::cout << "ContextMenu constructed at " << this << std::endl;
879
880     return;
881 } /* ContextMenu() */

```

4.2.2.2 ~ContextMenu()

```

ContextMenu::~ContextMenu (
    void )

```

Destructor for the [ContextMenu](#) class.

```

1031 {
1032     std::cout << "ContextMenu at " << this << " destroyed" << std::endl;
1033
1034     return;
1035 } /* ~ContextMenu() */

```

4.2.3 Member Function Documentation

4.2.3.1 __drawConsoleScreenFrame()

```

void ContextMenu::__drawConsoleScreenFrame (
    void ) [private]

```

Helper method to draw console screen frame.

```

467 {
468     this->render_window_ptr->draw(this->console_screen_frame_top);
469     this->render_window_ptr->draw(this->console_screen_frame_left);
470     this->render_window_ptr->draw(this->console_screen_frame_bottom);
471     this->render_window_ptr->draw(this->console_screen_frame_right);
472
473     return;
474 } /* __drawContextScreenFrame() */

```

4.2.3.2 __drawConsoleText()

```

void ContextMenu::__drawConsoleText (
    void ) [private]

```

Helper method to draw animated text to context menu console screen.

```

590 {
591     // 1. set up console text (drawable)
592     sf::Text console_text;
593
594     if (this->console_string_changed) {
595         this->assets_manager_ptr->getSound("console string print")->play();
596
597         console_text.setString(this->console_string.substr(0, this->console_substring_idx));
598
599         this->console_substring_idx++;
600
601         while (
602             (this->console_string.substr(0, this->console_substring_idx).back() == ' ') or
603             (this->console_string.substr(0, this->console_substring_idx).back() == '\n')
604         ) {
605             this->console_substring_idx++;
606
607             if (this->console_substring_idx >= this->console_string.size()) {
608                 break;
609             }
610         }
611
612         if (this->console_substring_idx >= this->console_string.size()) {
613             this->console_string_changed = false;
614         }
615     }
616
617     else {
618         console_text.setString(this->console_string);
619     }
620
621     console_text.setFont(*(this->assets_manager_ptr->getFont("Glass_TTY_VT220")));
622     console_text.setCharacterSize(16);
623     console_text.setFillColor(MONOCROME_TEXT_GREEN);
624
625     console_text.setPosition(
626         this->position_x - 50 - 300 + 16,
627         this->position_y + GAME_HEIGHT - 50 - 340 + 16
628     );
629
630
631     // 2. draw console text
632     this->render_window_ptr->draw(console_text);
633
634
635     // 3. assemble and draw blinking console cursor
636     if ((this->frame % FRAMES_PER_SECOND) > FRAMES_PER_SECOND / 2) {
637         sf::RectangleShape console_cursor(sf::Vector2f(10, 16));
638
639         console_cursor.setFillColor(MONOCROME_TEXT_GREEN);
640
641         console_cursor.setPosition(
642             console_text.getPosition().x,
643             console_text.getPosition().y + console_text.getLocalBounds().height + 10
644         );
645
646         this->render_window_ptr->draw(console_cursor);
647     }
648
649     // 4. updating frame count if console is in menu state
650     if (this->console_state == ConsoleState::MENU) {
651         std::string frame_count_string = "FRAME: ";
652         frame_count_string += std::to_string(this->frame);

```

```

653
654     sf::Text frame_count_text(
655         frame_count_string,
656         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
657         16
658     );
659
660     frame_count_text.setFillColor(MONOCHROME_TEXT_GREEN);
661
662     frame_count_text.setPosition(
663         console_text.getPosition().x,
664         console_text.getPosition().y + console_text.getLocalBounds().height - 10
665     );
666
667     this->render_window_ptr->draw(frame_count_text);
668 }
669
670 return;
671 } /* __drawConsoleText() */

```

4.2.3.3 __drawVisualScreenFrame()

```

void ContextMenu::__drawVisualScreenFrame (
    void ) [private]

```

Helper method to draw visual screen frame.

```

242 {
243     this->render_window_ptr->draw(this->visual_screen_frame_top);
244     this->render_window_ptr->draw(this->visual_screen_frame_left);
245     this->render_window_ptr->draw(this->visual_screen_frame_bottom);
246     this->render_window_ptr->draw(this->visual_screen_frame_right);
247
248     return;
249 } /* __drawVisualScreenFrame() */

```

4.2.3.4 __handleKeyPressEvents()

```

void ContextMenu::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

686 {
687     switch (this->event_ptr->key.code) {
688         case (sf::Keyboard::Escape): {
689             if (this->console_state == ConsoleState :: MENU) {
690                 this->__setConsoleState(ConsoleState :: READY);
691             }
692
693             else {
694                 this->__setConsoleState(ConsoleState :: MENU);
695             }
696
697             break;
698         }
699
700         case (sf::Keyboard::Q): {
701             if (this->console_state == ConsoleState :: MENU) {
702                 this->__sendQuitGameMessage();
703             }
704         }
705
706         case (sf::Keyboard::R): {
707             if (this->console_state == ConsoleState :: MENU) {
708                 this->__sendRestartGameMessage();
709             }
710         }
711     }
712 }
713

```

```

714
715         default: {
716             // do nothing!
717
718             break;
719         }
720     }
721
722     return;
723 } /* __handleKeyPressEvents() */

```

4.2.3.5 __handleMouseButtonEvents()

```

void ContextMenu::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

738 {
739     switch (this->event_ptr->mouseButton.button) {
740         case (sf::Mouse::Left): {
741             //...
742
743             break;
744         }
745
746         case (sf::Mouse::Right): {
747             //...
748
749             break;
750         }
751     }
752
753     default: {
754         // do nothing!
755
756         break;
757     }
758 }
759
760
761     return;
762 } /* __handleMouseButtonEvents() */

```

4.2.3.6 __sendQuitGameMessage()

```

void ContextMenu::__sendQuitGameMessage (
    void ) [private]

```

Helper method to format and send a quit game message.

```

777 {
778     Message quit_game_message;
779
780     quit_game_message.channel = GAME_CHANNEL;
781     quit_game_message.subject = "quit game";
782
783     this->message_hub_ptr->sendMessage(quit_game_message);
784
785     std::cout << "Quit game message sent by " << this << std::endl;
786     return;
787 } /* __sendQuitGameMessage() */

```

4.2.3.7 __sendRestartGameMessage()

```
void ContextMenu::__sendRestartGameMessage (
    void ) [private]
```

Helper method to format and send a restart game message.

```
802 {
803     Message restart_game_message;
804
805     restart_game_message.channel = GAME_CHANNEL;
806     restart_game_message.subject = "restart game";
807
808     this->message_hub_ptr->sendMessage(restart_game_message);
809
810     std::cout << "Restart game message sent by " << this << std::endl;
811     return;
812 } /* __sendRestartGameMessage() */
```

4.2.3.8 __setConsoleState()

```
void ContextMenu::__setConsoleState (
    ConsoleState console_state ) [private]
```

Helper method to set state of console screen and update string if necessary.

Parameters

<i>console_state</i>	The state (ConsoleState) to set the console to.
----------------------	---

```
491 {
492     // 1. if no change, do nothing
493     if (this->console_state == console_state) {
494         return;
495     }
496
497     // 2. update console state, set console string accordingly
498     this->console_state = console_state;
499     this->__setConsoleString();
500
501     return;
502 } /* __setConsoleState() */
```

4.2.3.9 __setConsoleString()

```
void ContextMenu::__setConsoleString (
    void ) [private]
```

Helper method to set console string depending on console state.

```
517 {
518     this->console_string_changed = true;
519     this->console_substring_idx = 0;
520
521     this->console_string.clear();
522
523     switch (this->console_state) {
524     case (ConsoleState :: MENU): {
525         // 32 char x 17 line console "-----\n";
526         this->console_string = "          **** MENU ****\n";
527         this->console_string += "          \n";
528         this->console_string += "[ENTER]:  END TURN\n";
529         this->console_string += "          \n";
530         this->console_string += "[R]:   RESTART\n";
531     }
```



```

531         this->console_string += "\n";
532         this->console_string += "[TAB]: TOGGLE RESOURCE OVERLAY\n";
533         this->console_string += "[T]: TOGGLE TUTORIAL\n";
534         this->console_string += "\n";
535         this->console_string += "\n";
536         this->console_string += "\n";
537         this->console_string += "\n";
538         this->console_string += "\n";
539         this->console_string += "[Q]: QUIT\n";
540         this->console_string += "[ESC]: CLOSE MENU\n";
541         this->console_string += "\n";
542
543         break;
544     }
545
546     case (ConsoleState :: TILE): {
547         // take console string from tile state message
548
549         break;
550     }
551
552     default: {
553         // 32 char x 17 line console "-----\n";
554         this->console_string = " **** RTZ 64 CONTEXT V12 **** \n";
555         this->console_string += "\n";
556         this->console_string += "64K RAM SYSTEM 38911 BYTES FREE\n";
557         this->console_string += "\n";
558         this->console_string += "[TAB]: TOGGLE RESOURCE OVERLAY\n";
559         this->console_string += "\n";
560         this->console_string += "[ESC]: MENU\n";
561         this->console_string += "[LEFT CLICK]: TILE INFO/OPTIONS\n";
562         this->console_string += "[RIGHT CLICK]: CLEAR SELECTION\n";
563         this->console_string += "\n";
564         this->console_string += "[ENTER]: END TURN\n";
565         this->console_string += "\n";
566         this->console_string += "READY.\n";
567
568         break;
569     }
570
571     }
572 }
573
574 return;
575 } /* __setConsoleString() */

```

4.2.3.10 __setUpConsoleScreen()

```

void ContextMenu::__setUpConsoleScreen (
    void ) [private]

```

Helper method to set up context menu console screen (drawable).

```

264 {
265     this->console_screen.setSize(sf::Vector2f(300, 340));
266     this->console_screen.setOrigin(300, 340);
267     this->console_screen.setPosition(
268         this->position_x - 50,
269         this->position_y + GAME_HEIGHT - 50
270     );
271     this->console_screen.setFillColor(MONOCHROME_SCREEN_BACKGROUND);
272
273     return;
274 } /* __setUpConsoleScreen() */

```

4.2.3.11 __setUpConsoleScreenFrame()

```

void ContextMenu::__setUpConsoleScreenFrame (
    void ) [private]

```

Helper method to set up framing for context menu console screen (drawable).

```

289 {
290     int n_points = 4;
291
292     // 1. top framing
293     this->console_screen_frame_top.setPointCount(n_points);
294
295     this->console_screen_frame_top.setPoint(
296         0,
297         sf::Vector2f(
298             this->position_x - 50,
299             this->position_y + GAME_HEIGHT - 50 - 340
300         )
301     );
302     this->console_screen_frame_top.setPoint(
303         1,
304         sf::Vector2f(
305             this->position_x - 50 + 16,
306             this->position_y + GAME_HEIGHT - 50 - 340 - 16
307         )
308     );
309     this->console_screen_frame_top.setPoint(
310         2,
311         sf::Vector2f(
312             this->position_x - 350 - 16,
313             this->position_y + GAME_HEIGHT - 50 - 340 - 16
314         )
315     );
316     this->console_screen_frame_top.setPoint(
317         3,
318         sf::Vector2f(
319             this->position_x - 350,
320             this->position_y + GAME_HEIGHT - 50 - 340
321         )
322     );
323
324     this->console_screen_frame_top.setFillColors(VISUAL_SCREEN_FRAME_GREY);
325
326     this->console_screen_frame_top.setOutlineThickness(2);
327     this->console_screen_frame_top.setOutlineColor(sf::Color(0, 0, 0, 255));
328
329     this->console_screen_frame_top.move(0, -2);
330
331
332     // 2. left framing
333     this->console_screen_frame_left.setPointCount(n_points);
334
335     this->console_screen_frame_left.setPoint(
336         0,
337         sf::Vector2f(
338             this->position_x - 350,
339             this->position_y + GAME_HEIGHT - 50 - 340
340         )
341     );
342     this->console_screen_frame_left.setPoint(
343         1,
344         sf::Vector2f(
345             this->position_x - 350 - 16,
346             this->position_y + GAME_HEIGHT - 50 - 340 - 16
347         )
348     );
349     this->console_screen_frame_left.setPoint(
350         2,
351         sf::Vector2f(
352             this->position_x - 350 - 16,
353             this->position_y + GAME_HEIGHT - 50 + 16
354         )
355     );
356     this->console_screen_frame_left.setPoint(
357         3,
358         sf::Vector2f(
359             this->position_x - 350,
360             this->position_y + GAME_HEIGHT - 50
361         )
362     );
363
364     this->console_screen_frame_left.setFillColors(VISUAL_SCREEN_FRAME_GREY);
365
366     this->console_screen_frame_left.setOutlineThickness(2);
367     this->console_screen_frame_left.setOutlineColor(sf::Color(0, 0, 0, 255));
368
369     this->console_screen_frame_left.move(-2, 0);
370
371
372     // 3. bottom framing
373     this->console_screen_frame_bottom.setPointCount(n_points);
374

```

```

375     this->console_screen_frame_bottom.setPoint(
376         0,
377         sf::Vector2f(
378             this->position_x - 350,
379             this->position_y + GAME_HEIGHT - 50
380         )
381     );
382     this->console_screen_frame_bottom.setPoint(
383         1,
384         sf::Vector2f(
385             this->position_x - 350 - 16,
386             this->position_y + GAME_HEIGHT - 50 + 16
387         )
388     );
389     this->console_screen_frame_bottom.setPoint(
390         2,
391         sf::Vector2f(
392             this->position_x - 50 + 16,
393             this->position_y + GAME_HEIGHT - 50 + 16
394         )
395     );
396     this->console_screen_frame_bottom.setPoint(
397         3,
398         sf::Vector2f(
399             this->position_x - 50,
400             this->position_y + GAME_HEIGHT - 50
401         )
402     );
403
404     this->console_screen_frame_bottom.setFillColor(VISUAL_SCREEN_FRAME_GREY);
405
406     this->console_screen_frame_bottom.setOutlineThickness(2);
407     this->console_screen_frame_bottom.setOutlineColor(sf::Color(0, 0, 0, 255));
408
409     this->console_screen_frame_bottom.move(0, 2);
410
411     // 4. right framing
412     this->console_screen_frame_right.setPointCount(n_points);
413
414     this->console_screen_frame_right.setPoint(
415         0,
416         sf::Vector2f(
417             this->position_x - 50,
418             this->position_y + GAME_HEIGHT - 50
419         )
420     );
421
422     this->console_screen_frame_right.setPoint(
423         1,
424         sf::Vector2f(
425             this->position_x - 50 + 16,
426             this->position_y + GAME_HEIGHT - 50 + 16
427         )
428     );
429     this->console_screen_frame_right.setPoint(
430         2,
431         sf::Vector2f(
432             this->position_x - 50 + 16,
433             this->position_y + GAME_HEIGHT - 50 - 340 - 16
434         )
435     );
436     this->console_screen_frame_right.setPoint(
437         3,
438         sf::Vector2f(
439             this->position_x - 50,
440             this->position_y + GAME_HEIGHT - 50 - 340
441         )
442     );
443
444     this->console_screen_frame_right.setFillColor(VISUAL_SCREEN_FRAME_GREY);
445
446     this->console_screen_frame_right.setOutlineThickness(2);
447     this->console_screen_frame_right.setOutlineColor(sf::Color(0, 0, 0, 255));
448
449     this->console_screen_frame_right.move(2, 0);
450
451     return;
452 } /* __setUpConsoleScreenFrame() */

```

4.2.3.12 __setUpMenuFrame()

```
void ContextMenu::__setUpMenuFrame (
```

```
void ) [private]
```

Helper method to set up context menu frame (drawable).

```
68 {
69     this->menu_frame.setSize(sf::Vector2f(400, GAME_HEIGHT));
70     this->menu_frame.setOrigin(400, 0);
71     this->menu_frame.setPosition(this->position_x, this->position_y);
72     this->menu_frame.setFillColor(MENU_FRAME_GREY);
73
74     return;
75 } /* __setUpMenuFrame() */
```

4.2.3.13 __setUpVisualScreen()

```
void ContextMenu::__setUpVisualScreen (
    void ) [private]
```

Helper method to set up context menu visual screen (drawable).

```
90 {
91     this->visual_screen.setSize(sf::Vector2f(300, 300));
92     this->visual_screen.setOrigin(300, 0);
93     this->visual_screen.setPosition(this->position_x - 50, this->position_y + 50);
94     this->visual_screen.setFillColor(MONochrome_SCREEN_BACKGROUND);
95
96     return;
97 } /* __setUpVisualScreen() */
```

4.2.3.14 __setUpVisualScreenFrame()

```
void ContextMenu::__setUpVisualScreenFrame (
    void ) [private]
```

Helper method to set up framing for context menu visual screen (drawable).

```
112 {
113     int n_points = 4;
114
115     // 1. top framing
116     this->visual_screen_frame_top.setPointCount(n_points);
117
118     this->visual_screen_frame_top.setPoint(
119         0,
120         sf::Vector2f(this->position_x - 50, this->position_y + 50)
121     );
122     this->visual_screen_frame_top.setPoint(
123         1,
124         sf::Vector2f(this->position_x - 50 + 16, this->position_y + 50 - 16)
125     );
126     this->visual_screen_frame_top.setPoint(
127         2,
128         sf::Vector2f(this->position_x - 350 - 16, this->position_y + 50 - 16)
129     );
130     this->visual_screen_frame_top.setPoint(
131         3,
132         sf::Vector2f(this->position_x - 350, this->position_y + 50)
133     );
134
135     this->visual_screen_frame_top.setFillColor(VISUAL_SCREEN_FRAME_GREY);
136
137     this->visual_screen_frame_top.setOutlineThickness(2);
138     this->visual_screen_frame_top.setOutlineColor(sf::Color(0, 0, 0, 255));
139
140     this->visual_screen_frame_top.move(0, -2);
141
142
143     // 2. left framing
144     this->visual_screen_frame_left.setPointCount(n_points);
145
146     this->visual_screen_frame_left.setPoint(
```

```

147         0,
148         sf::Vector2f(this->position_x - 350, this->position_y + 50)
149     );
150     this->visual_screen_frame_left.setPoint(
151         1,
152         sf::Vector2f(this->position_x - 350 - 16, this->position_y + 50 - 16)
153     );
154     this->visual_screen_frame_left.setPoint(
155         2,
156         sf::Vector2f(this->position_x - 350 - 16, this->position_y + 350 + 16)
157     );
158     this->visual_screen_frame_left.setPoint(
159         3,
160         sf::Vector2f(this->position_x - 350, this->position_y + 350)
161     );
162
163     this->visual_screen_frame_left.setFillColor(VISUAL_SCREEN_FRAME_GREY);
164
165     this->visual_screen_frame_left.setOutlineThickness(2);
166     this->visual_screen_frame_left.setOutlineColor(sf::Color(0, 0, 0, 255));
167
168     this->visual_screen_frame_left.move(-2, 0);
169
170
171     // 3. bottom framing
172     this->visual_screen_frame_bottom.setPointCount(n_points);
173
174     this->visual_screen_frame_bottom.setPoint(
175         0,
176         sf::Vector2f(this->position_x - 350, this->position_y + 350)
177     );
178     this->visual_screen_frame_bottom.setPoint(
179         1,
180         sf::Vector2f(this->position_x - 350 - 16, this->position_y + 350 + 16)
181     );
182     this->visual_screen_frame_bottom.setPoint(
183         2,
184         sf::Vector2f(this->position_x - 50 + 16, this->position_y + 350 + 16)
185     );
186     this->visual_screen_frame_bottom.setPoint(
187         3,
188         sf::Vector2f(this->position_x - 50, this->position_y + 350)
189     );
190
191     this->visual_screen_frame_bottom.setFillColor(VISUAL_SCREEN_FRAME_GREY);
192
193     this->visual_screen_frame_bottom.setOutlineThickness(2);
194     this->visual_screen_frame_bottom.setOutlineColor(sf::Color(0, 0, 0, 255));
195
196     this->visual_screen_frame_bottom.move(0, 2);
197
198
199     // 4. right framing
200     this->visual_screen_frame_right.setPointCount(n_points);
201
202     this->visual_screen_frame_right.setPoint(
203         0,
204         sf::Vector2f(this->position_x - 50, this->position_y + 350)
205     );
206     this->visual_screen_frame_right.setPoint(
207         1,
208         sf::Vector2f(this->position_x - 50 + 16, this->position_y + 350 + 16)
209     );
210     this->visual_screen_frame_right.setPoint(
211         2,
212         sf::Vector2f(this->position_x - 50 + 16, this->position_y + 50 - 16)
213     );
214     this->visual_screen_frame_right.setPoint(
215         3,
216         sf::Vector2f(this->position_x - 50, this->position_y + 50)
217     );
218
219     this->visual_screen_frame_right.setFillColor(VISUAL_SCREEN_FRAME_GREY);
220
221     this->visual_screen_frame_right.setOutlineThickness(2);
222     this->visual_screen_frame_right.setOutlineColor(sf::Color(0, 0, 0, 255));
223
224     this->visual_screen_frame_right.move(2, 0);
225
226     return;
227 } /* __setUpVisualScreenFrame() */

```

4.2.3.15 draw()

```
void ContextMenu::draw (
    void )
```

Method to draw the hex tile to the render window. To be called once per frame.

```
1001 {
1002     // 1. menu frame
1003     this->render_window_ptr->draw(this->menu_frame);
1004
1005     // 2. visual screen
1006     this->render_window_ptr->draw(this->visual_screen);
1007     this->__drawVisualScreenFrame();
1008
1009     // 3. console screen
1010     this->render_window_ptr->draw(this->console_screen);
1011     this->__drawConsoleScreenFrame();
1012     this->__drawConsoleText();
1013
1014     this->frame++;
1015     return;
1016 } /* draw() */
```

4.2.3.16 processEvent()

```
void ContextMenu::processEvent (
    void )
```

Method to processEvent [ContextMenu](#). To be called once per event.

```
896 {
897     if (this->event_ptr->type == sf::Event::KeyPressed) {
898         this->__handleKeyPressEvents();
899     }
900
901     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
902         this->__handleMouseButtonEvents();
903     }
904
905     return;
906 } /* processEvent() */
```

4.2.3.17 processMessage()

```
void ContextMenu::processMessage (
    void )
```

Method to processMessage [ContextMenu](#). To be called once per message.

```
921 {
922     switch (this->console_state) {
923         case (ConsoleState :: TILE): {
924             // process no tile selected
925             if (not this->message_hub_ptr->isEmpty(NO_TILE_SELECTED_CHANNEL)) {
926                 Message no_tile_selected_message = this->message_hub_ptr->receiveMessage(
927                     NO_TILE_SELECTED_CHANNEL
928                 );
929
930                 if (no_tile_selected_message.subject == "no tile selected") {
931                     this->__setConsoleState(ConsoleState :: READY);
932
933                     std::cout << "No tile selected message received by " << this <<
934                         std::endl;
935                     this->message_hub_ptr->popMessage(NO_TILE_SELECTED_CHANNEL);
936                 }
937             }
938
939             // process tile state
```

```

940         if (not this->message_hub_ptr->isEmpty(TILE_STATE_CHANNEL)) {
941             Message tile_state_message = this->message_hub_ptr->receiveMessage(
942                 TILE_STATE_CHANNEL
943             );
944
945             if (tile_state_message.subject == "tile state") {
946                 this->console_string = tile_state_message.string_payload["console string"];
947
948                 this->console_string_changed = true;
949                 this->console_substring_idx = 0;
950
951                 std::cout << "Tile state message received by " << this << std::endl;
952                 this->message_hub_ptr->popMessage(TILE_STATE_CHANNEL);
953             }
954         }
955
956         // process tile selected (subsequent left clicks causing program to hang)
957         if (not this->message_hub_ptr->isEmpty(TILE_SELECTED_CHANNEL)) {
958             this->message_hub_ptr->popMessage(TILE_SELECTED_CHANNEL);
959         }
960
961         break;
962     }
963
964     default: {
965         // process tile selected
966         if (not this->message_hub_ptr->isEmpty(TILE_SELECTED_CHANNEL)) {
967             Message tile_selected_message = this->message_hub_ptr->receiveMessage(
968                 TILE_SELECTED_CHANNEL
969             );
970
971             if (tile_selected_message.subject == "tile selected") {
972                 this->__setConsoleState(ConsoleState :: TILE);
973
974                 std::cout << "Tile selected message received by " << this <<
975                     std::endl;
976                 this->message_hub_ptr->popMessage(TILE_SELECTED_CHANNEL);
977             }
978         }
979
980         break;
981     }
982 }
983
984 return;
985 } /* processMessage() */

```

4.2.4 Member Data Documentation

4.2.4.1 assets_manager_ptr

`AssetsManager*` ContextMenu::assets_manager_ptr [private]

A pointer to the assets manager.

4.2.4.2 console_screen

`sf::RectangleShape` ContextMenu::console_screen

The context menu console screen (for animated text output).

4.2.4.3 console_screen_frame_bottom

```
sf::ConvexShape ContextMenu::console_screen_frame_bottom
```

The bottom framing of the console screen.

4.2.4.4 console_screen_frame_left

```
sf::ConvexShape ContextMenu::console_screen_frame_left
```

The left framing of the console screen.

4.2.4.5 console_screen_frame_right

```
sf::ConvexShape ContextMenu::console_screen_frame_right
```

The right framing of the console screen.

4.2.4.6 console_screen_frame_top

```
sf::ConvexShape ContextMenu::console_screen_frame_top
```

The top framing of the console screen.

4.2.4.7 console_state

```
ConsoleState ContextMenu::console_state
```

The current state of the console screen.

4.2.4.8 console_string

```
std::string ContextMenu::console_string
```

The string to be printed to the console screen.

4.2.4.9 console_string_changed

```
bool ContextMenu::console_string_changed
```

Boolean which indicates if console string just changed.

4.2.4.10 console_substring_idx

```
size_t ContextMenu::console_substring_idx
```

The current final index of the console string draw.

4.2.4.11 event_ptr

```
sf::Event* ContextMenu::event_ptr [private]
```

A pointer to the event class.

4.2.4.12 frame

```
unsigned long long int ContextMenu::frame
```

The current frame of this object.

4.2.4.13 game_menu_up

```
bool ContextMenu::game_menu_up
```

Indicates whether or not the game menu is up.

4.2.4.14 menu_frame

```
sf::RectangleShape ContextMenu::menu_frame
```

The frame of the context menu.

4.2.4.15 message_hub_ptr

```
MessageHub* ContextMenu::message_hub_ptr [private]
```

A pointer to the message hub.

4.2.4.16 position_x

```
double ContextMenu::position_x
```

The position of the object.

4.2.4.17 position_y

```
double ContextMenu::position_y
```

The position of the object.

4.2.4.18 render_window_ptr

```
sf::RenderWindow* ContextMenu::render_window_ptr [private]
```

A pointer to the render window.

4.2.4.19 visual_screen

```
sf::RectangleShape ContextMenu::visual_screen
```

The context menu screen for visuals.

4.2.4.20 visual_screen_frame_bottom

```
sf::ConvexShape ContextMenu::visual_screen_frame_bottom
```

The bottom framing of the visual screen.

4.2.4.21 visual_screen_frame_left

```
sf::ConvexShape ContextMenu::visual_screen_frame_left
```

The left framing of the visual screen.

4.2.4.22 visual_screen_frame_right

```
sf::ConvexShape ContextMenu::visual_screen_frame_right
```

The right framing of the visual screen.

4.2.4.23 visual_screen_frame_top

```
sf::ConvexShape ContextMenu::visual_screen_frame_top
```

The top framing of the visual screen.

The documentation for this class was generated from the following files:

- header/[ContextMenu.h](#)
- source/[ContextMenu.cpp](#)

4.3 DieselGenerator Class Reference

A settlement class (child class of [TileImprovement](#)).

```
#include <DieselGenerator.h>
```

Inheritance diagram for DieselGenerator:



Collaboration diagram for DieselGenerator:



Public Member Functions

- [DieselGenerator](#) (double, double, int, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [DieselGenerator](#) class.
- std::string [getTileOptionsSubstring](#) (void)
Helper method to assemble and return tile options substring.
- void [setIsSelected](#) (bool)
Method to set the is selected attribute.
- void [advanceTurn](#) (void)
Method to handle turn advance.
- void [processEvent](#) (void)
Method to process [DieselGenerator](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [DieselGenerator](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual [~DieselGenerator](#) (void)
Destructor for the [DieselGenerator](#) class.

Public Attributes

- int [capacity_kW](#)
The rated production capacity [kW] of the diesel generator.
- int [production_MWh](#)
The current production [MWh] of the diesel generator.
- int [max_production_MWh](#)
The maximum production [MWh] for this turn.
- double [smoke_da](#)
The per frame delta in smoke particle alpha value.

- double [smoke_dx](#)
The per frame delta in smoke particle x position.
- double [smoke_dy](#)
The per frame delta in smoke particle y position.
- double [smoke_prob](#)
The probability of spawning a new smoke prob in any given frame.
- std::list< sf::Sprite > [smoke_sprite_list](#)
A list of smoke sprite (for exhaust animation).
- int [fuel_cost](#)
The fuel costs for this turn.
- int [emissions_tonnes_CO2e](#)
The emissions for this turn.

Private Member Functions

- void [__setUpTileImprovementSpriteAnimated](#) (void)
Helper method to set up tile improvement sprite (static).
- void [__drawProductionMenu](#) (void)
Helper method to draw production menu assets.
- void [__upgrade](#) (void)
Helper method to upgrade the diesel generator.
- void [__computeProductionCosts](#) (void)
Helper method to compute production costs (fuel, O&M, emissions) based on current production level.
- void [__breakdown](#) (void)
Helper method to trigger an equipment breakdown.
- void [__repair](#) (void)
Helper method to repair the diesel generator.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__sendImprovementStateMessage](#) (void)
Helper method to format and sent improvement state message.

Additional Inherited Members

4.3.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

4.3.2 Constructor & Destructor Documentation

4.3.2.1 DieselGenerator()

```
DieselGenerator::DieselGenerator (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [DieselGenerator](#) class.

Ref: [Wikipedia \[2023\]](#)

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>tile_resource</i>	The renewable resource quality of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```
502 :
503 TileImprovement (
504     position_x,
505     position_y,
506     tile_resource,
507     event_ptr,
508     render_window_ptr,
509     assets_manager_ptr,
510     message_hub_ptr
511 )
512 {
513     // 1. set attributes
514
515     // 1.1. private
516     //...
517
518     // 1.2. public
519     this->tile_improvement_type = TileImprovementType :: DIESEL_GENERATOR;
520
521     this->is_running = false;
522
523     this->health = 100;
524
525     this->capacity_kW = 200;
526     this->upgrade_level = 1;
527
528     this->production_MWh = 0;
529     this->max_production_MWh = 144;
530
531     this->smoke_da = 1e-8 * SECONDS_PER_FRAME;
532     this->smoke_dx = 5 * SECONDS_PER_FRAME;
533     this->smoke_dy = -10 * SECONDS_PER_FRAME;
534     this->smoke_prob = 16 * SECONDS_PER_FRAME;
535
536     this->smoke_sprite_list = {};
537
538     this->fuel_cost = 0;
539     this->emissions_tonnes_CO2e = 0;
540
541     this->tile_improvement_string = "DIESEL GEN";
542
543     this->__setUpTileImprovementSpriteAnimated();
544
545     std::cout << "DieselGenerator constructed at " << this << std::endl;
546
547     return;
```

```
548 }    /* DieselGenerator() */
```

4.3.2.2 ~DieselGenerator()

```
DieselGenerator::~~DieselGenerator (
    void ) [virtual]
```

Destructor for the [DieselGenerator](#) class.

```
929 {
930     std::cout << "DieselGenerator at " << this << " destroyed" << std::endl;
931
932     return;
933 }    /* ~DieselGenerator() */
```

4.3.3 Member Function Documentation

4.3.3.1 __breakdown()

```
void DieselGenerator::__breakdown (
    void ) [private]
```

Helper method to trigger an equipment breakdown.

```
264 {
265     TileImprovement :: __breakdown();
266
267     this->production_MWh = 0;
268     this->fuel_cost = 0;
269     this->operation_maintenance_cost = 0;
270     this->emissions_tonnes_CO2e = 0;
271
272     return;
273 }    /* __breakdown() */
```

4.3.3.2 __computeProductionCosts()

```
void DieselGenerator::__computeProductionCosts (
    void ) [private]
```

Helper method to compute production costs (fuel, O&M, emissions) based on current production level.

```
233 {
234     double litres_diesel = this->production_MWh * LITRES_DIESEL_PER_MWH_PRODUCTION;
235
236     double fuel_cost = (litres_diesel * COST_PER_LITRE_DIESEL) / 1000;
237     this->fuel_cost = round(fuel_cost);
238
239     double emissions_tonnes_CO2e = (litres_diesel * KG_CO2E_PER_LITRE_DIESEL) / 1000;
240     this->emissions_tonnes_CO2e = round(emissions_tonnes_CO2e);
241
242     double operation_maintenance_cost =
243         (this->production_MWh * DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
244     this->operation_maintenance_cost = round(operation_maintenance_cost);
245
246     this->__sendTileStateRequest();
247
248     return;
249 }    /* __computeProductionCosts() */
```

4.3.3.3 __drawProductionMenu()

```
void DieselGenerator::__drawProductionMenu (
    void ) [private]
```

Helper method to draw production menu assets.

```
114 {
115     // 1. draw animated sprite (in off state)
116     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
117         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
118         this->tile_improvement_sprite_animated[i].setPosition(400 - 138, 400 + 16);
119
120         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
121         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
122
123         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
124         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
125
126         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
127
128         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
129         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
130         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
131     }
132
133     // 2. draw production text
134     std::string production_string = "[W]: INCREASE PRODUCTION\n";
135     production_string += "[S]: DECREASE PRODUCTION\n";
136     production_string += "\n";
137
138     production_string += "PRODUCTION: ";
139     production_string += std::to_string(this->production_MWh);
140     production_string += " MWh (MAX ";
141     production_string += std::to_string(this->max_production_MWh);
142     production_string += ")\n";
143
144     production_string += "FUEL COST: ";
145     production_string += std::to_string(this->fuel_cost);
146     production_string += " K\n";
147
148     production_string += "O&M COST: ";
149     production_string += std::to_string(this->operation_maintenance_cost);
150     production_string += " K\n";
151
152     production_string += "EMISSIONS: ";
153     production_string += std::to_string(this->emissions_tonnes_CO2e);
154     production_string += " tonnes (CO2e)\n";
155
156     sf::Text production_text(
157         production_string,
158         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
159         16
160     );
161
162     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
163     production_text.setFillColor(MONochrome_TEXT_GREEN);
164
165     production_text.setPosition(400 + 30, 400 - 55);
166
167     this->render_window_ptr->draw(production_text);
168
169     return;
170 } /* __drawProductionMenu() */
```

4.3.3.4 __handleKeyPressEvents()

```
void DieselGenerator::__handleKeyPressEvents (
    void ) [private]
```

Helper method to handle key press events.

```
321 {
322     if (this->just_built) {
323         return;
324     }
325 }
```



```

326
327     switch (this->event_ptr->key.code) {
328         case (sf::Keyboard::U): {
329             this->__upgrade();
330
331             break;
332         }
333
334
335         case (sf::Keyboard::W): {
336             if (this->production_menu_open) {
337                 this->production_MWh++;
338
339                 if (this->production_MWh > this->max_production_MWh) {
340                     this->production_MWh = 0;
341                 }
342
343                 this->__computeProductionCosts();
344                 this->assets_manager_ptr->getSound("interface click")->play();
345             }
346
347             break;
348         }
349
350
351         case (sf::Keyboard::S): {
352             if (this->production_menu_open) {
353                 this->production_MWh--;
354
355                 if (this->production_MWh < 0) {
356                     this->production_MWh = this->max_production_MWh;
357                 }
358
359                 this->__computeProductionCosts();
360                 this->assets_manager_ptr->getSound("interface click")->play();
361             }
362
363             break;
364         }
365
366         default: {
367             // do nothing!
368
369             break;
370         }
371     }
372 }
373
374
375 return;
376 } /* __handleKeyPressEvents() */

```

4.3.3.5 __handleMouseButtonEvents()

```

void DieselGenerator::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

391 {
392     if (this->just_built) {
393         return;
394     }
395
396     switch (this->event_ptr->mouseButton.button) {
397         case (sf::Mouse::Left): {
398             //...
399
400             break;
401         }
402
403
404         case (sf::Mouse::Right): {
405             //...
406
407             break;
408         }
409     }
410

```

```

411         default: {
412             // do nothing!
413
414             break;
415         }
416     }
417
418     return;
419 } /* __handleMouseButtonEvents() */

```

4.3.3.6 __repair()

```

void DieselGenerator::__repair (
    void ) [private], [virtual]

```

Helper method to repair the diesel generator.

Reimplemented from [TileImprovement](#).

```

288 {
289     if (this->credits < DIESEL_GENERATOR_BUILD_COST) {
290         std::cout << "Cannot repair diesel generator: insufficient credits (need "
291             << DIESEL_GENERATOR_BUILD_COST << " K)" << std::endl;
292
293         this->__sendInsufficientCreditsMessage();
294         return;
295     }
296
297     TileImprovement :: __repair();
298
299     this->just_upgraded = true;
300
301     this->__sendCreditsSpentMessage(DIESEL_GENERATOR_BUILD_COST);
302     this->__sendTileStateRequest();
303     this->__sendGameStateRequest();
304
305     return;
306 } /* __repair() */

```

4.3.3.7 __sendImprovementStateMessage()

```

void DieselGenerator::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

434 {
435     Message improvement_state_message;
436
437     improvement_state_message.channel = GAME_CHANNEL;
438     improvement_state_message.subject = "improvement state";
439
440     improvement_state_message.int_payload["dispatch_MWh"] = this->production_MWh;
441     improvement_state_message.int_payload["fuel_cost"] = this->fuel_cost;
442     improvement_state_message.int_payload["operation_maintenance_cost"] =
443         this->operation_maintenance_cost;
444     improvement_state_message.int_payload["emissions_tonnes_CO2e"] =
445         this->emissions_tonnes_CO2e;
446
447     this->message_hub_ptr->sendMessage(improvement_state_message);
448
449     std::cout << "Improvement state message sent by " << this << std::endl;
450
451     return;
452 } /* __sendImprovementStateMessage() */

```

4.3.3.8 __setUpTileImprovementSpriteAnimated()

```
void DieselGenerator::__setUpTileImprovementSpriteAnimated (
    void ) [private]
```

Helper method to set up tile improvement sprite (static).

```
68 {
69     sf::Sprite diesel_generator_sheet (
70         *(this->assets_manager_ptr->getTexture("diesel generator"))
71     );
72
73     int n_elements = diesel_generator_sheet.getLocalBounds().height / 64;
74
75     for (int i = 0; i < n_elements; i++) {
76         this->tile_improvement_sprite_animated.push_back(
77             sf::Sprite(
78                 *(this->assets_manager_ptr->getTexture("diesel generator")),
79                 sf::IntRect(0, i * 64, 64, 64)
80             )
81         );
82
83         this->tile_improvement_sprite_animated.back().setOrigin(
84             this->tile_improvement_sprite_animated.back().getLocalBounds().width / 2,
85             this->tile_improvement_sprite_animated.back().getLocalBounds().height
86         );
87
88         this->tile_improvement_sprite_animated.back().setPosition(
89             this->position_x,
90             this->position_y - 32
91         );
92
93         this->tile_improvement_sprite_animated.back().setColor(
94             sf::Color(255, 255, 255, 0)
95         );
96     }
97
98     return;
99 } /* __setUpTileImprovementSpriteAnimated() */
```

4.3.3.9 __upgrade()

```
void DieselGenerator::__upgrade (
    void ) [private]
```

Helper method to upgrade the diesel generator.

```
185 {
186     if (this->credits < DIESEL_GENERATOR_BUILD_COST) {
187         std::cout << "Cannot upgrade diesel generator: insufficient credits (need "
188             << DIESEL_GENERATOR_BUILD_COST << " K)" << std::endl;
189
190         this->__sendInsufficientCreditsMessage();
191         return;
192     }
193
194     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
195         return;
196     }
197
198     this->is_running = false;
199
200     TileImprovement :: __repair();
201
202     this->capacity_kW += 200;
203     this->upgrade_level++;
204
205     this->production_MWh = 0;
206     this->max_production_MWh += 144;
207
208     this->just_upgraded = true;
209
210     this->assets_manager_ptr->getSound("upgrade")->play();
211
212     this->__sendCreditsSpentMessage(DIESEL_GENERATOR_BUILD_COST);
213     this->__sendTileStateRequest();
214     this->__sendGameStateRequest();
215
216     return;
217 } /* __upgrade() */
```

4.3.3.10 advanceTurn()

```
void DieselGenerator::advanceTurn (
    void ) [virtual]
```

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```
658 {
659     // 1. send improvement state message
660     this->__sendImprovementStateMessage();
661
662     // 2. handle start/stop
663     if ((not this->is_running) and (this->production_MWh > 0)) {
664         this->is_running = true;
665         this->assets_manager_ptr->getSound("diesel start")->play();
666     }
667
668     else if (this->is_running and (this->production_MWh <= 0)) {
669         this->is_running = false;
670         this->tile_improvement_sprite_animated[1].setScale(sf::Vector2f(1, 1));
671     }
672
673     // 3. handle equipment health and breakdowns
674     if (this->is_running) {
675         this->health--;
676
677         if (this->health <= 50) {
678             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
679
680             if ((double)rand() / RAND_MAX <= breakdown_prob) {
681                 this->health = 0;
682             }
683         }
684
685         if (this->health <= 0) {
686             this->__breakdown();
687         }
688     }
689
690     // 4. send tile state request (if selected)
691     if (this->is_selected) {
692         this->__sendTileStateRequest();
693     }
694
695     return;
696 } /* advanceTurn() */
```

4.3.3.11 draw()

```
void DieselGenerator::draw (
    void ) [virtual]
```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```
760 {
761     // 1. if just built, call base method and return
762     if (this->just_built) {
763         TileImprovement :: draw();
764
765         return;
766     }
767
768     // 2. handle upgrade effects
769     if (this->just_upgraded) {
770         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
771             this->tile_improvement_sprite_animated[i].setColor(
772                 sf::Color(
773                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
774                     255,
775                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
776                     255
```

```

777         )
778     );
779
780     this->tile_improvement_sprite_animated[i].setScale(
781         sf::Vector2f(
782             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
783             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
784         )
785     );
786 }
787
788     this->upgrade_frame++;
789 }
790
791 if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
792     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
793         this->tile_improvement_sprite_animated[i].setColor(
794             sf::Color(255,255,255,255)
795         );
796
797         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
798     }
799
800     this->just_upgraded = false;
801     this->upgrade_frame = 0;
802 }
803
804
805 // 3. draw first element of animated sprite
806 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
807
808
809 // 4. draw second element of animated sprite
810 double move_x = 0;
811 double move_y = 0;
812
813 if (this->is_running) {
814     this->tile_improvement_sprite_animated[1].setScale(
815         sf::Vector2f(
816             1 + 0.05 * pow(cos((6 * M_PI * this->frame) / FRAMES_PER_SECOND), 2),
817             1 + 0.05 * pow(cos((6 * M_PI * this->frame) / FRAMES_PER_SECOND), 2)
818         )
819     );
820
821     move_x = 1 * ((double)rand() / RAND_MAX) - 0.5;
822     move_y = 1 * ((double)rand() / RAND_MAX) - 0.5;
823
824     this->tile_improvement_sprite_animated[1].move(move_x, move_y);
825 }
826
827 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
828
829 if (this->is_running) {
830     this->tile_improvement_sprite_animated[1].move(-1 * move_x, -1 * move_y);
831 }
832
833
834 // 5. draw smoke effects
835 if (this->is_running) {
836     if ((double)rand() / RAND_MAX < smoke_prob) {
837         this->smoke_sprite_list.push_back(
838             sf::Sprite(*this->assets_manager_ptr->getTexture("emissions"))
839         );
840
841         this->smoke_sprite_list.back().setOrigin(
842             this->smoke_sprite_list.back().getLocalBounds().width / 2,
843             this->smoke_sprite_list.back().getLocalBounds().height / 2
844         );
845
846         this->smoke_sprite_list.back().setPosition(
847             this->position_x + 9 + 4 * ((double)rand() / RAND_MAX) - 2,
848             this->position_y - 33
849         );
850     }
851 }
852
853 std::list<sf::Sprite>::iterator iter = this->smoke_sprite_list.begin();
854
855 double alpha = 255;
856
857 while (iter != this->smoke_sprite_list.end()) {
858     this->render_window_ptr->draw(*iter);
859
860     alpha = (*iter).getColor().a;
861
862     alpha -= this->smoke_da;
863 }

```

```

864         if (alpha <= 0) {
865             iter = this->smoke_sprite_list.erase(iter);
866             continue;
867         }
868
869         (*iter).setColor(sf::Color(255, 255, 255, alpha));
870
871         (*iter).move(
872             this->smoke_dx + 2 * (((double)rand() / RAND_MAX) - 1) / FRAMES_PER_SECOND,
873             this->smoke_dy
874         );
875
876         (*iter).rotate((((double)rand() / RAND_MAX)));
877
878         iter++;
879     }
880
881
882     // 6. handle dispatch illustration
883     if (this->production_MWh > 0) {
884         this->dispatch_text.setString(std::to_string(this->production_MWh));
885         this->__drawDispatch();
886     }
887
888
889     // 7. draw production menu
890     if (this->production_menu_open) {
891         this->render_window_ptr->draw(this->production_menu_backing);
892         this->render_window_ptr->draw(this->production_menu_backing_text);
893
894         this->__drawProductionMenu();
895     }
896
897
898     // 8. handle broken effects
899     if (this->is_broken) {
900         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
901             this->tile_improvement_sprite_animated[i].setColor(
902                 sf::Color(
903                     255,
904                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
905                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
906                     255
907                 )
908             );
909         }
910     }
911
912     this->frame++;
913     return;
914 } /* draw() */

```

4.3.3.12 getTileOptionsSubstring()

```

std::string DieselGenerator::getTileOptionsSubstring (
    void ) [virtual]

```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

565 {
566     int upgrade_cost = DIESEL_GENERATOR_BUILD_COST;
567
568     // 32 char x 17 line console "-----\n";
569     std::string options_substring = "CAPACITY: ";
570     options_substring += std::to_string(this->capacity_kW);
571     options_substring += " kW (level ";
572     options_substring += std::to_string(this->upgrade_level);
573     options_substring += ")\n";
574 }

```

```

575     options_substring           += "PRODUCTION: ";
576     options_substring           += std::to_string(this->production_MWh);
577     options_substring           += " MWh (MAX ";
578     options_substring           += std::to_string(this->max_production_MWh);
579     options_substring           += ") \n";
580
581     options_substring           += "HEALTH: ";
582     options_substring           += std::to_string(this->health);
583     options_substring           += "/100";
584
585     if (this->health <= 0) {
586         options_substring       += " ** BROKEN! ** \n";
587     }
588
589     else {
590         options_substring       += " \n";
591     }
592
593     options_substring           += "
594     options_substring           += " **** DIESEL GEN OPTIONS ****
595     options_substring           += "
596
597     if (this->is_broken) {
598         options_substring       += " [R]: REPAIR ";
599         options_substring       += std::to_string(DIESEL_GENERATOR_BUILD_COST);
600         options_substring       += " K) \n";
601     }
602
603     else {
604         options_substring       += " [E]: OPEN PRODUCTION MENU \n";
605     }
606
607     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
608         options_substring       += " [U]: + 200 kW ";
609         options_substring       += std::to_string(upgrade_cost);
610         options_substring       += " K) \n";
611     }
612
613     options_substring           += "HOLD [P]: SCRAP ";
614     options_substring           += std::to_string(SCRAP_COST);
615     options_substring           += " K)";
616
617     return options_substring;
618 } /* getTileOptionsSubstring() */

```

4.3.3.13 processEvent()

```

void DieselGenerator::processEvent (
    void ) [virtual]

```

Method to process [DieselGenerator](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```

711 {
712     TileImprovement :: processEvent ();
713
714     if (this->event_ptr->type == sf::Event::KeyPressed) {
715         this->__handleKeyPressEvents ();
716     }
717
718     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
719         this->__handleMouseButtonEvents ();
720     }
721
722     return;
723 } /* processEvent() */

```

4.3.3.14 processMessage()

```
void DieselGenerator::processMessage (
    void ) [virtual]
```

Method to process [DieselGenerator](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```
738 {
739     TileImprovement :: processMessage ();
740
741     //...
742
743     return;
744 } /* processMessage() */
```

4.3.3.15 setIsSelected()

```
void DieselGenerator::setIsSelected (
    bool is_selected ) [virtual]
```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```
635 {
636     TileImprovement :: setIsSelected(is_selected);
637
638     if (this->is_running and this->is_selected) {
639         this->assets_manager_ptr->getSound("diesel running")->play();
640     }
641
642     return;
643 } /* setIsSelected() */
```

4.3.4 Member Data Documentation

4.3.4.1 capacity_kW

```
int DieselGenerator::capacity_kW
```

The rated production capacity [kW] of the diesel generator.

4.3.4.2 emissions_tonnes_CO2e

```
int DieselGenerator::emissions_tonnes_CO2e
```

The emissions for this turn.

4.3.4.3 fuel_cost

```
int DieselGenerator::fuel_cost
```

The fuel costs for this turn.

4.3.4.4 max_production_MWh

```
int DieselGenerator::max_production_MWh
```

The maximum production [MWh] for this turn.

4.3.4.5 production_MWh

```
int DieselGenerator::production_MWh
```

The current production [MWh] of the diesel generator.

4.3.4.6 smoke_da

```
double DieselGenerator::smoke_da
```

The per frame delta in smoke particle alpha value.

4.3.4.7 smoke_dx

```
double DieselGenerator::smoke_dx
```

The per frame delta in smoke particle x position.

4.3.4.8 smoke_dy

```
double DieselGenerator::smoke_dy
```

The per frame delta in smoke particle y position.

4.3.4.9 smoke_prob

```
double DieselGenerator::smoke_prob
```

The probability of spawning a new smoke prob in any given frame.

4.3.4.10 smoke_sprite_list

```
std::list<sf::Sprite> DieselGenerator::smoke_sprite_list
```

A list of smoke sprite (for exhaust animation).

The documentation for this class was generated from the following files:

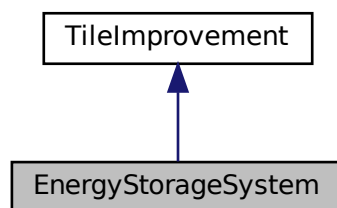
- header/[DieselGenerator.h](#)
- source/[DieselGenerator.cpp](#)

4.4 EnergyStorageSystem Class Reference

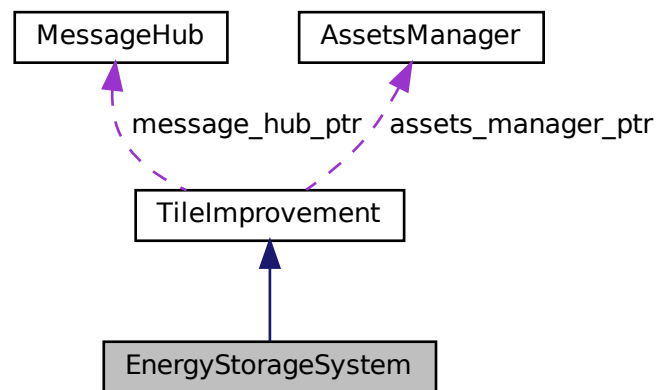
A settlement class (child class of [TileImprovement](#)).

```
#include <EnergyStorageSystem.h>
```

Inheritance diagram for EnergyStorageSystem:



Collaboration diagram for EnergyStorageSystem:



Public Member Functions

- [EnergyStorageSystem](#) (double, double, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [EnergyStorageSystem](#) class.
- void [setIsSelected](#) (bool)
Method to set the is selected attribute.
- std::string [getTileOptionsSubstring](#) (void)
Helper method to assemble and return tile options substring.
- void [processEvent](#) (void)
Method to process [EnergyStorageSystem](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [EnergyStorageSystem](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual [~EnergyStorageSystem](#) (void)
Destructor for the [EnergyStorageSystem](#) class.

Public Attributes

- int [capacity_MWh](#)
The rated energy capacity [MWh] of the energy storage system.
- int [charge_MWh](#)
The charge [MWh] in the energy storage system.

Private Member Functions

- void [__setUpTileImprovementSpriteStatic](#) (void)
Helper method to set up tile improvement sprite (static).
- void [__setUpProductionMenu](#) (void)
Helper method to set up and position production menu assets (drawable).
- void [__upgrade](#) (void)
Helper method to upgrade the diesel generator.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.

Additional Inherited Members

4.4.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

4.4.2 Constructor & Destructor Documentation

4.4.2.1 EnergyStorageSystem()

```
EnergyStorageSystem::EnergyStorageSystem (
    double position_x,
    double position_y,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [EnergyStorageSystem](#) class.

Ref: [Wikipedia \[2023\]](#)

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```
291 :
292 TileImprovement (
```

```

293     position_x,
294     position_y,
295     event_ptr,
296     render_window_ptr,
297     assets_manager_ptr,
298     message_hub_ptr
299 )
300 {
301     // 1. set attributes
302
303     // 1.1. private
304     //...
305
306     // 1.2. public
307     this->tile_improvement_type = TileImprovementType :: ENERGY_STORAGE_SYSTEM;
308
309     this->is_running = false;
310
311     this->health = 100;
312
313     this->capacity_MWh = 1;
314     this->upgrade_level = 1;
315
316     this->charge_MWh = 0;
317
318     this->tile_improvement_string = "ENERGY STORAGE";
319
320     this->__setUpTileImprovementSpriteStatic();
321     this->__setUpProductionMenu();
322
323     std::cout << "EnergyStorageSystem constructed at " << this << std::endl;
324
325     return;
326 } /* EnergyStorageSystem() */

```

4.4.2.2 ~EnergyStorageSystem()

```

EnergyStorageSystem::~EnergyStorageSystem (
    void ) [virtual]

```

Destructor for the [EnergyStorageSystem](#) class.

```

504 {
505     std::cout << "EnergyStorageSystem at " << this << " destroyed" << std::endl;
506
507     return;
508 } /* ~EnergyStorageSystem() */

```

4.4.3 Member Function Documentation

4.4.3.1 __handleKeyPressEvents()

```

void EnergyStorageSystem::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

179 {
180     if (this->just_built) {
181         return;
182     }
183
184     switch (this->event_ptr->key.code) {
185         case (sf::Keyboard::U): {
186             if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
187                 this->__upgrade();
188             }
189         }
190     }
191 }

```

```

189
190         break;
191     }
192
193     default: {
194         // do nothing!
195
196         break;
197     }
198 }
199
200
201 return;
202 } /* __handleKeyPressEvents() */

```

4.4.3.2 __handleMouseButtonEvents()

```

void EnergyStorageSystem::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

217 {
218     if (this->just_built) {
219         return;
220     }
221
222     switch (this->event_ptr->mouseButton.button) {
223     case (sf::Mouse::Left): {
224         //...
225
226         break;
227     }
228
229     case (sf::Mouse::Right): {
230         //...
231
232         break;
233     }
234
235     default: {
236         // do nothing!
237
238         break;
239     }
240 }
241
242 return;
243 } /* __handleMouseButtonEvents() */

```

4.4.3.3 __setUpProductionMenu()

```

void EnergyStorageSystem::__setUpProductionMenu (
    void ) [private]

```

Helper method to set up and position production menu assets (drawable).

```

103 {
104     // 1. modify production menu text
105     this->production_menu_backing_text.setString("**** DISCHARGE MENU ****");
106     this->production_menu_backing_text.setFont (
107         *(this->assets_manager_ptr->getFont ("Glass_TTY_VT220"))
108     );
109     this->production_menu_backing_text.setCharacterSize(16);
110     this->production_menu_backing_text.setFill_color(MONOCROME_TEXT_GREEN);
111     this->production_menu_backing_text.setOrigin(
112         this->production_menu_backing_text.getLocalBounds().width / 2, 0
113     );
114     this->production_menu_backing_text.setPosition(400, 400 - 128 + 4);
115
116     return;
117 } /* __setUpProductionMenu() */

```

4.4.3.4 __setUpTileImprovementSpriteStatic()

```
void EnergyStorageSystem::__setUpTileImprovementSpriteStatic (
    void ) [private]
```

Helper method to set up tile improvement sprite (static).

```
68 {
69     this->tile_improvement_sprite_static.setTexture(
70         *(this->assets_manager_ptr->getTexture("energy storage system"))
71     );
72
73     this->tile_improvement_sprite_static.setOrigin(
74         this->tile_improvement_sprite_static.getLocalBounds().width / 2,
75         this->tile_improvement_sprite_static.getLocalBounds().height
76     );
77
78     this->tile_improvement_sprite_static.setPosition(
79         this->position_x,
80         this->position_y - 32
81     );
82
83     this->tile_improvement_sprite_static.setColor(
84         sf::Color(255, 255, 255, 0)
85     );
86
87     return;
88 } /* __setUpTileImprovementSpriteStatic() */
```

4.4.3.5 __upgrade()

```
void EnergyStorageSystem::__upgrade (
    void ) [private]
```

Helper method to upgrade the diesel generator.

```
132 {
133     /*
134     int upgrade_cost = DIESEL_GENERATOR_BUILD_COST;
135
136     if (this->credits < upgrade_cost) {
137         std::cout << "Cannot upgrade diesel generator: insufficient credits (need "
138             << upgrade_cost << " K)" << std::endl;
139
140         this->__sendInsufficientCreditsMessage();
141         return;
142     }
143
144     this->is_running = false;
145
146     this->health = 100;
147
148     this->capacity_kW += 100;
149     this->upgrade_level++;
150
151     this->production_MWh = 0;
152     this->max_production_MWh += 72;
153
154     this->just_upgraded = true;
155
156     this->assets_manager_ptr->getSound("upgrade")->play();
157
158     this->__sendCreditsSpentMessage(upgrade_cost);
159     this->__sendTileStateRequest();
160     this->__sendGameStateRequest();
161     */
162
163     return;
164 } /* __upgrade() */
```

4.4.3.6 draw()

```
void EnergyStorageSystem::draw (
    void ) [virtual]
```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```
466 {
467     // 1. if just built, call base method and return
468     if (this->just_built) {
469         TileImprovement :: draw();
470
471         return;
472     }
473
474     // 2. draw static sprite
475     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
476
477     // 3. draw production menu
478     if (this->production_menu_open) {
479         this->render_window_ptr->draw(this->production_menu_backing);
480         this->render_window_ptr->draw(this->production_menu_backing_text);
481
482         //...
483     }
484
485     this->frame++;
486     return;
487 }
488 /* draw() */
```

4.4.3.7 getTileOptionsSubstring()

```
std::string EnergyStorageSystem::getTileOptionsSubstring (
    void ) [virtual]
```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```
368 {
369     int upgrade_cost = ENERGY_STORAGE_SYSTEM_BUILD_COST;
370
371     // 32 char x 17 line console "-----\n";
372     std::string options_substring = "CAPACITY: ";
373     options_substring += std::to_string(this->capacity_MWh);
374     options_substring += " MWh (level ";
375     options_substring += std::to_string(this->upgrade_level);
376     options_substring += ")\n";
377
378     options_substring += "CHARGE: ";
379     options_substring += std::to_string(this->charge_MWh);
380     options_substring += " MWh\n";
381
382     options_substring += "HEALTH: ";
383     options_substring += std::to_string(this->health);
384     options_substring += "/100\n";
385
386     options_substring += "
387     options_substring += "**** ENERGY STORAGE OPTIONS ****\n";
388     options_substring += "
389     options_substring += "      [E]:  OPEN DISCHARGE MENU  \n";
390
391     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
392         options_substring += "      [U]:  UPGRADE  (";
```



```

393         options_substring          += std::to_string(upgrade_cost);
394         options_substring          += " K)\n";
395     }
396
397     options_substring               += "HOLD [P]:  SCRAP (";
398     options_substring               += std::to_string(SCRAP_COST);
399     options_substring               += " K)";
400
401     return options_substring;
402 } /* getTileOptionsSubstring() */

```

4.4.3.8 processEvent()

```

void EnergyStorageSystem::processEvent (
    void ) [virtual]

```

Method to process [EnergyStorageSystem](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```

417 {
418     TileImprovement :: processEvent();
419
420     if (this->event_ptr->type == sf::Event::KeyPressed) {
421         this->__handleKeyPressEvents();
422     }
423
424     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
425         this->__handleMouseButtonEvents();
426     }
427
428     return;
429 } /* processEvent() */

```

4.4.3.9 processMessage()

```

void EnergyStorageSystem::processMessage (
    void ) [virtual]

```

Method to process [EnergyStorageSystem](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```

444 {
445     TileImprovement :: processMessage();
446
447     //...
448
449     return;
450 } /* processMessage() */

```

4.4.3.10 setIsSelected()

```

void EnergyStorageSystem::setIsSelected (
    bool is_selected ) [virtual]

```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```

343 {
344     TileImprovement :: setIsSelected(is_selected);
345
346     if (this->is_selected) {
347         this->assets_manager_ptr->getSound("energy storage system")->play();
348     }
349
350     return;
351 } /* setIsSelected() */

```

4.4.4 Member Data Documentation

4.4.4.1 capacity_MWh

```
int EnergyStorageSystem::capacity_MWh
```

The rated energy capacity [MWh] of the energy storage system.

4.4.4.2 charge_MWh

```
int EnergyStorageSystem::charge_MWh
```

The charge [MWh] in the energy storage system.

The documentation for this class was generated from the following files:

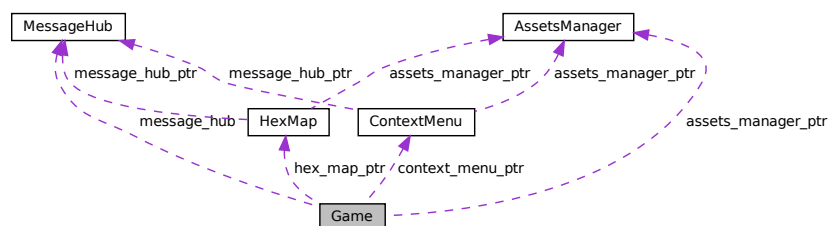
- header/[EnergyStorageSystem.h](#)
- source/[EnergyStorageSystem.cpp](#)

4.5 Game Class Reference

A class which acts as the central class for the game, by containing all other classes and implementing the game loop.

```
#include <Game.h>
```

Collaboration diagram for Game:



Public Member Functions

- [Game](#) (sf::RenderWindow *, [AssetsManager](#) *, bool)
Constructor for the [Game](#) class.
- bool [run](#) (void)
Method to run game (defines game loop).
- [~Game](#) (void)
Destructor for the [Game](#) class.

Public Attributes

- [GamePhase](#) [game_phase](#)
The current phase of the game.
- bool [quit_game](#)
Boolean indicating whether to quit (true) or create a new [Game](#) instance (false).
- bool [game_loop_broken](#)
Boolean indicating whether or not the game loop is broken.
- bool [show_frame_clock_overlay](#)
Boolean indicating whether or not to show frame and clock overlay.
- bool [check_terminating_conditions](#)
Boolean indicating whether or not to check terminating conditions.
- bool [message_deadlock](#)
A boolean indicating whether a message deadlock has been detected.
- bool [show_tutorial](#)
A boolean indicating whether or not to show the tutorial.
- bool [turn_end](#)
A boolean indicating a turn end.
- bool [draw_turn_advance_banner](#)
A boolean indicating whether or not to draw the turn advance banner.
- bool [increase_turn_advance_alpha](#)
A boolean which indicates whether the turn advance alpha is increasing or decreasing.
- bool [transition_from_title](#)
A boolean which indicates if construction follows a title transition.
- size_t [tutorial_page](#)
Index for which page of the tutorial to show.
- std::string [tutorial_string](#)
A string representation of the current tutorial page.
- sf::Text [tutorial_text](#)
A text representation (drawable) of the tutorial page.
- unsigned long long int [frame](#)
The current frame of the game.
- double [time_since_start_s](#)
The time elapsed [s] since the start of the game.
- int [year](#)
Current game year.
- int [month](#)
Current game month.
- int [population](#)
Current population.
- int [credits](#)

- *Current balance of credits.*
- int [demand_MWh](#)
Current energy demand [MWh].
- int [cumulative_emissions_tonnes](#)
Cumulative emissions [tonnes] (1 tonne = 1000 kg).
- int [past_demand_MWh](#)
The demand in the previous turn.
- double [turn_advance_alpha](#)
The alpha value for the turn advance banner.
- int [demand_served_MWh](#)
The demand served at the end of a turn.
- int [demand_remaining_MWh](#)
The demand remaining at the end of a turn.
- int [overproduction_MWh](#)
The amount of overproduction at the end of a turn.
- int [turn_fuel_cost](#)
The cost of fuel at the end of a turn.
- int [turn_operation_maintenance_cost](#)
The cost of operation and maintenance at the end of a turn.
- int [turn_emissions_tonnes](#)
The amount of emissions at the end of a turn.
- int [dispatch_income](#)
The amount earned from dispatch at the end of a turn.
- int [overproduction_penalty](#)
The penalty for overproduction.
- int [net_credit_flow](#)
The net credit flow at the end of a turn.
- int [consecutive_zero_emissions_months](#)
The number of recent, consecutive zero emission months.
- size_t [substring_idx](#)
The index of the turn summary or tutorial substring.
- std::string [turn_summary_string](#)
A string representation of the end of turn summary.
- sf::Text [turn_summary_text](#)
A text representation (drawable) of the end of turn summary.
- int [message_deadlock_frame](#)
A frame counter for detecting message deadlock.
- int [turn](#) = 0
The current game turn.
- std::vector< double > [demand_vec_MWh](#)
A vector of daily demands [MWh] for the current month.
- sf::Clock [clock](#)
The game clock.
- sf::Event [event](#)
The game events class.
- sf::RectangleShape [fade_rectangle](#)
A fading rectangle (for smooth transition from title to game).
- MessageHub [message_hub](#)
The message hub (for inter-object message traffic).
- HexMap * [hex_map_ptr](#)
Pointer to the hex map (defines game world).
- ContextMenu * [context_menu_ptr](#)
Pointer to the context menu.

Private Member Functions

- void [__toggleFrameClockOverlay](#) (void)
Helper method to toggle frame clock overlay.
- void [__checkTerminatingConditions](#) (void)
Helper method to check terminating conditions (i.e., loss or victory conditions).
- void [__updatePopulation](#) (void)
Helper method to update (i.e. grow) population.
- void [__advanceTurn](#) (void)
Helper method to advance turn.
- void [__computeCurrentDemand](#) (void)
Helper method to compute current energy demand.
- void [__toggleTutorial](#) (void)
Helper method to handle toggling the tutorial on and off.
- void [__incrementTutorial](#) (void)
Helper method to increment tutorial page (with wrap around).
- void [__decrementTutorial](#) (void)
Helper method to decrement tutorial page (with wrap around).
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__handleImprovementStateMessage](#) (Message)
Helper method to handle improvement state messages.
- void [__processEvent](#) (void)
Helper method to process [Game](#). To be called once per event.
- void [__processMessage](#) (void)
Helper method to process [Game](#). To be called once per message.
- void [__sendGameStateMessage](#) (void)
Helper method to format and send a game state message.
- void [__sendTurnAdvanceMessage](#) (void)
Helper method to format and send a turn advance message.
- void [__sendCreditsEarnedMessage](#) (void)
Helper method to format and send a credits earned message.
- void [__insufficientCreditsAlarm](#) (void)
Helper method to sound and display and insufficient credits alarm.
- void [__summarizeTurn](#) (void)
Helper method to generate end of turn summary.
- void [__drawLossDemand](#) (void)
Helper method to draw loss (demand) pop-up.
- void [__drawLossCredits](#) (void)
Helper method to draw loss (credits) pop-up.
- void [__drawLossEmissions](#) (void)
Helper method to draw loss (emissions) pop-up.
- void [__drawVictory](#) (void)
Helper method to draw victory pop-up.
- void [__drawTurnAdvanceBanner](#) (void)
Helper method to draw turn advance banner.
- void [__drawTutorial](#) (void)
Helper method to draw tutorial text.
- void [__drawTurnSummary](#) (void)

- *Helper method to draw turn summary.*
void [__drawFrameClockOverlay](#) (void)
- *Helper method to draw frame clock overlay.*
void [__drawHUD](#) (void)
- *Helper method to heads-up display (HUD).*
void [__draw](#) (void)
- *Helper method to draw game to the render window. To be called once per frame.*

Private Attributes

- sf::RenderWindow * [render_window_ptr](#)
A pointer to the render window.
- [AssetsManager](#) * [assets_manager_ptr](#)
A pointer to the assets manager.

4.5.1 Detailed Description

A class which acts as the central class for the game, by containing all other classes and implementing the game loop.

4.5.2 Constructor & Destructor Documentation

4.5.2.1 Game()

```
Game::Game (
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    bool transition_from_title )
```

Constructor for the [Game](#) class.

Parameters

<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>transition_from_title</i>	Boolean which indicates if this construction is following the title transition.

```
1748 {
1749     // 1. set attributes
1750
1751     // 1.1. private
1752     this->render_window_ptr = render_window_ptr;
1753
1754     this->assets_manager_ptr = assets_manager_ptr;
1755
1756     // 1.2. public
1757     this->game_phase = GamePhase :: BUILD_SETTLEMENT;
1758
1759     this->quit_game = false;
1760     this->game_loop_broken = false;
1761     this->show_frame_clock_overlay = false;
```

```

1762     this->check_terminating_conditions = false;
1763     this->show_tutorial = true;
1764     this->turn_end = false;
1765     this->draw_turn_advance_banner = false;
1766     this->increase_turn_advance_alpha = true;
1767     this->transition_from_title = transition_from_title;
1768
1769     this->tutorial_page = 0;
1770     this->tutorial_string = TUTORIAL_PAGES[this->tutorial_page];
1771
1772     this->tutorial_text.setFont(
1773         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220"))
1774     );
1775     this->tutorial_text.setCharacterSize(16);
1776     this->tutorial_text.setFillColor(MONOCROME_TEXT_GREEN);
1777     this->tutorial_text.setPosition(GAME_WIDTH - 400 + 64, 64);
1778
1779     this->frame = 0;
1780     this->time_since_start_s = 0;
1781
1782     this->message_deadlock = false;
1783     this->message_deadlock_frame = 0;
1784
1785     double seconds_since_epoch = time(NULL);
1786     double years_since_epoch = seconds_since_epoch / SECONDS_PER_YEAR;
1787
1788     this->year = 1970 + (int)years_since_epoch;
1789     this->month = 0;
1790
1791     this->population = 0;
1792     this->credits = STARTING_CREDITS;
1793     this->demand_MWh = 0;
1794     this->cumulative_emissions_tonnes = 0;
1795
1796     this->past_demand_MWh = 0;
1797     this->turn_advance_alpha = 0;
1798
1799     this->demand_vec_MWh.resize(30, 0);
1800
1801     this->demand_served_MWh = 0;
1802     this->demand_remaining_MWh = 0;
1803     this->overproduction_MWh = 0;
1804     this->turn_fuel_cost = 0;
1805     this->turn_operation_maintenance_cost = 0;
1806     this->turn_emissions_tonnes = 0;
1807
1808     this->overproduction_penalty = 0;
1809     this->dispatch_income = 0;
1810     this->net_credit_flow = 0;
1811
1812     this->consecutive_zero_emissions_months = 0;
1813
1814     this->substring_idx = 0;
1815     this->turn_summary_string = "";
1816
1817     this->turn_summary_text.setFont(
1818         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220"))
1819     );
1820     this->turn_summary_text.setCharacterSize(16);
1821     this->turn_summary_text.setFillColor(MONOCROME_TEXT_GREEN);
1822     this->turn_summary_text.setPosition(GAME_WIDTH - 400 + 64, 64);
1823
1824     this->fade_rectangle.setSize(sf::Vector2f(GAME_WIDTH, GAME_HEIGHT));
1825     this->fade_rectangle.setFillColor(sf::Color(0, 0, 0, 255));
1826
1827     this->hex_map_ptr = new HexMap(
1828         6,
1829         &(this->event),
1830         this->render_window_ptr,
1831         this->assets_manager_ptr,
1832         &(this->message_hub)
1833     );
1834
1835     this->context_menu_ptr = new ContextMenu(
1836         &(this->event),
1837         this->render_window_ptr,
1838         this->assets_manager_ptr,
1839         &(this->message_hub)
1840     );
1841
1842     // 2. add message channel(s)
1843     this->message_hub.addChannel(GAME_CHANNEL);
1844     this->message_hub.addChannel(GAME_STATE_CHANNEL);
1845
1846     this->__sendGameStateMessage();
1847
1848     std::cout << "Game constructed at " << this << std::endl;

```

```

1849
1850     return;
1851 }    /* Game() */

```

4.5.2.2 ~Game()

```

Game::~~Game (
    void )

```

Destructor for the `Game` class.

```

1978 {
1979     // 1. clean up attributes
1980     delete this->hex_map_ptr;
1981     delete this->context_menu_ptr;
1982
1983     std::cout << "Game at " << this << " destroyed" << std::endl;
1984
1985     return;
1986 }    /* ~Game() */

```

4.5.3 Member Function Documentation

4.5.3.1 __advanceTurn()

```

void Game::__advanceTurn (
    void ) [private]

```

Helper method to advance turn.

```

170 {
171     // 1. advance turn, raise turn end flag
172     this->turn++;
173     this->turn_end = true;
174
175     // 2. reset turn summary attributes
176     this->demand_served_MWh = 0;
177     this->demand_remaining_MWh = 0;
178     this->overproduction_MWh = 0;
179     this->turn_fuel_cost = 0;
180     this->turn_operation_maintenance_cost = 0;
181     this->turn_emissions_tonnes = 0;
182
183     this->overproduction_penalty = 0;
184     this->dispatch_income = 0;
185     this->net_credit_flow = 0;
186
187     // 3. advance month/year
188     this->month++;
189     if (this->month > 12) {
190         this->year++;
191         this->month = 1;
192     }
193
194     // 4. update population
195     if (this->turn == 1) {
196         this->population = STARTING_POPULATION;
197     }
198
199     else {
200         this->__updatePopulation();
201     }
202
203     // 5. update demand
204     this->__computeCurrentDemand();
205
206     // 6. send turn advance message
207     this->__sendTurnAdvanceMessage();
208     this->__sendGameStateMessage();
209
210 }    /* __advanceTurn() */

```


4.5.3.2 __checkTerminatingConditions()

```
void Game::__checkTerminatingConditions (
    void ) [private]
```

Helper method to check terminating conditions (i.e., loss or victory conditions).

```
94 {
95     // 1. loss emissions
96     if (this->cumulative_emissions_tonnes >= EMISSIONS_LIFETIME_LIMIT_TONNES) {
97         this->assets_manager_ptr->getSound("loss")->play();
98         this->game_phase = GamePhase :: LOSS_EMISSIONS;
99     }
100
101     // 2. loss demand
102     else if (this->demand_remaining_MWh > 0) {
103         this->assets_manager_ptr->getSound("loss")->play();
104         this->game_phase = GamePhase :: LOSS_DEMAND;
105     }
106
107     // 3. loss credits
108     else if (this->credits < 0) {
109         this->assets_manager_ptr->getSound("loss")->play();
110         this->game_phase = GamePhase :: LOSS_CREDITS;
111     }
112
113     // 4. victory
114     else if (
115         (this->population >= 1000) and
116         (this->consecutive_zero_emissions_months >= 12)
117     ) {
118         this->assets_manager_ptr->getSound("victory")->play();
119         this->game_phase = GamePhase :: VICTORY;
120     }
121
122     // 5. send game state message
123     //this->__sendGameStateMessage();
124
125     return;
126 } /* __checkTerminatingConditions() */
```

4.5.3.3 __computeCurrentDemand()

```
void Game::__computeCurrentDemand (
    void ) [private]
```

Helper method to compute current energy demand.

```
225 {
226     this->past_demand_MWh = this->demand_MWh;
227
228     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
229     std::default_random_engine generator(seed);
230
231     std::normal_distribution<double> normal_dist(
232         MEAN_DAILY_DEMAND_RATIOS[this->month - 1],
233         STDEV_DAILY_DEMAND_RATIOS[this->month - 1]
234     );
235
236     double demand_MWh = 0;
237
238     for (int i = 0; i < 30; i++) {
239         this->demand_vec_MWh[i] =
240             normal_dist(generator) * MAXIMUM_DAILY_DEMAND_PER_CAPITA * this->population;
241
242         demand_MWh += this->demand_vec_MWh[i];
243     }
244
245     this->demand_MWh = round(demand_MWh);
246
247     return;
248 } /* __computeCurrentDemand() */
```

4.5.3.4 __decrementTutorial()

```
void Game::__decrementTutorial (
    void ) [private]
```

Helper method to decrement tutorial page (with wrap around).

```
322 {
323     if (this->tutorial_page == 0) {
324         this->tutorial_page = TUTORIAL_PAGES.size() - 1;
325     }
326     else {
327         this->tutorial_page--;
328     }
329 }
330
331 this->tutorial_string = TUTORIAL_PAGES[this->tutorial_page];
332 this->substring_idx = 0;
333
334 this->assets_manager_ptr->getSound("interface click")->play();
335
336 return;
337 } /* __decrementTutorial() */
```

4.5.3.5 __draw()

```
void Game::__draw (
    void ) [private]
```

Helper method to draw game to the render window. To be called once per frame.

```
1637 {
1638     // 1. HUD
1639     this->__drawHUD();
1640
1641     // 2. frame / clock overlay
1642     if (this->show_frame_clock_overlay) {
1643         this->__drawFrameClockOverlay();
1644     }
1645
1646     // 3. tutorial or turn summary
1647     if (this->show_tutorial) {
1648         this->__drawTutorial();
1649     }
1650
1651     else if (not this->turn_summary_string.empty()) {
1652         this->__drawTurnSummary();
1653     }
1654
1655     // 4. turn advance banner
1656     if (this->draw_turn_advance_banner) {
1657         this->__drawTurnAdvanceBanner();
1658     }
1659
1660     // 5. title transition
1661     if (this->transition_from_title) {
1662         this->render_window_ptr->draw(this->fade_rectangle);
1663
1664         double alpha = this->fade_rectangle.getFillColor().a;
1665
1666         alpha -= FRAMES_PER_SECOND / 20;
1667
1668         if (alpha < 0) {
1669             alpha = 0;
1670             this->transition_from_title = false;
1671         }
1672
1673         this->fade_rectangle.setFillColor(sf::Color(0, 0, 0, alpha));
1674     }
1675
1676     // 6. terminating conditions
1677     switch (this->game_phase) {
1678         case (GamePhase :: LOSS_DEMAND): {
1679             this->__drawLossDemand();
1680
1681             break;
1682         }
```

```

1683
1684
1685     case (GamePhase :: LOSS_CREDITS): {
1686         this->__drawLossCredits();
1687
1688         break;
1689     }
1690
1691
1692     case (GamePhase :: LOSS_EMISSIONS): {
1693         this->__drawLossEmissions();
1694
1695         break;
1696     }
1697
1698
1699     case (GamePhase :: VICTORY): {
1700         this->__drawVictory();
1701
1702         break;
1703     }
1704
1705
1706     default: {
1707         // do nothing!
1708
1709         break;
1710     }
1711 }
1712
1713 return;
1714 } /* draw() */

```

4.5.3.6 __drawFrameClockOverlay()

```

void Game::__drawFrameClockOverlay (
    void ) [private]

```

Helper method to draw frame clock overlay.

```

1460 {
1461     std::string frame_clock_string = "FRAME: ";
1462     frame_clock_string += std::to_string(this->frame);
1463     frame_clock_string += "\nTIME SINCE START [s]: ";
1464     frame_clock_string += std::to_string(this->time_since_start_s);
1465
1466     sf::Text frame_clock_text(
1467         frame_clock_string,
1468         *(this->assets_manager_ptr->getFont("DroidSansMono")),
1469         16
1470     );
1471
1472     sf::RectangleShape frame_clock_backing(
1473         sf::Vector2f(
1474             1.02 * frame_clock_text.getLocalBounds().width,
1475             1.20 * frame_clock_text.getLocalBounds().height
1476         )
1477     );
1478     frame_clock_backing.setFillColor(sf::Color(0, 0, 0, 255));
1479
1480     this->render_window_ptr->draw(frame_clock_backing);
1481     this->render_window_ptr->draw(frame_clock_text);
1482
1483     return;
1484 } /* __drawFrameClockOverlay() */

```

4.5.3.7 __drawHUD()

```

void Game::__drawHUD (
    void ) [private]

```

Helper method to heads-up display (HUD).

```

1499 {
1500     // 1. first line (top)
1501     std::string HUD_string = "YEAR: ";
1502     HUD_string += std::to_string(this->year);
1503
1504     HUD_string += "    MONTH: ";
1505     HUD_string += std::to_string(this->month);
1506
1507     HUD_string += "    POPULATION: ";
1508     HUD_string += std::to_string(this->population);
1509
1510     HUD_string += "    CREDITS: ";
1511     HUD_string += std::to_string(this->credits);
1512     HUD_string += " K";
1513
1514     HUD_string += "    CURRENT DEMAND: ";
1515     HUD_string += std::to_string(this->demand_MWh);
1516     HUD_string += " MWh";
1517
1518     sf::Text HUD_text(
1519         HUD_string,
1520         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
1521         16
1522     );
1523
1524     HUD_text.setPosition(
1525         (800 - HUD_text.getLocalBounds().width) / 2,
1526         8
1527     );
1528
1529     HUD_text.setFillColor(MONOCROME_TEXT_GREEN);
1530
1531     this->render_window_ptr->draw(HUD_text);
1532
1533
1534     // 2. second line (top)
1535     HUD_string = "CUMULATIVE EMISSIONS: ";
1536     HUD_string += std::to_string(this->cumulative_emissions_tonnes);
1537     HUD_string += " tonnes (CO2e)";
1538
1539     HUD_string += "    LIFETIME LIMIT: ";
1540     HUD_string += std::to_string(EMISSIONS_LIFETIME_LIMIT_TONNES);
1541     HUD_string += " tonnes (CO2e)";
1542
1543     HUD_text.setString(HUD_string);
1544
1545     HUD_text.setPosition(
1546         (800 - HUD_text.getLocalBounds().width) / 2,
1547         35
1548     );
1549
1550     this->render_window_ptr->draw(HUD_text);
1551
1552
1553     // 3. third line (bottom)
1554     HUD_string = "GAME PHASE: ";
1555
1556     switch (this->game_phase) {
1557     case (GamePhase :: BUILD_SETTLEMENT): {
1558         HUD_string += "BUILD SETTLEMENT";
1559
1560         break;
1561     }
1562
1563
1564     case (GamePhase :: SYSTEM_MANAGEMENT): {
1565         HUD_string += "SYSTEM MANAGEMENT";
1566
1567         break;
1568     }
1569
1570
1571     case (GamePhase :: LOSS_EMISSIONS): {
1572         HUD_string += "LOSS (EMISSIONS)";
1573
1574         break;
1575     }
1576
1577
1578     case (GamePhase :: LOSS_DEMAND): {
1579         HUD_string += "LOSS (DEMAND)";
1580
1581         break;
1582     }
1583
1584

```

```

1585         case (GamePhase :: LOSS_CREDITS): {
1586             HUD_string += "LOSS (CREDITS)";
1587
1588             break;
1589         }
1590
1591         case (GamePhase :: VICTORY): {
1592             HUD_string += "VICTORY";
1593
1594             break;
1595         }
1596
1597         default: {
1598             HUD_string += "???";
1599
1600             break;
1601         }
1602     }
1603
1604     HUD_string += "    TURN: ";
1605     HUD_string += std::to_string(this->turn);
1606
1607     HUD_string += "    CONSECUTIVE ZERO EMISSIONS MONTHS: ";
1608     HUD_string += std::to_string(this->consecutive_zero_emissions_months);
1609
1610     HUD_text.setString(HUD_string);
1611
1612     HUD_text.setPosition(
1613         (800 - HUD_text.getLocalBounds().width) / 2,
1614         GAME_HEIGHT - 35
1615     );
1616
1617     this->render_window_ptr->draw(HUD_text);
1618
1619     return;
1620 } /* __drawHUD() */

```

4.5.3.8 __drawLossCredits()

```

void Game::__drawLossCredits (
    void ) [private]

```

Helper method to draw loss (credits) pop-up.

```

1101 {
1102     // 1. construct loss text and backing rectangle
1103     std::string loss_credits_string = "    LOSS! - RAN OUT OF CREDITS    \n";
1104     loss_credits_string += "    press any key to restart    ";
1105
1106     sf::Text loss_credits_text(
1107         loss_credits_string,
1108         (*(this->assets_manager_ptr->getFont("DroidSansMono"))),
1109         32
1110     );
1111
1112     loss_credits_text.setOrigin(
1113         loss_credits_text.getLocalBounds().width / 2,
1114         loss_credits_text.getLocalBounds().height / 2
1115     );
1116
1117     loss_credits_text.setPosition(400, GAME_HEIGHT / 2);
1118
1119     sf::RectangleShape backing_rectangle(
1120         sf::Vector2f(
1121             800,
1122             1.5 * loss_credits_text.getLocalBounds().height
1123         )
1124     );
1125
1126     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
1127
1128     backing_rectangle.setOrigin(
1129         backing_rectangle.getLocalBounds().width / 2,
1130         backing_rectangle.getLocalBounds().height / 2
1131     );
1132
1133     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);

```

```

1134
1135 // 3. colour cycle and draw
1136 if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
1137     loss_credits_text.setFillColor(MONOCROME_TEXT_RED);
1138 }
1139
1140 else {
1141     loss_credits_text.setFillColor(sf::Color(255, 255, 255, 255));
1142 }
1143
1144 this->render_window_ptr->draw(backing_rectangle);
1145 this->render_window_ptr->draw(loss_credits_text);
1146
1147 return;
1148 } /* __drawLossCredits() */

```

4.5.3.9 __drawLossDemand()

```

void Game::__drawLossDemand (
    void ) [private]

```

Helper method to draw loss (demand) pop-up.

```

1039 {
1040     // 1. construct alarm text and backing rectangle
1041     std::string loss_demand_string = "    LOSS! - FAILED TO MEET DEMAND    \n";
1042     loss_demand_string += "        press any key to restart        ";
1043
1044     sf::Text loss_demand_text(
1045         loss_demand_string,
1046         (*(this->assets_manager_ptr->getFont("DroidSansMono"))),
1047         32
1048     );
1049
1050     loss_demand_text.setOrigin(
1051         loss_demand_text.getLocalBounds().width / 2,
1052         loss_demand_text.getLocalBounds().height / 2
1053     );
1054
1055     loss_demand_text.setPosition(400, GAME_HEIGHT / 2);
1056
1057     sf::RectangleShape backing_rectangle(
1058         sf::Vector2f(
1059             800,
1060             1.5 * loss_demand_text.getLocalBounds().height
1061         )
1062     );
1063
1064     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
1065
1066     backing_rectangle.setOrigin(
1067         backing_rectangle.getLocalBounds().width / 2,
1068         backing_rectangle.getLocalBounds().height / 2
1069     );
1070
1071     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1072
1073     // 3. colour cycle and draw
1074     if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
1075         loss_demand_text.setFillColor(MONOCROME_TEXT_RED);
1076     }
1077
1078     else {
1079         loss_demand_text.setFillColor(sf::Color(255, 255, 255, 255));
1080     }
1081
1082     this->render_window_ptr->draw(backing_rectangle);
1083     this->render_window_ptr->draw(loss_demand_text);
1084
1085     return;
1086 } /* __drawLossDemand() */

```

4.5.3.10 __drawLossEmissions()

```
void Game::__drawLossEmissions (
    void ) [private]
```

Helper method to draw loss (emissions) pop-up.

```
1163 {
1164     // 1. construct loss text and backing rectangle
1165     std::string loss_emissions_string = "      LOSS! - EXCESSIVE EMISSIONS    \n";
1166     loss_emissions_string += "      press any key to restart      ";
1167
1168     sf::Text loss_emissions_text(
1169         loss_emissions_string,
1170         (*(this->assets_manager_ptr->getFont("DroidSansMono"))),
1171         32
1172     );
1173
1174     loss_emissions_text.setOrigin(
1175         loss_emissions_text.getLocalBounds().width / 2,
1176         loss_emissions_text.getLocalBounds().height / 2
1177     );
1178
1179     loss_emissions_text.setPosition(400, GAME_HEIGHT / 2);
1180
1181     sf::RectangleShape backing_rectangle(
1182         sf::Vector2f(
1183             800,
1184             1.5 * loss_emissions_text.getLocalBounds().height
1185         )
1186     );
1187
1188     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
1189
1190     backing_rectangle.setOrigin(
1191         backing_rectangle.getLocalBounds().width / 2,
1192         backing_rectangle.getLocalBounds().height / 2
1193     );
1194
1195     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1196
1197     // 3. colour cycle and draw
1198     if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
1199         loss_emissions_text.setFillColor(MONochrome_TEXT_RED);
1200     }
1201
1202     else {
1203         loss_emissions_text.setFillColor(sf::Color(255, 255, 255, 255));
1204     }
1205
1206     this->render_window_ptr->draw(backing_rectangle);
1207     this->render_window_ptr->draw(loss_emissions_text);
1208
1209     return;
1210 } /* __drawLossEmissions() */
```

4.5.3.11 __drawTurnAdvanceBanner()

```
void Game::__drawTurnAdvanceBanner (
    void ) [private]
```

Helper method to draw turn advance banner.

```
1287 {
1288     // 1. construct advance banner text
1289     std::string turn_advance_banner_string = "      Turn: ";
1290     turn_advance_banner_string += std::to_string(this->turn);
1291     turn_advance_banner_string += "\n";
1292     turn_advance_banner_string += "Year: ";
1293     turn_advance_banner_string += std::to_string(this->year);
1294     turn_advance_banner_string += "      Month: ";
1295     turn_advance_banner_string += std::to_string(this->month);
1296
1297     sf::Text turn_advance_banner_text(
1298         turn_advance_banner_string,
1299         *(this->assets_manager_ptr->getFont("DroidSansMono")),
1300         24
```

```

1301     );
1302
1303     turn_advance_banner_text.setOrigin(
1304         turn_advance_banner_text.getLocalBounds().width / 2,
1305         turn_advance_banner_text.getLocalBounds().height / 2
1306     );
1307
1308     turn_advance_banner_text.setPosition(400, GAME_HEIGHT / 2);
1309
1310     turn_advance_banner_text.setFillColor(sf::Color(0, 0, 0, this->turn_advance_alpha));
1311
1312
1313     // 2. construct advance banner backing
1314     sf::RectangleShape backing_rectangle(
1315         sf::Vector2f(
1316             800,
1317             1.5 * turn_advance_banner_text.getLocalBounds().height
1318         )
1319     );
1320
1321     sf::Color backing_colour = RESOURCE_CHIP_GREY;
1322     backing_colour.a = this->turn_advance_alpha;
1323
1324     backing_rectangle.setFillColor(backing_colour);
1325
1326     backing_rectangle.setOrigin(
1327         backing_rectangle.getLocalBounds().width / 2,
1328         backing_rectangle.getLocalBounds().height / 2
1329     );
1330
1331     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1332
1333
1334     // 3. draw
1335     this->render_window_ptr->draw(backing_rectangle);
1336     this->render_window_ptr->draw(turn_advance_banner_text);
1337
1338     // 4. adjust alpha, check terminating conditions
1339     if (this->increase_turn_advance_alpha) {
1340         this->turn_advance_alpha += 180 * SECONDS_PER_FRAME;
1341
1342         if (this->turn_advance_alpha >= 255) {
1343             this->turn_advance_alpha = 255;
1344             this->increase_turn_advance_alpha = false;
1345         }
1346     }
1347
1348     else {
1349         this->turn_advance_alpha -= 180 * SECONDS_PER_FRAME;
1350
1351         if (this->turn_advance_alpha <= 0) {
1352             this->draw_turn_advance_banner = false;
1353         }
1354     }
1355
1356     return;
1357 } /* __drawTurnAdvanceBanner() */

```

4.5.3.12 __drawTurnSummary()

```

void Game::__drawTurnSummary (
    void ) [private]

```

Helper method to draw turn summary.

```

1416 {
1417     if (this->substring_idx < this->turn_summary_string.size()) {
1418         this->assets_manager_ptr->getSound("console string print")->play();
1419
1420         this->turn_summary_text.setString(
1421             this->turn_summary_string.substr(0, this->substring_idx)
1422         );
1423
1424         while (
1425             (this->turn_summary_string.substr(0, this->substring_idx).back() == ' ') or
1426             (this->turn_summary_string.substr(0, this->substring_idx).back() == '\n')
1427         ) {
1428             this->substring_idx++;
1429

```



```

1430         if (this->substring_idx == this->turn_summary_string.size() - 1) {
1431             this->turn_summary_text.setString(
1432                 this->turn_summary_string.substr(0, this->substring_idx)
1433             );
1434         }
1435         break;
1436     }
1437 }
1438
1439 this->substring_idx++;
1440 }
1441
1442 this->render_window_ptr->draw(this->turn_summary_text);
1443
1444 return;
1445 } /* __drawTurnSummary() */

```

4.5.3.13 __drawTutorial()

```

void Game::__drawTutorial (
    void ) [private]

```

Helper method to draw tutorial text.

```

1372 {
1373     if (this->substring_idx < this->tutorial_string.size()) {
1374         this->assets_manager_ptr->getSound("console string print")->play();
1375
1376         this->tutorial_text.setString(
1377             this->tutorial_string.substr(0, this->substring_idx)
1378         );
1379
1380         while (
1381             (this->tutorial_string.substr(0, this->substring_idx).back() == ' ') or
1382             (this->tutorial_string.substr(0, this->substring_idx).back() == '\n')
1383         ) {
1384             this->substring_idx++;
1385
1386             if (this->substring_idx == this->tutorial_string.size() - 1) {
1387                 this->tutorial_text.setString(
1388                     this->tutorial_string.substr(0, this->substring_idx)
1389                 );
1390
1391                 break;
1392             }
1393         }
1394
1395         this->substring_idx++;
1396     }
1397
1398     this->render_window_ptr->draw(this->tutorial_text);
1399
1400     return;
1401 } /* __drawTutorial() */

```

4.5.3.14 __drawVictory()

```

void Game::__drawVictory (
    void ) [private]

```

Helper method to draw victory pop-up.

```

1225 {
1226     // 1. construct victory text and backing rectangle
1227     std::string victory_string = "          **** VICTORY! ****          \n";
1228     victory_string += "          press any key to restart          ";
1229
1230     sf::Text victory_text(
1231         victory_string,
1232         (*this->assets_manager_ptr->getFont("DroidSansMono")),
1233         32

```

```

1234     );
1235
1236     victory_text.setOrigin(
1237         victory_text.getLocalBounds().width / 2,
1238         victory_text.getLocalBounds().height / 2
1239     );
1240
1241     victory_text.setPosition(400, GAME_HEIGHT / 2);
1242
1243     sf::RectangleShape backing_rectangle(
1244         sf::Vector2f(
1245             800,
1246             1.5 * victory_text.getLocalBounds().height
1247         )
1248     );
1249
1250     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
1251
1252     backing_rectangle.setOrigin(
1253         backing_rectangle.getLocalBounds().width / 2,
1254         backing_rectangle.getLocalBounds().height / 2
1255     );
1256
1257     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1258
1259     // 3. colour cycle and draw
1260     if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
1261         victory_text.setFillColor(MONOCHROME_TEXT_GREEN);
1262     }
1263
1264     else {
1265         victory_text.setFillColor(sf::Color(255, 255, 255, 255));
1266     }
1267
1268     this->render_window_ptr->draw(backing_rectangle);
1269     this->render_window_ptr->draw(victory_text);
1270
1271     return;
1272 } /* __drawVictory() */

```

4.5.3.15 __handleImprovementStateMessage()

```

void Game::__handleImprovementStateMessage (
    Message improvement_state_message ) [private]

```

Helper method to handle improvement state messages.

```

464 {
465     // 1. dispatch
466     if (improvement_state_message.int_payload.count("dispatch_MWh") > 0) {
467         this->demand_served_MWh += improvement_state_message.int_payload["dispatch_MWh"];
468     }
469
470     // 2. fuel costs
471     if (improvement_state_message.int_payload.count("fuel_cost") > 0) {
472         this->turn_fuel_cost += improvement_state_message.int_payload["fuel_cost"];
473     }
474
475     // 3. operation and maintenance costs
476     if (improvement_state_message.int_payload.count("operation_maintenance_cost") > 0) {
477         this->turn_operation_maintenance_cost +=
478             improvement_state_message.int_payload["operation_maintenance_cost"];
479     }
480
481     // 4. emissions
482     if (improvement_state_message.int_payload.count("emissions_tonnes_CO2e") > 0) {
483         double emissions_tonnes_CO2e =
484             improvement_state_message.int_payload["emissions_tonnes_CO2e"];
485
486         this->cumulative_emissions_tonnes += emissions_tonnes_CO2e;
487         this->turn_emissions_tonnes += emissions_tonnes_CO2e;
488     }
489
490     return;
491 } /* __handleImprovementStateMessage() */

```

4.5.3.16 __handleKeyPressEvents()

```
void Game::__handleKeyPressEvents (
    void ) [private]
```

Helper method to handle key press events.

```
352 {
353     switch (this->event.key.code) {
354         case (sf::Keyboard::Enter): {
355             if (this->game_phase == GamePhase :: SYSTEM_MANAGEMENT) {
356                 this->__advanceTurn();
357             }
358
359             break;
360         }
361
362
363         case (sf::Keyboard::Tilde): {
364             this->__toggleFrameClockOverlay();
365
366             break;
367         }
368
369         case (sf::Keyboard::Tab): {
370             this->hex_map_ptr->toggleResourceOverlay();
371
372             break;
373         }
374
375
376         case (sf::Keyboard::T): {
377             this->__toggleTutorial();
378
379             break;
380         }
381
382
383         case (sf::Keyboard::Left): {
384             if (this->show_tutorial) {
385                 this->__decrementTutorial();
386             }
387
388             break;
389         }
390
391
392         case (sf::Keyboard::Right): {
393             if (this->show_tutorial) {
394                 this->__incrementTutorial();
395             }
396
397             break;
398         }
399
400
401         default: {
402             // do nothing!
403
404             break;
405         }
406     }
407 }
408
409 return;
410 } /* __handleKeyPressEvents() */
```

4.5.3.17 __handleMouseButtonEvents()

```
void Game::__handleMouseButtonEvents (
    void ) [private]
```

Helper method to handle mouse button events.

```
425 {
426     switch (this->event.mouseButton.button) {
427         case (sf::Mouse::Left): {
```

```

428         //...
429
430         break;
431     }
432
433
434     case (sf::Mouse::Right): {
435         //...
436
437         break;
438     }
439
440
441     default: {
442         // do nothing!
443
444         break;
445     }
446 }
447
448 return;
449 } /* __handleMouseButtonEvents() */

```

4.5.3.18 __incrementTutorial()

```

void Game::__incrementTutorial (
    void ) [private]

```

Helper method to increment tutorial page (with wrap around).

```

292 {
293     if (this->tutorial_page == TUTORIAL_PAGES.size() - 1) {
294         this->tutorial_page = 0;
295     }
296
297     else {
298         this->tutorial_page++;
299     }
300
301     this->tutorial_string = TUTORIAL_PAGES[this->tutorial_page];
302     this->substring_idx = 0;
303
304     this->assets_manager_ptr->getSound("interface click")->play();
305
306     return;
307 } /* __incrementTutorial() */

```

4.5.3.19 __insufficientCreditsAlarm()

```

void Game::__insufficientCreditsAlarm (
    void ) [private]

```

Helper method to sound and display and insufficient credits alarm.

```

806 {
807     // 1. sound buzzer
808     this->assets_manager_ptr->getSound("insufficient credits")->play();
809
810     // 2. construct alarm text and backing rectangle
811     sf::Text insufficient_credits_text(
812         "INSUFFICIENT CREDITS",
813         (*(this->assets_manager_ptr->getFont("DroidSansMono"))),
814         32
815     );
816
817     insufficient_credits_text.setOrigin(
818         insufficient_credits_text.getLocalBounds().width / 2,
819         insufficient_credits_text.getLocalBounds().height / 2
820     );
821
822     insufficient_credits_text.setPosition(400, GAME_HEIGHT / 2);

```

```

823
824     sf::RectangleShape backing_rectangle(
825         sf::Vector2f(
826             1.1 * insufficient_credits_text.getLocalBounds().width,
827             1.5 * insufficient_credits_text.getLocalBounds().height
828         )
829     );
830
831     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
832
833     backing_rectangle.setOrigin(
834         backing_rectangle.getLocalBounds().width / 2,
835         backing_rectangle.getLocalBounds().height / 2
836     );
837
838     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
839
840     // 3. display loop (blocking ~3 seconds)
841     bool red_flag = true;
842     int alarm_frame = 0;
843     double time_since_alarm_s = 0;
844
845     sf::Clock alarm_clock;
846
847     while (alarm_frame < 2.5 * FRAMES_PER_SECOND) {
848
849         time_since_alarm_s = alarm_clock.getElapsedTime().asSeconds();
850
851         if (time_since_alarm_s >= (alarm_frame + 1) * SECONDS_PER_FRAME) {
852             while (this->render_window_ptr->pollEvent(this->event)) {
853                 // do nothing!
854             }
855
856             this->render_window_ptr->clear();
857
858             this->hex_map_ptr->draw();
859             this->context_menu_ptr->draw();
860             this->__draw();
861
862             if (alarm_frame % (FRAMES_PER_SECOND / 3) == 0) {
863                 if (red_flag) {
864                     red_flag = false;
865                 }
866                 else {
867                     red_flag = true;
868                 }
869             }
870
871             if (red_flag) {
872                 insufficient_credits_text.setFillColor(MONOCHROME_TEXT_RED);
873             }
874             else {
875                 insufficient_credits_text.setFillColor(sf::Color(255, 255, 255));
876             }
877
878             this->render_window_ptr->draw(backing_rectangle);
879             this->render_window_ptr->draw(insufficient_credits_text);
880
881             this->render_window_ptr->display();
882
883             alarm_frame++;
884             this->frame++;
885         }
886
887         // check track status, move to next if stopped
888         if (this->assets_manager_ptr->getTrackStatus() == sf::SoundSource::Stopped) {
889             this->assets_manager_ptr->nextTrack();
890             this->assets_manager_ptr->playTrack();
891         }
892     }
893
894     return;
895 }
896
897 /* __insufficientCreditsAlarm( */

```

4.5.3.20 __processEvent()

```

void Game::__processEvent (
    void ) [private]

```

Helper method to process `Game`. To be called once per event.

```

506 {
507     if (this->event.type == sf::Event::Closed) {
508         this->quit_game = true;
509         this->game_loop_broken = true;
510     }
511
512     if (this->event.type == sf::Event::KeyPressed) {
513         this->__handleKeyPressEvents();
514     }
515
516     if (this->event.type == sf::Event::MouseButtonPressed) {
517         this->__handleMouseButtonEvents();
518     }
519
520     return;
521 } /* __processEvent() */

```

4.5.3.21 __processMessage()

```

void Game::__processMessage (
    void ) [private]

```

Helper method to process `Game`. To be called once per message.

```

677 {
678     if (not this->message_hub.isEmpty(GAME_CHANNEL)) {
679         Message game_channel_message = this->message_hub.receiveMessage(GAME_CHANNEL);
680
681         if (game_channel_message.subject == "quit game") {
682             this->quit_game = true;
683             this->game_loop_broken = true;
684
685             std::cout << "Quit game message received by " << this << std::endl;
686             this->message_hub.popMessage(GAME_CHANNEL);
687         }
688
689         if (game_channel_message.subject == "restart game") {
690             this->game_loop_broken = true;
691
692             std::cout << "Restart game message received by " << this << std::endl;
693             this->message_hub.popMessage(GAME_CHANNEL);
694         }
695
696         if (game_channel_message.subject == "state request") {
697             std::cout << "Game state request message received by " << this << std::endl;
698
699             this->__sendGameStateMessage();
700             this->message_hub.popMessage(GAME_CHANNEL);
701         }
702
703         if (game_channel_message.subject == "credits spent") {
704             this->credits -= game_channel_message.int_payload["credits spent"];
705
706             std::cout << "Credits spent message (" <<
707                 game_channel_message.int_payload["credits spent"] << ") received by "
708                 << this << std::endl;
709
710             std::cout << "Current credits (Game): " << this->credits << " K" <<
711                 std::endl;
712
713             this->message_hub.popMessage(GAME_CHANNEL);
714         }
715
716         if (game_channel_message.subject == "insufficient credits") {
717             std::cout << "Insufficient credits message received by " << this <<
718                 std::endl;
719
720             this->__insufficientCreditsAlarm();
721
722             this->message_hub.popMessage(GAME_CHANNEL);
723         }
724
725         if (game_channel_message.subject == "update game phase") {
726             std::cout << "Update game phase message received by " << this << std::endl;
727
728             if (
729                 game_channel_message.string_payload["game phase"] == "system management"
730             ) {

```

```

731         this->game_phase = GamePhase :: SYSTEM_MANAGEMENT;
732         this->__advanceTurn();
733     }
734
735     else if (
736         game_channel_message.string_payload["game phase"] == "loss emissions"
737     ) {
738         this->game_phase = GamePhase :: LOSS_EMISSIONS;
739     }
740
741     else if (
742         game_channel_message.string_payload["game phase"] == "loss demand"
743     ) {
744         this->game_phase = GamePhase :: LOSS_DEMAND;
745     }
746
747     else if (
748         game_channel_message.string_payload["game phase"] == "loss credits"
749     ) {
750         this->game_phase = GamePhase :: LOSS_CREDITS;
751     }
752
753     else if (
754         game_channel_message.string_payload["game phase"] == "victory"
755     ) {
756         this->game_phase = GamePhase :: VICTORY;
757     }
758
759     this->message_hub.popMessage(GAME_CHANNEL);
760 }
761
762 if (game_channel_message.subject == "improvement state") {
763     std::cout << "Improvement state message received by " << this << std::endl;
764
765     this->__handleImprovementStateMessage(game_channel_message);
766
767     this->message_hub.popMessage(GAME_CHANNEL);
768 }
769 }
770
771 if (not this->message_hub.isEmpty(GAME_STATE_CHANNEL)) {
772     Message game_state_message =
773         this->message_hub.receiveMessage(GAME_STATE_CHANNEL);
774
775     if (game_state_message.subject == "turn advance") {
776         if (game_state_message.number_of_reads > 0) {
777             std::cout << "Turn advance message received by " << this << std::endl;
778             this->message_hub.popMessage(GAME_STATE_CHANNEL);
779         }
780     }
781
782     if (game_state_message.subject == "game state") {
783         if (game_state_message.number_of_reads > 0) {
784             std::cout << "Game state message received by " << this << std::endl;
785             this->message_hub.popMessage(GAME_STATE_CHANNEL);
786         }
787     }
788 }
789
790 return;
791 } /* __processMessage() */

```

4.5.3.22 __sendCreditsEarnedMessage()

```

void Game::__sendCreditsEarnedMessage (
    void ) [private]

```

Helper method to format and send a credits earned message.

```

652 {
653     Message credits_earned_message;
654
655     credits_earned_message.channel = SETTLEMENT_CHANNEL;
656     credits_earned_message.subject = "credits earned";
657
658     this->message_hub.sendMessage(credits_earned_message);
659
660     std::cout << "Credits earned message sent by " << this << std::endl;
661     return;
662 } /* __sendCreditsEarnedMessage() */

```

4.5.3.23 __sendGameStateMessage()

```
void Game::__sendGameStateMessage (
    void ) [private]
```

Helper method to format and send a game state message.

```
536 {
537     Message game_state_message;
538
539     game_state_message.channel = GAME_STATE_CHANNEL;
540     game_state_message.subject = "game state";
541
542     game_state_message.int_payload["year"] = this->year;
543     game_state_message.int_payload["month"] = this->month;
544     game_state_message.int_payload["population"] = this->population;
545     game_state_message.int_payload["credits"] = this->credits;
546     game_state_message.int_payload["demand_MWh"] = this->demand_MWh;
547     game_state_message.int_payload["cumulative_emissions_tonnes"] =
548         this->cumulative_emissions_tonnes;
549
550     game_state_message.int_payload["reads"] = 0;
551
552     switch (this->game_phase) {
553     case (GamePhase :: BUILD_SETTLEMENT): {
554         game_state_message.string_payload["game phase"] = "build settlement";
555         break;
556     }
557
558     case (GamePhase :: SYSTEM_MANAGEMENT): {
559         game_state_message.string_payload["game phase"] = "system management";
560         break;
561     }
562
563     case (GamePhase :: LOSS_EMISSIONS): {
564         game_state_message.string_payload["game phase"] = "loss emissions";
565         break;
566     }
567
568     case (GamePhase :: LOSS_DEMAND): {
569         game_state_message.string_payload["game phase"] = "loss demand";
570         break;
571     }
572
573     case (GamePhase :: LOSS_CREDITS): {
574         game_state_message.string_payload["game phase"] = "loss credits";
575         break;
576     }
577
578     case (GamePhase :: VICTORY): {
579         game_state_message.string_payload["game phase"] = "victory";
580         break;
581     }
582
583     default: {
584         // do nothing!
585         break;
586     }
587 }
588
589 game_state_message.vector_payload["demand_vec_MWh"] = this->demand_vec_MWh;
590
591 this->message_hub.sendMessage(game_state_message);
592
593 std::cout << "Game state message sent by " << this << std::endl;
594 return;
595 }
596
597 /* __sendGameStateMessage() */
```


4.5.3.24 __sendTurnAdvanceMessage()

```
void Game::__sendTurnAdvanceMessage (
    void ) [private]
```

Helper method to format and send a turn advance message.

```
623 {
624     Message turn_advance_message;
625
626     turn_advance_message.channel = GAME_STATE_CHANNEL;
627     turn_advance_message.subject = "turn advance";
628
629     turn_advance_message.int_payload["credits"] = this->credits;
630     turn_advance_message.int_payload["month"] = this->month;
631     turn_advance_message.int_payload["demand_MWh"] = this->demand_MWh;
632
633     this->message_hub.sendMessage(turn_advance_message);
634
635     std::cout << "Turn advance message sent by " << this << std::endl;
636     return;
637 } /* __sendTurnAdvanceMessage() */
```

4.5.3.25 __summarizeTurn()

```
void Game::__summarizeTurn (
    void ) [private]
```

Helper method to generate end of turn summary.

```
913 {
914     if (this->turn - 1 == 0) {
915         return;
916     }
917
918     this->substring_idx = 0;
919
920     // 1. handle dispatch and demand
921     if (this->demand_served_MWh > this->past_demand_MWh) {
922         this->overproduction_MWh = this->demand_served_MWh - this->past_demand_MWh;
923         this->demand_served_MWh -= this->overproduction_MWh;
924
925         this->overproduction_penalty =
926             round(CREDITS_PER_MWH_SERVED * this->overproduction_MWh);
927     }
928
929     else if (this->demand_served_MWh < this->past_demand_MWh) {
930         this->demand_remaining_MWh = this->past_demand_MWh - this->demand_served_MWh;
931     }
932
933     // 2. compute dispatch income
934     this->dispatch_income = round(CREDITS_PER_MWH_SERVED * this->demand_served_MWh);
935
936     if (this->dispatch_income > 0) {
937         this->__sendCreditsEarnedMessage();
938     }
939
940     // 3. compute net credit flow
941     this->net_credit_flow = this->dispatch_income -
942         this->overproduction_penalty -
943         this->turn_fuel_cost -
944         this->turn_operation_maintenance_cost;
945
946     this->credits += this->net_credit_flow;
947
948     // 4. assemble turn summary string
949     this->turn_summary_string.clear();
950
951     //16 line x 32 char console "          \n";
952     this->turn_summary_string = "          **** TURN ";
953     this->turn_summary_string += std::to_string(this->turn - 1);
954     this->turn_summary_string += " SUMMARY **** \n";
955     this->turn_summary_string += "          \n";
956
957     this->turn_summary_string += "DEMAND:          ";
958     this->turn_summary_string += std::to_string(this->past_demand_MWh);
959     this->turn_summary_string += " MWh\n";
```

```

960
961     this->turn_summary_string += "DEMAND SERVED:      ";
962     this->turn_summary_string += std::to_string(this->demand_served_MWh);
963     this->turn_summary_string += " MWh\n";
964
965     if (this->overproduction_MWh > 0) {
966         this->turn_summary_string += "OVERPRODUCTION:  ";
967         this->turn_summary_string += std::to_string(this->overproduction_MWh);
968         this->turn_summary_string += " MWh\n";
969     }
970
971     else if (this->demand_remaining_MWh > 0) {
972         this->turn_summary_string += "DEMAND REMAINING:  ";
973         this->turn_summary_string += std::to_string(this->demand_remaining_MWh);
974         this->turn_summary_string += " MWh\n";
975     }
976
977     this->turn_summary_string += "                                \n";
978     this->turn_summary_string += "                                \n";
979
980     this->turn_summary_string += "DISPATCH INCOME:  +";
981     this->turn_summary_string += std::to_string(this->dispatch_income);
982     this->turn_summary_string += " K\n";
983
984     this->turn_summary_string += "FUEL COST:        -";
985     this->turn_summary_string += std::to_string(this->turn_fuel_cost);
986     this->turn_summary_string += " K\n";
987
988     this->turn_summary_string += "OP & MAINT COST:  -";
989     this->turn_summary_string += std::to_string(this->turn_operation_maintenance_cost);
990     this->turn_summary_string += " K\n";
991
992     this->turn_summary_string += "OVERPRODUCTION:   -";
993     this->turn_summary_string += std::to_string(this->overproduction_penalty);
994     this->turn_summary_string += " K\n";
995
996     this->turn_summary_string += "-----\n";
997
998     this->turn_summary_string += "NET:              ";
999
1000     if (this->net_credit_flow > 0) {
1001         this->turn_summary_string += "+";
1002     }
1003
1004     this->turn_summary_string += std::to_string(this->net_credit_flow);
1005     this->turn_summary_string += " K\n";
1006
1007     this->turn_summary_string += "                                \n";
1008
1009     this->turn_summary_string += "EMISSIONS: ";
1010     this->turn_summary_string += std::to_string(this->turn_emissions_tonnes);
1011     this->turn_summary_string += " tonnes CO2e\n";
1012
1013     if (this->turn_emissions_tonnes <= 0) {
1014         this->consecutive_zero_emissions_months++;
1015     }
1016
1017     else {
1018         this->consecutive_zero_emissions_months = 0;
1019     }
1020
1021     // 5. send game state message
1022     this->__sendGameStateMessage();
1023
1024     return;
1025 } /* _summarizeTurn() */

```

4.5.3.26 __toggleFrameClockOverlay()

```

void Game::__toggleFrameClockOverlay (
    void ) [private]

```

Helper method to toggle frame clock overlay.

```

68 {
69     if (this->show_frame_clock_overlay) {
70         this->show_frame_clock_overlay = false;
71     }
72 }

```

```

73     else {
74         this->show_frame_clock_overlay = true;
75     }
76
77     return;
78 } /* __toggleFrameClockOverlay() */

```

4.5.3.27 __toggleTutorial()

```

void Game::__toggleTutorial (
    void ) [private]

```

Helper method to handle toggling the tutorial on and off.

```

263 {
264     if (this->show_tutorial) {
265         this->show_tutorial = false;
266     }
267
268     else {
269         this->show_tutorial = true;
270     }
271
272     this->substring_idx = 0;
273
274     this->assets_manager_ptr->getSound("interface click")->play();
275
276     return;
277 } /* __toggleTutorial() */

```

4.5.3.28 __updatePopulation()

```

void Game::__updatePopulation (
    void ) [private]

```

Helper method to update (i.e. grow) population.

```

141 {
142     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
143     std::default_random_engine generator(seed);
144
145     std::normal_distribution<double> normal_dist(
146         MEAN_POPULATION_GROWTH_RATE,
147         STDEV_POPULATION_GROWTH_RATE
148     );
149
150     double growth_rate = normal_dist(generator);
151
152     this->population = ceil((1 + growth_rate) * this->population);
153
154     return;
155 } /* __updatePopulation() */

```

4.5.3.29 run()

```

bool Game::run (
    void )

```

Method to run game (defines game loop).

Returns

Boolean indicating whether to quit (true) or create a new [Game](#) instance (false).

```

1869 {
1870     // start game loop
1871     while (not this->game_loop_broken) {
1872         this->time_since_start_s = this->clock.getElapsedTime().asSeconds();
1873
1874         if (this->time_since_start_s >= (this->frame + 1) * SECONDS_PER_FRAME) {
1875             // process events
1876             while (
1877                 (not this->transition_from_title) and
1878                 (this->render_window_ptr->pollEvent(this->event))
1879             ) {
1880                 if (
1881                     (this->game_phase == GamePhase::BUILD_SETTLEMENT) or
1882                     (this->game_phase == GamePhase::SYSTEM_MANAGEMENT)
1883                 ) {
1884                     this->hex_map_ptr->processEvent();
1885                     this->context_menu_ptr->processEvent();
1886                     this->__processEvent();
1887                 }
1888                 else {
1889                     if (this->event.type == sf::Event::KeyPressed) {
1890                         this->game_loop_broken = true;
1891                     }
1892                 }
1893             }
1894
1895             // process messages
1896             while (this->message_hub.hasTraffic()) {
1897                 this->hex_map_ptr->processMessage();
1898                 this->context_menu_ptr->processMessage();
1899                 this->__processMessage();
1900
1901                 this->check_terminating_conditions = true;
1902
1903                 if (not this->message_deadlock) {
1904                     this->message_deadlock_frame++;
1905
1906                     if (this->message_deadlock_frame > 5 * FRAMES_PER_SECOND) {
1907                         this->message_hub.printState();
1908                         this->message_deadlock = true;
1909                     }
1910                 }
1911             }
1912
1913             this->message_deadlock = false;
1914             this->message_deadlock_frame = 0;
1915
1916             // handle turn end summary
1917             if (this->turn_end) {
1918                 std::cout << "**** END OF TURN " << std::to_string(this->turn - 1) <<
1919                     " ****" << std::endl;
1920
1921                 this->__summarizeTurn();
1922
1923                 this->turn_end = false;
1924
1925                 this->draw_turn_advance_banner = true;
1926                 this->turn_advance_alpha = 0;
1927                 this->increase_turn_advance_alpha = true;
1928             }
1929
1930             // check terminating conditions
1931             if (this->check_terminating_conditions) {
1932                 this->__checkTerminatingConditions();
1933                 this->check_terminating_conditions = false;
1934             }
1935
1936             // draw frame
1937             this->render_window_ptr->clear();
1938
1939             this->hex_map_ptr->draw();
1940             this->context_menu_ptr->draw();
1941             this->__draw();
1942
1943             this->render_window_ptr->display();
1944
1945             // increment frame
1946             this->frame++;
1947         }
1948     }
1949 }

```

```
1953
1954     // check track status, move to next if stopped
1955     if (this->assets_manager_ptr->getTrackStatus() == sf::SoundSource::Stopped) {
1956         this->assets_manager_ptr->nextTrack();
1957         this->assets_manager_ptr->playTrack();
1958     }
1959
1960     }
1961
1962     return this->quit_game;
1963 } /* run() */
```

4.5.4 Member Data Documentation

4.5.4.1 assets_manager_ptr

```
AssetsManager* Game::assets_manager_ptr [private]
```

A pointer to the assets manager.

4.5.4.2 check_terminating_conditions

```
bool Game::check_terminating_conditions
```

Boolean indicating whether or not to check terminating conditions.

4.5.4.3 clock

```
sf::Clock Game::clock
```

The game clock.

4.5.4.4 consecutive_zero_emissions_months

```
int Game::consecutive_zero_emissions_months
```

The number of recent, consecutive zero emission months.

4.5.4.5 context_menu_ptr

```
ContextMenu* Game::context_menu_ptr
```

Pointer to the context menu.

4.5.4.6 credits

```
int Game::credits
```

Current balance of credits.

4.5.4.7 cumulative_emissions_tonnes

```
int Game::cumulative_emissions_tonnes
```

Cumulative emissions [tonnes] (1 tonne = 1000 kg).

4.5.4.8 demand_MWh

```
int Game::demand_MWh
```

Current energy demand [MWh].

4.5.4.9 demand_remaining_MWh

```
int Game::demand_remaining_MWh
```

The demand remaining at the end of a turn.

4.5.4.10 demand_served_MWh

```
int Game::demand_served_MWh
```

The demand served at the end of a turn.

4.5.4.11 demand_vec_MWh

```
std::vector<double> Game::demand_vec_MWh
```

A vector of daily demands [MWh] for the current month.

4.5.4.12 dispatch_income

```
int Game::dispatch_income
```

The amount earned from dispatch at the end of a turn.

4.5.4.13 draw_turn_advance_banner

```
bool Game::draw_turn_advance_banner
```

A boolean indicating whether or not to draw the turn advance banner.

4.5.4.14 event

```
sf::Event Game::event
```

The game events class.

4.5.4.15 fade_rectangle

```
sf::RectangleShape Game::fade_rectangle
```

A fading rectangle (for smooth transition from title to game).

4.5.4.16 frame

```
unsigned long long int Game::frame
```

The current frame of the game.

4.5.4.17 game_loop_broken

```
bool Game::game_loop_broken
```

Boolean indicating whether or not the game loop is broken.

4.5.4.18 game_phase

```
GamePhase Game::game_phase
```

The current phase of the game.

4.5.4.19 hex_map_ptr

```
HexMap* Game::hex_map_ptr
```

Pointer to the hex map (defines game world).

4.5.4.20 increase_turn_advance_alpha

```
bool Game::increase_turn_advance_alpha
```

A boolean which indicates whether the turn advance alpha is increasing or decreasing.

4.5.4.21 message_deadlock

```
bool Game::message_deadlock
```

A boolean indicating whether a message deadlock has been detected.

4.5.4.22 message_deadlock_frame

```
int Game::message_deadlock_frame
```

A frame counter for detecting message deadlock.

4.5.4.23 message_hub

`MessageHub` `Game::message_hub`

The message hub (for inter-object message traffic).

4.5.4.24 month

`int` `Game::month`

Current game month.

4.5.4.25 net_credit_flow

`int` `Game::net_credit_flow`

The net credit flow at the end of a turn.

4.5.4.26 overproduction_MWh

`int` `Game::overproduction_MWh`

The amount of overproduction at the end of a turn.

4.5.4.27 overproduction_penalty

`int` `Game::overproduction_penalty`

The penalty for overproduction.

4.5.4.28 past_demand_MWh

`int` `Game::past_demand_MWh`

The demand in the previous turn.

4.5.4.29 population

```
int Game::population
```

Current population.

4.5.4.30 quit_game

```
bool Game::quit_game
```

Boolean indicating whether to quit (true) or create a new [Game](#) instance (false).

4.5.4.31 render_window_ptr

```
sf::RenderWindow* Game::render_window_ptr [private]
```

A pointer to the render window.

4.5.4.32 show_frame_clock_overlay

```
bool Game::show_frame_clock_overlay
```

Boolean indicating whether or not to show frame and clock overlay.

4.5.4.33 show_tutorial

```
bool Game::show_tutorial
```

A boolean indicating whether or not to show the tutorial.

4.5.4.34 substring_idx

```
size_t Game::substring_idx
```

The index of the turn summary or tutorial substring.

4.5.4.35 time_since_start_s

```
double Game::time_since_start_s
```

The time elapsed [s] since the start of the game.

4.5.4.36 transition_from_title

```
bool Game::transition_from_title
```

A boolean which indicates if construction follows a title transition.

4.5.4.37 turn

```
int Game::turn = 0
```

The current game turn.

4.5.4.38 turn_advance_alpha

```
double Game::turn_advance_alpha
```

The alpha value for the turn advance banner.

4.5.4.39 turn_emissions_tonnes

```
int Game::turn_emissions_tonnes
```

The amount of emissions at the end of a turn.

4.5.4.40 turn_end

```
bool Game::turn_end
```

A boolean indicating a turn end.

4.5.4.41 turn_fuel_cost

```
int Game::turn_fuel_cost
```

The cost of fuel at the end of a turn.

4.5.4.42 turn_operation_maintenance_cost

```
int Game::turn_operation_maintenance_cost
```

The cost of operation and maintenance at the end of a turn.

4.5.4.43 turn_summary_string

```
std::string Game::turn_summary_string
```

A string representation of the end of turn summary.

4.5.4.44 turn_summary_text

```
sf::Text Game::turn_summary_text
```

A text representation (drawable) of the end of turn summary.

4.5.4.45 tutorial_page

```
size_t Game::tutorial_page
```

Index for which page of the tutorial to show.

4.5.4.46 tutorial_string

```
std::string Game::tutorial_string
```

A string representation of the current tutorial page.

4.5.4.47 tutorial_text

```
sf::Text Game::tutorial_text
```

A text representation (drawable) of the tutorial page.

4.5.4.48 year

```
int Game::year
```

Current game year.

The documentation for this class was generated from the following files:

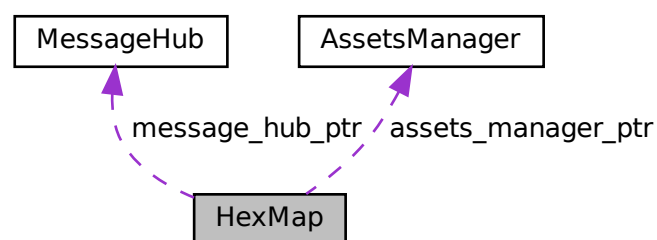
- header/[Game.h](#)
- source/[Game.cpp](#)

4.6 HexMap Class Reference

A class which defines a hex map of hex tiles.

```
#include <HexMap.h>
```

Collaboration diagram for HexMap:



Public Member Functions

- [HexMap](#) (int, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor (intended) for the [HexMap](#) class.
- void [assess](#) (void)
Method to assess the resource of the selected tile.
- void [reroll](#) (void)
Method to re-roll the hex map.
- void [toggleResourceOverlay](#) (void)
Method to toggle the hex map resource overlay.
- void [processEvent](#) (void)
Method to process [HexMap](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [HexMap](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex map to the render window. To be called once per frame.
- void [clear](#) (void)
Method to clear the hex map.
- [~HexMap](#) (void)
Destructor for the [HexMap](#) class.

Public Attributes

- bool [show_resource](#)
A boolean which indicates whether or not to show resource value.
- bool [tile_selected](#)
A boolean which indicates if a tile is currently selected.
- bool [settlement_position_logged](#)
A boolean which indicates if the settlement position has been logged.
- bool [just_constructed](#)
A boolean which indicates if the [HexMap](#) has just been constructed.
- int [n_layers](#)
The number of layers in the hex map.
- int [n_tiles](#)
The number of tiles in the hex map.
- unsigned long long int [frame](#)
The current frame of this object.
- size_t [initial_draw_tile_idx](#)
The current tile idx (for the initial draw tile wave animation).
- int [demand_MWh](#)
Current energy demand [MWh].
- double [dalpha](#)
The change in tile alpha (for the tile wave animation).
- double [position_x](#)
The x position of the hex map's origin (i.e. central) tile.
- double [position_y](#)
The y position of the hex map's origin (i.e. central) tile.
- double [settlement_position_x](#)
The x position of the settlement.
- double [settlement_position_y](#)

- The y position of the settlement.*

 - `sf::RectangleShape` [glass_screen](#)

To give the effect of an old glass screen over the hex map.
- `std::vector< double >` [tile_position_x_vec](#)

A vector of tile x positions.
- `std::vector< double >` [tile_position_y_vec](#)

A vector of tile y position.
- `std::vector< HexTile * >` [border_tiles_vec](#)

A vector of pointers to the border tiles.
- `std::map< double, std::map< double, HexTile * > >` [hex_map](#)

A position-indexed, nested map of hex tiles.
- `std::vector< HexTile * >` [hex_draw_order_vec](#)

A vector of hex tiles, in drawing order.

Private Member Functions

- `void` [__setUpGlassScreen](#) (`void`)

Helper method to set up glass screen effect (drawable).
- `void` [__layTiles](#) (`void`)

Helper method to lay the hex tiles down to generate the game world.
- `void` [__buildDrawOrderVector](#) (`void`)

Helper method to build tile drawing order vector.
- `void` [__setUpInitialDraw](#) (`void`)

Helper method to set up initial map draw (scale all tiles to zero, to support tile wave animation).
- `void` [__handleInitialDraw](#) (`void`)

Helper method to handle initial map draw (tile wave animation).
- `std::vector< double >` [__getNoise](#) (`int`, `int=128`)

Helper method to generate a vector of noise, with values mapped to the closed interval [0, 1]. Applies a random cosine series approach.
- `void` [__procedurallyGenerateTileTypes](#) (`void`)

Helper method to procedurally generate tile types and set tiles accordingly.
- `std::vector< double >` [__getValidMapIndexPositions](#) (`double`, `double`)

Helper method to translate given position into valid index position for a.
- `std::vector< HexTile * >` [__getNeighboursVector](#) (`HexTile *`)

Helper method to assemble a vector pointers to all neighbours of the given tile.
- `TileType` [__getMajorityTileType](#) (`HexTile *`)

Function to return majority tile type of a tile and its neighbours. If no clear majority, simply returns the type of the given tile.
- `void` [__smoothTileTypes](#) (`void`)

Helper method to smooth tile types using a majority rules approach.
- `bool` [__isLakeTouchingOcean](#) (`HexTile *`)
- `void` [__enforceOceanContinuity](#) (`void`)

Helper method to scan tiles and enforce ocean continuity. That is to say, if a lake tile is found to be in contact with an ocean tile, then it becomes ocean.
- `void` [__procedurallyGenerateTileResources](#) (`void`)

Helper method to procedurally generate tile resources and set tiles accordingly.
- `void` [__assembleHexMap](#) (`void`)

Helper method to assemble the hex map.
- `HexTile *` [__getSelectedTile](#) (`void`)

Helper method to get pointer to selected tile.
- `void` [__logSettlementPosition](#) (`void`)

- Helper method to log settlement position (if not already done).*
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__sendNoTileSelectedMessage](#) (void)
Helper method to format and send message on no tile selected.
- void [__assessNeighbours](#) ([HexTile](#) *)
Helper method to assess all neighbours of the given tile.
- void [__drawTotalDispatch](#) (void)
Helper method to compute and draw current total production / dispatch from all production assets.

Private Attributes

- sf::Event * [event_ptr](#)
A pointer to the event class.
- sf::RenderWindow * [render_window_ptr](#)
A pointer to the render window.
- [AssetsManager](#) * [assets_manager_ptr](#)
A pointer to the assets manager.
- [MessageHub](#) * [message_hub_ptr](#)
A pointer to the message hub.

4.6.1 Detailed Description

A class which defines a hex map of hex tiles.

4.6.2 Constructor & Destructor Documentation

4.6.2.1 HexMap()

```
HexMap::HexMap (
    int n_layers,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor (intended) for the [HexMap](#) class.

Parameters

<i>n_layers</i>	The number of layers in the HexMap .
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.


```

1411 {
1412     // 1. set attributes
1413
1414     // 1.1. private
1415     this->event_ptr = event_ptr;
1416     this->render_window_ptr = render_window_ptr;
1417
1418     this->assets_manager_ptr = assets_manager_ptr;
1419     this->message_hub_ptr = message_hub_ptr;
1420
1421     // 1.2. public
1422     this->show_resource = false;
1423     this->tile_selected = false;
1424     this->settlement_position_logged = false;
1425     this->just_constructed = true;
1426
1427     this->frame = 0;
1428     this->initial_draw_tile_idx = 1;
1429
1430     this->n_layers = n_layers;
1431     if (this->n_layers < 0) {
1432         this->n_layers = 0;
1433     }
1434
1435     this->demand_MWh = 0;
1436
1437     this->dalpha = 1.6 * FRAMES_PER_SECOND;
1438
1439     this->position_x = 400;
1440     this->position_y = 400;
1441
1442     this->settlement_position_x = 0;
1443     this->settlement_position_y = 0;
1444
1445     // 2. assemble n layer hex map
1446     this->__assembleHexMap();
1447
1448     // 3. set up and position drawable attributes
1449     this->__setUpGlassScreen();
1450
1451     // 4. add message channel(s)
1452     this->message_hub_ptr->addChannel(TILE_SELECTED_CHANNEL);
1453     this->message_hub_ptr->addChannel(NO_TILE_SELECTED_CHANNEL);
1454     this->message_hub_ptr->addChannel(TILE_STATE_CHANNEL);
1455     this->message_hub_ptr->addChannel(HEX_MAP_CHANNEL);
1456
1457     std::cout << "HexMap constructed at " << this << std::endl;
1458
1459     return;
1460 } /* HexMap(), intended */

```

4.6.2.2 ~HexMap()

```

HexMap::~HexMap (
    void )

```

Destructor for the [HexMap](#) class.

```

1792 {
1793     this->clear();
1794
1795     std::cout << "HexMap at " << this << " destroyed" << std::endl;
1796
1797     return;
1798 } /* ~HexMap() */

```

4.6.3 Member Function Documentation

4.6.3.1 __assembleHexMap()

```
void HexMap::__assembleHexMap (
    void ) [private]
```

Helper method to assemble the hex map.

```
966 {
967     // 1. seed RNG (using milliseconds since 1 Jan 1970)
968     unsigned long long int milliseconds_since_epoch =
969         std::chrono::duration_cast<std::chrono::milliseconds>(
970             std::chrono::system_clock::now().time_since_epoch()
971         ).count();
972     srand(milliseconds_since_epoch);
973
974     // 2. lay tiles
975     this->__layTiles();
976     this->__buildDrawOrderVector();
977
978     // 3. procedurally generate types
979     this->__procedurallyGenerateTileTypes();
980
981     // 4. procedurally generate resources
982     this->__procedurallyGenerateTileResources();
983
984     // 5. set up initial draw
985     this->__setUpInitialDraw();
986
987     return;
988 } /* __assembleHexMap() */
```

4.6.3.2 __assessNeighbours()

```
void HexMap::__assessNeighbours (
    HexTile * hex_ptr ) [private]
```

Helper method to assess all neighbours of the given tile.

Parameters

<i>Pointer</i>	to the tile whose neighbours are to be assessed.
----------------	--

```
1217 {
1218     std::vector<HexTile*> neighbours_vec = this->__getNeighboursVector(hex_ptr);
1219
1220     for (size_t i = 0; i < neighbours_vec.size(); i++) {
1221         neighbours_vec[i]->assess();
1222     }
1223
1224     return;
1225 } /* __assessNeighbours() */
```

4.6.3.3 __buildDrawOrderVector()

```
void HexMap::__buildDrawOrderVector (
    void ) [private]
```

Helper method to build tile drawing order vector.

```
273 {
274     // 1. build temp list of tiles
275     std::list<HexTile*> temp_list;
276
277     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
```

```

278     std::map<double, HexTile*>::iterator hex_map_iter_y;
279     for (
280         hex_map_iter_x = this->hex_map.begin();
281         hex_map_iter_x != this->hex_map.end();
282         hex_map_iter_x++
283     ) {
284         for (
285             hex_map_iter_y = hex_map_iter_x->second.begin();
286             hex_map_iter_y != hex_map_iter_x->second.end();
287             hex_map_iter_y++
288         ) {
289             temp_list.push_back(hex_map_iter_y->second);
290         }
291     }
292
293     // 2. move elements from temp list to drawing order vector
294     double min_position_y = 0;
295     std::list<HexTile*>::iterator list_iter;
296
297     while (not temp_list.empty()) {
298         // 2.1. determine min y position
299         min_position_y = std::numeric_limits<double>::infinity();
300
301         for (
302             list_iter = temp_list.begin();
303             list_iter != temp_list.end();
304             list_iter++
305         ) {
306             if ((*list_iter)->position_y < min_position_y) {
307                 min_position_y = (*list_iter)->position_y;
308             }
309         }
310
311         // 2.2 move min y list elements to drawing order vec
312         list_iter = temp_list.begin();
313         while (list_iter != temp_list.end()) {
314             if ((*list_iter)->position_y == min_position_y) {
315                 this->hex_draw_order_vec.push_back((*list_iter));
316                 list_iter = temp_list.erase(list_iter);
317             }
318             else {
319                 list_iter++;
320             }
321         }
322     }
323 }
324
325 return;
326 } /* __buildDrawOrderVector() */

```

4.6.3.4 __drawTotalDispatch()

```

void HexMap::__drawTotalDispatch (
    void ) [private]

```

Helper method to compute and draw current total production / dispatch from all production assets.

```

1241 {
1242     // 1. compute total production / dispatch
1243     int total_production_dispatch_MWh = 0;
1244
1245     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
1246     std::map<double, HexTile*>::iterator hex_map_iter_y;
1247
1248     TileImprovement* tile_improvement_ptr;
1249
1250     for (
1251         hex_map_iter_x = this->hex_map.begin();
1252         hex_map_iter_x != this->hex_map.end();
1253         hex_map_iter_x++
1254     ) {
1255         for (
1256             hex_map_iter_y = hex_map_iter_x->second.begin();
1257             hex_map_iter_y != hex_map_iter_x->second.end();
1258             hex_map_iter_y++
1259         ) {
1260             if (
1261                 (hex_map_iter_y->second->has_improvement) and
1262                 (hex_map_iter_y->second->tile_improvement_ptr->tile_improvement_type !=

```

```

1263         TileImprovementType :: SETTLEMENT)
1264     ) {
1265         tile_improvement_ptr = hex_map_iter_y->second->tile_improvement_ptr;
1266
1267         switch (tile_improvement_ptr->tile_improvement_type) {
1268             case (TileImprovementType :: DIESEL_GENERATOR): {
1269                 total_production_dispatch_MWh +=
1270                     ((DieselGenerator*)tile_improvement_ptr->production_MWh;
1271
1272                 break;
1273             }
1274
1275
1276             case (TileImprovementType :: SOLAR_PV): {
1277                 total_production_dispatch_MWh +=
1278                     ((SolarPV*)tile_improvement_ptr->dispatch_MWh;
1279
1280                 break;
1281             }
1282
1283
1284             case (TileImprovementType :: TIDAL_TURBINE): {
1285                 total_production_dispatch_MWh +=
1286                     ((TidalTurbine*)tile_improvement_ptr->dispatch_MWh;
1287
1288                 break;
1289             }
1290
1291
1292             case (TileImprovementType :: WAVE_ENERGY_CONVERTER): {
1293                 total_production_dispatch_MWh +=
1294                     ((WaveEnergyConverter*)tile_improvement_ptr->dispatch_MWh;
1295
1296                 break;
1297             }
1298
1299
1300             case (TileImprovementType :: WIND_TURBINE): {
1301                 total_production_dispatch_MWh +=
1302                     ((WindTurbine*)tile_improvement_ptr->dispatch_MWh;
1303
1304                 break;
1305             }
1306
1307
1308             default: {
1309                 // do nothing!
1310
1311                 break;
1312             }
1313         }
1314     }
1315 }
1316
1317 // 2. construct total text
1318 sf::Text total_production_dispatch_text(
1319     std::to_string(total_production_dispatch_MWh),
1320     *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
1321     16
1322 );
1323
1324 total_production_dispatch_text.setOrigin(
1325     total_production_dispatch_text.getLocalBounds().width / 2,
1326     total_production_dispatch_text.getLocalBounds().height / 2
1327 );
1328
1329 total_production_dispatch_text.setPosition(800 - 20, 20 - 4);
1330
1331 sf::Color text_colour;
1332
1333 if (total_production_dispatch_MWh < this->demand_MWh) {
1334     text_colour = MONOCHROME_TEXT_RED;
1335 }
1336
1337 else if (total_production_dispatch_MWh > this->demand_MWh) {
1338     text_colour = MONOCHROME_TEXT_AMBER;
1339 }
1340
1341 else {
1342     text_colour = MONOCHROME_TEXT_GREEN;
1343 }
1344
1345 total_production_dispatch_text.setFillColor(text_colour);
1346
1347 // 4. construct total backing
1348 sf::RectangleShape total_production_dispatch_backing(sf::Vector2f(32, 32));

```

```

1350
1351     total_production_dispatch_backing.setOrigin(
1352         total_production_dispatch_backing.getLocalBounds().width / 2,
1353         total_production_dispatch_backing.getLocalBounds().height / 2
1354     );
1355
1356     total_production_dispatch_backing.setPosition(800 - 20, 20);
1357
1358     total_production_dispatch_backing.setFillColor(MONOCHROME_SCREEN_BACKGROUND);
1359
1360     total_production_dispatch_backing.setOutlineColor(MENU_FRAME_GREY);
1361     total_production_dispatch_backing.setOutlineThickness(2);
1362
1363     // 4. draw
1364     if (total_production_dispatch_MWh > 0) {
1365         this->render_window_ptr->draw(total_production_dispatch_backing);
1366         this->render_window_ptr->draw(total_production_dispatch_text);
1367     }
1368
1369     return;
1370 } /* __drawTotalDispatch() */

```

4.6.3.5 __enforceOceanContinuity()

```

void HexMap::__enforceOceanContinuity (
    void ) [private]

```

Helper method to scan tiles and enforce ocean continuity. That is to say, if a lake tile is found to be in contact with an ocean tile, then it becomes ocean.

```

877 {
878     std::cout << "enforcing ocean continuity ..." << std::endl;
879
880     bool tile_changed = false;
881
882     // 1. scan tiles and enforce (where appropriate)
883     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
884     std::map<double, HexTile*>::iterator hex_map_iter_y;
885     HexTile* hex_ptr;
886     for (
887         hex_map_iter_x = this->hex_map.begin();
888         hex_map_iter_x != this->hex_map.end();
889         hex_map_iter_x++
890     ) {
891         for (
892             hex_map_iter_y = hex_map_iter_x->second.begin();
893             hex_map_iter_y != hex_map_iter_x->second.end();
894             hex_map_iter_y++
895         ) {
896             hex_ptr = hex_map_iter_y->second;
897
898             if (this->__isLakeTouchingOcean(hex_ptr)) {
899                 hex_ptr->setTileType(TileType :: OCEAN);
900                 tile_changed = true;
901             }
902         }
903     }
904
905     if (tile_changed) {
906         this->__enforceOceanContinuity();
907     }
908     else {
909         return;
910     }
911 } /* __enforceOceanContinuity() */

```

4.6.3.6 __getMajorityTileType()

```

TileType HexMap::__getMajorityTileType (
    HexTile * hex_ptr ) [private]

```

Function to return majority tile type of a tile and its neighbours. If no clear majority, simply returns the type of the given tile.

Parameters

<code>hex_ptr</code>	Pointer to the given tile.
----------------------	----------------------------

Returns

The majority tile type of the tile and its neighbours. If no clear majority type, then the type of the given tile is simply returned.

```

733 {
734     // 1. init type count map
735     std::map<TileType, int> type_count_map;
736     type_count_map[hex_ptr->tile_type] = 1;
737
738     // 2. survey neighbours, count type instances
739     std::vector<HexTile*> neighbours_vec = this->__getNeighboursVector(hex_ptr);
740
741     for (size_t i = 0; i < neighbours_vec.size(); i++) {
742         if (type_count_map.count(neighbours_vec[i]->tile_type) <= 0) {
743             type_count_map[neighbours_vec[i]->tile_type] = 1;
744         }
745         else {
746             type_count_map[neighbours_vec[i]->tile_type] += 1;
747         }
748     }
749
750     // 3. find majority tile type
751     int max_count = -1 * std::numeric_limits<int>::infinity();
752     TileType majority_tile_type = hex_ptr->tile_type;
753
754     std::map<TileType, int>::iterator map_iter;
755     for (
756         map_iter = type_count_map.begin();
757         map_iter != type_count_map.end();
758         map_iter++
759     ){
760         if (map_iter->second > max_count) {
761             max_count = map_iter->second;
762             majority_tile_type = map_iter->first;
763         }
764     }
765
766     // 4. detect ties
767     for (
768         map_iter = type_count_map.begin();
769         map_iter != type_count_map.end();
770         map_iter++
771     ){
772         if (
773             map_iter->second == max_count and
774             map_iter->first != majority_tile_type
775         ) {
776             majority_tile_type = hex_ptr->tile_type;
777             break;
778         }
779     }
780
781     return majority_tile_type;
782 } /* __getMajorityTileType() */

```

4.6.3.7 __getNeighboursVector()

```

std::vector< HexTile * > HexMap::__getNeighboursVector (
    HexTile * hex_ptr ) [private]

```

Helper method to assemble a vector pointers to all neighbours of the given tile.

Parameters

<code>hex_ptr</code>	A pointer to the given tile.
----------------------	------------------------------

Returns

A vector of pointers to all neighbours of the given tile.

```

675 {
676     std::vector<HexTile*> neighbours_vec;
677
678     // 1. build potential neighbour positions
679     std::vector<double> potential_neighbour_x_vec(6, 0);
680     std::vector<double> potential_neighbour_y_vec(6, 0);
681
682     for (int i = 0; i < 6; i++) {
683         potential_neighbour_x_vec[i] = hex_ptr->position_x +
684             2 * hex_ptr->minor_radius * cos((60 * i) * (M_PI / 180));
685
686         potential_neighbour_y_vec[i] = hex_ptr->position_y +
687             2 * hex_ptr->minor_radius * sin((60 * i) * (M_PI / 180));
688     }
689
690     // 2. populate neighbours vector
691     std::vector<double> map_index_positions;
692     double potential_x = 0;
693     double potential_y = 0;
694
695     for (int i = 0; i < 6; i++) {
696         potential_x = potential_neighbour_x_vec[i];
697         potential_y = potential_neighbour_y_vec[i];
698
699         map_index_positions = this->__getValidMapIndexPositions(
700             potential_x,
701             potential_y
702         );
703
704         if (not (map_index_positions[0] == -1)) {
705             neighbours_vec.push_back(
706                 this->hex_map[map_index_positions[0]][map_index_positions[1]]
707             );
708         }
709     }
710
711     return neighbours_vec;
712 } /* __getNeighbourVector() */

```

4.6.3.8 __getNoise()

```

std::vector< double > HexMap::__getNoise (
    int n_elements,
    int n_components = 128 ) [private]

```

Helper method to generate a vector of noise, with values mapped to the closed interval [0, 1]. Applies a random cosine series approach.

Parameters

<i>n_elements</i>	The number of elements in the generated noise vector.
<i>n_components</i>	The number of components to use in the random cosine series. Defaults to 64.

Returns

A vector of noise, with values mapped to the closed interval [0, 1].

```

440 {
441     // 1. generate random amplitude, wave number, direction, and phase vectors
442     std::vector<double> random_amplitude_vec(n_components, 0);
443     std::vector<double> random_wave_number_vec(n_components, 0);
444     std::vector<double> random_frequency_vec(n_components, 0);
445     std::vector<double> random_direction_vec(n_components, 0);
446     std::vector<double> random_phase_vec(n_components, 0);
447
448     for (int i = 0; i < n_components; i++) {

```

```

449         random_amplitude_vec[i] = 10 * ((double)rand() / RAND_MAX);
450
451         random_wave_number_vec[i] = 2 * M_PI * ((double)rand() / RAND_MAX);
452
453         random_frequency_vec[i] = ((double)rand() / RAND_MAX);
454
455         random_direction_vec[i] = 2 * M_PI * ((double)rand() / RAND_MAX);
456
457         random_phase_vec[i] = 2 * M_PI * ((double)rand() / RAND_MAX);
458     }
459
460     // 2. generate noise vec
461     double amp = 0;
462     double wave_no = 0;
463     double freq = 0;
464     double dir = 0;
465     double phase = 0;
466
467     double x = 0;
468     double y = 0;
469     double t = time(NULL);
470
471     double max_noise = -1 * std::numeric_limits<double>::infinity();
472     double min_noise = std::numeric_limits<double>::infinity();
473
474     double noise = 0;
475     std::vector<double> noise_vec(n_elements, 0);
476
477     for (int i = 0; i < n_elements; i++) {
478         x = this->tile_position_x_vec[i] - this->position_x;
479         y = this->tile_position_y_vec[i] - this->position_y;
480
481         for (int j = 0; j < n_components; j++) {
482             amp = random_amplitude_vec[j];
483             wave_no = random_wave_number_vec[j];
484             freq = random_frequency_vec[j];
485             dir = random_direction_vec[j];
486             phase = random_phase_vec[j];
487
488             noise += (amp / (j + 1)) * cos(
489                 wave_no * (j + 1) * (x * sin(dir) + y * cos(dir)) +
490                 2 * M_PI * (j + 1) * freq * t +
491                 phase
492             );
493         }
494
495         noise_vec[i] = noise;
496
497         if (noise > max_noise) {
498             max_noise = noise;
499         }
500
501         else if (noise < min_noise) {
502             min_noise = noise;
503         }
504
505         noise = 0;
506     }
507
508     // 3. normalize noise vec
509     for (int i = 0; i < n_elements; i++) {
510         noise_vec[i] = (noise_vec[i] - min_noise) / (max_noise - min_noise);
511
512         if (noise_vec[i] < 0) {
513             noise_vec[i] = 0;
514         }
515         else if (noise_vec[i] > 1) {
516             noise_vec[i] = 1;
517         }
518     }
519
520     return noise_vec;
521 } /* __getNoise() */

```

4.6.3.9 __getSelectedTile()

```

HexTile * HexMap::__getSelectedTile (
    void ) [private]

```

Helper method to get pointer to selected tile.

Returns

Pointer to selected tile (or NULL if no tile selected).

```

1005 {
1006     HexTile* selected_tile_ptr = NULL;
1007
1008     bool break_flag = false;
1009     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
1010     std::map<double, HexTile*>::iterator hex_map_iter_y;
1011
1012     for (
1013         hex_map_iter_x = this->hex_map.begin();
1014         hex_map_iter_x != this->hex_map.end();
1015         hex_map_iter_x++
1016     ) {
1017         for (
1018             hex_map_iter_y = hex_map_iter_x->second.begin();
1019             hex_map_iter_y != hex_map_iter_x->second.end();
1020             hex_map_iter_y++
1021         ) {
1022             if (hex_map_iter_y->second->is_selected) {
1023                 selected_tile_ptr = hex_map_iter_y->second;
1024                 break_flag = true;
1025             }
1026
1027             if (break_flag) {
1028                 break;
1029             }
1030         }
1031
1032         if (break_flag) {
1033             break;
1034         }
1035     }
1036
1037     return selected_tile_ptr;
1038 } /* __getSelectedTile() */

```

4.6.3.10 __getValidMapIndexPositions()

```

std::vector< double > HexMap::__getValidMapIndexPositions (
    double potential_x,
    double potential_y ) [private]

```

Helper method to translate given position into valid index position for a.

Parameters

<i>potential_x</i>	The potential x position of the tile.
<i>potential_y</i>	The potential y position of the tile.

Returns

A vector of positions, either valid for indexing into the hex map, or sentinel values (-1) if invalid.

```

621 {
622     std::vector<double> map_index_positions = {-1, -1};
623
624     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
625     std::map<double, HexTile*>::iterator hex_map_iter_y;
626     HexTile* hex_ptr;
627
628     double distance = 0;
629
630     for (
631         hex_map_iter_x = this->hex_map.begin();

```

```

632     hex_map_iter_x != this->hex_map.end();
633     hex_map_iter_x++
634 ) {
635     for (
636         hex_map_iter_y = hex_map_iter_x->second.begin();
637         hex_map_iter_y != hex_map_iter_x->second.end();
638         hex_map_iter_y++
639     ) {
640         hex_ptr = hex_map_iter_y->second;
641
642         distance = sqrt (
643             pow(hex_ptr->position_x - potential_x, 2) +
644             pow(hex_ptr->position_y - potential_y, 2)
645         );
646
647         if (distance <= hex_ptr->minor_radius / 4) {
648             map_index_positions = {hex_ptr->position_x, hex_ptr->position_y};
649             return map_index_positions;
650         }
651     }
652 }
653
654 return map_index_positions;
655 } /* __isInHexMap() */

```

4.6.3.11 __handleInitialDraw()

```

void HexMap::__handleInitialDraw (
    void ) [private]

```

Helper method to handle initial map draw (tile wave animation).

```

373 {
374     double alpha = 0;
375     sf::Color tile_colour(255, 255, 255, 255);
376
377     for (size_t i = 0; i < this->initial_draw_tile_idx; i++) {
378         tile_colour = this->hex_draw_order_vec[i]->tile_sprite.getFillColor();
379         alpha = tile_colour.a;
380
381         alpha += this->dalpha;
382
383         if (alpha >= 255) {
384             alpha = 255;
385         }
386
387         tile_colour.a = alpha;
388
389         this->hex_draw_order_vec[i]->tile_sprite.setFillColor(tile_colour);
390         this->hex_draw_order_vec[i]->tile_decoration_sprite.setColor(
391             sf::Color(255, 255, 255, alpha)
392         );
393
394         if (i < this->hex_draw_order_vec.size() - 1) {
395             if (i == this->initial_draw_tile_idx - 1) {
396                 if (alpha >= 128) {
397                     this->initial_draw_tile_idx++;
398
399                     if (
400                         this->assets_manager_ptr->getSound("card flick")->getStatus() !=
401                         sf::SoundSource::Playing
402                     ) {
403                         this->assets_manager_ptr->getSound("card flick")->play();
404                     }
405                 }
406             }
407         }
408
409         else {
410             if (alpha >= 255) {
411                 this->just_constructed = false;
412             }
413         }
414     }
415
416     return;
417 } /* __handleInitialDraw() */

```

4.6.3.12 __handleKeyPressEvents()

```
void HexMap::__handleKeyPressEvents (
    void ) [private]
```

Helper method to handle key press events.

```
1109 {
1110     switch (this->event_ptr->key.code) {
1111         case (sf::Keyboard::Escape): {
1112             this->tile_selected = false;
1113         }
1114
1115         default: {
1116             // do nothing!
1117
1118             break;
1119         }
1120     }
1121 }
1122
1123 return;
1124 } /* __handleKeyPressEvents() */
```

4.6.3.13 __handleMouseButtonEvents()

```
void HexMap::__handleMouseButtonEvents (
    void ) [private]
```

Helper method to handle mouse button events.

```
1139 {
1140     switch (this->event_ptr->mouseButton.button) {
1141         case (sf::Mouse::Left): {
1142             HexTile* hex_ptr = this->__getSelectedTile();
1143
1144             if (hex_ptr != NULL) {
1145                 this->tile_selected = true;
1146             }
1147
1148             else if (this->tile_selected) {
1149                 this->tile_selected = false;
1150                 this->__sendNoTileSelectedMessage();
1151             }
1152
1153             break;
1154         }
1155
1156         case (sf::Mouse::Right): {
1157             if (this->tile_selected) {
1158                 this->tile_selected = false;
1159                 this->__sendNoTileSelectedMessage();
1160             }
1161
1162             break;
1163         }
1164
1165         default: {
1166             // do nothing!
1167
1168             break;
1169         }
1170     }
1171 }
1172
1173 return;
1174 } /* __handleMouseButtonEvents() */
```

4.6.3.14 __isLakeTouchingOcean()

```
bool HexMap::__isLakeTouchingOcean (
    HexTile * hex_ptr ) [private]
844 {
845     // 1. if not lake tile, return
846     if (not (hex_ptr->tile_type == TileType :: LAKE)) {
847         return false;
848     }
849
850     // 2. scan neighbours for ocean tiles
851     std::vector<HexTile*> neighbours_vec = this->__getNeighboursVector(hex_ptr);
852
853     for (size_t i = 0; i < neighbours_vec.size(); i++) {
854         if (neighbours_vec[i]->tile_type == TileType :: OCEAN) {
855             return true;
856         }
857     }
858
859     return false;
860 } /* __isLakeTouchingOcean() */
```

4.6.3.15 __layTiles()

```
void HexMap::__layTiles (
    void ) [private]
```

Helper method to lay the hex tiles down to generate the game world.

```
88 {
89     this->n_tiles = 0;
90
91     // 1. add origin tile
92     HexTile* hex_ptr = new HexTile(
93         this->position_x,
94         this->position_y,
95         this->event_ptr,
96         this->render_window_ptr,
97         this->assets_manager_ptr,
98         this->message_hub_ptr
99     );
100
101     this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
102     this->tile_position_x_vec.push_back(hex_ptr->position_x);
103     this->tile_position_y_vec.push_back(hex_ptr->position_y);
104     this->n_tiles++;
105
106
107     // 2. fill out first row (reflect across origin tile)
108     for (int i = 0; i < this->n_layers; i++) {
109         hex_ptr = new HexTile(
110             this->position_x + 2 * (i + 1) * hex_ptr->minor_radius,
111             this->position_y,
112             this->event_ptr,
113             this->render_window_ptr,
114             this->assets_manager_ptr,
115             this->message_hub_ptr
116         );
117
118         this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
119         this->tile_position_x_vec.push_back(hex_ptr->position_x);
120         this->tile_position_y_vec.push_back(hex_ptr->position_y);
121         this->n_tiles++;
122
123         if (i == this->n_layers - 1) {
124             this->border_tiles_vec.push_back(hex_ptr);
125         }
126
127         hex_ptr = new HexTile(
128             this->position_x - 2 * (i + 1) * hex_ptr->minor_radius,
129             this->position_y,
130             this->event_ptr,
131             this->render_window_ptr,
132             this->assets_manager_ptr,
133             this->message_hub_ptr
134         );
135     }
```

```

136         this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
137         this->tile_position_x_vec.push_back(hex_ptr->position_x);
138         this->tile_position_y_vec.push_back(hex_ptr->position_y);
139         this->n_tiles++;
140
141         if (i == this->n_layers - 1) {
142             this->border_tiles_vec.push_back(hex_ptr);
143         }
144     }
145
146     // 3. fill out subsequent rows (reflect across first row)
147     HexTile* first_row_left_tile = hex_ptr;
148
149     int offset_count = 1;
150
151     double x_offset = 0;
152     double y_offset = 0;
153
154     for (
155         int row_width = 2 * this->n_layers;
156         row_width > this->n_layers;
157         row_width--
158     ) {
159         // 3.1. upper row
160         x_offset = first_row_left_tile->position_x +
161             2 * offset_count * first_row_left_tile->minor_radius *
162             cos(60 * (M_PI / 180));
163
164         y_offset = first_row_left_tile->position_y -
165             2 * offset_count * first_row_left_tile->minor_radius *
166             sin(60 * (M_PI / 180));
167
168         hex_ptr = new HexTile(
169             x_offset,
170             y_offset,
171             this->event_ptr,
172             this->render_window_ptr,
173             this->assets_manager_ptr,
174             this->message_hub_ptr
175         );
176
177         this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
178         this->tile_position_x_vec.push_back(hex_ptr->position_x);
179         this->tile_position_y_vec.push_back(hex_ptr->position_y);
180         this->n_tiles++;
181
182         this->border_tiles_vec.push_back(hex_ptr);
183
184         for (int i = 1; i < row_width; i++) {
185             x_offset += 2 * first_row_left_tile->minor_radius;
186
187             hex_ptr = new HexTile(
188                 x_offset,
189                 y_offset,
190                 this->event_ptr,
191                 this->render_window_ptr,
192                 this->assets_manager_ptr,
193                 this->message_hub_ptr
194             );
195
196             this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
197             this->tile_position_x_vec.push_back(hex_ptr->position_x);
198             this->tile_position_y_vec.push_back(hex_ptr->position_y);
199             this->n_tiles++;
200
201             if (row_width == this->n_layers + 1 or i == row_width - 1) {
202                 this->border_tiles_vec.push_back(hex_ptr);
203             }
204         }
205     }
206
207     // 3.2. lower row
208     x_offset = first_row_left_tile->position_x +
209         2 * offset_count * first_row_left_tile->minor_radius *
210         cos(60 * (M_PI / 180));
211
212     y_offset = first_row_left_tile->position_y +
213         2 * offset_count * first_row_left_tile->minor_radius *
214         sin(60 * (M_PI / 180));
215
216     hex_ptr = new HexTile(
217         x_offset,
218         y_offset,
219         this->event_ptr,
220         this->render_window_ptr,
221         this->assets_manager_ptr,
222         this->message_hub_ptr

```

```

223     );
224
225     this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
226     this->tile_position_x_vec.push_back(hex_ptr->position_x);
227     this->tile_position_y_vec.push_back(hex_ptr->position_y);
228     this->n_tiles++;
229
230     this->border_tiles_vec.push_back(hex_ptr);
231
232     for (int i = 1; i < row_width; i++) {
233         x_offset += 2 * first_row_left_tile->minor_radius;
234
235         hex_ptr = new HexTile(
236             x_offset,
237             y_offset,
238             this->event_ptr,
239             this->render_window_ptr,
240             this->assets_manager_ptr,
241             this->message_hub_ptr
242         );
243
244         this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
245         this->tile_position_x_vec.push_back(hex_ptr->position_x);
246         this->tile_position_y_vec.push_back(hex_ptr->position_y);
247         this->n_tiles++;
248
249         if (row_width == this->n_layers + 1 or i == row_width - 1) {
250             this->border_tiles_vec.push_back(hex_ptr);
251         }
252     }
253
254     offset_count++;
255 }
256
257 return;
258 } /* __layTiles() */

```

4.6.3.16 __logSettlementPosition()

```

void HexMap::__logSettlementPosition (
    void ) [private]

```

Helper method to log settlement position (if not already done).

```

1053 {
1054     bool break_flag = false;
1055
1056     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
1057     std::map<double, HexTile*>::iterator hex_map_iter_y;
1058
1059     for (
1060         hex_map_iter_x = this->hex_map.begin();
1061         hex_map_iter_x != this->hex_map.end();
1062         hex_map_iter_x++
1063     ) {
1064         for (
1065             hex_map_iter_y = hex_map_iter_x->second.begin();
1066             hex_map_iter_y != hex_map_iter_x->second.end();
1067             hex_map_iter_y++
1068         ) {
1069             if (
1070                 (hex_map_iter_y->second->has_improvement) and
1071                 (hex_map_iter_y->second->tile_improvement_ptr->tile_improvement_type ==
1072                     TileImprovementType :: SETTLEMENT)
1073             ) {
1074                 this->settlement_position_x = hex_map_iter_y->second->position_x;
1075                 this->settlement_position_y = hex_map_iter_y->second->position_y;
1076
1077                 this->settlement_position_logged = true;
1078
1079                 std::cout << "Settlement position logged, (" <<
1080                     this->settlement_position_x << ", " <<
1081                     this->settlement_position_y << ") " << std::endl;
1082
1083                 break_flag = true;
1084                 break;
1085             }
1086         }
1087     }

```

```

1088         if (break_flag) {
1089             break;
1090         }
1091     }
1092
1093     return;
1094 } /* __logSettlementPosition() */

```

4.6.3.17 __procedurallyGenerateTileResources()

```

void HexMap::__procedurallyGenerateTileResources (
    void ) [private]

```

Helper method to procedurally generate tile resources and set tiles accordingly.

```

926 {
927     // 1. get random cosine series noise vec
928     std::vector<double> noise_vec = this->__getNoise(this->n_tiles);
929
930     // 2. set tile resources based on random cosine series noise
931     int noise_idx = 0;
932
933     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
934     std::map<double, HexTile*>::iterator hex_map_iter_y;
935     for (
936         hex_map_iter_x = this->hex_map.begin();
937         hex_map_iter_x != this->hex_map.end();
938         hex_map_iter_x++
939     ) {
940         for (
941             hex_map_iter_y = hex_map_iter_x->second.begin();
942             hex_map_iter_y != hex_map_iter_x->second.end();
943             hex_map_iter_y++
944         ) {
945             hex_map_iter_y->second->setTileResource(noise_vec[noise_idx]);
946             noise_idx++;
947         }
948     }
949
950     return;
951 } /* __procedurallyGenerateTileResources() */

```

4.6.3.18 __procedurallyGenerateTileTypes()

```

void HexMap::__procedurallyGenerateTileTypes (
    void ) [private]

```

Helper method to procedurally generate tile types and set tiles accordingly.

```

536 {
537     // 1. get random cosine series noise vec
538     std::vector<double> noise_vec = this->__getNoise(this->n_tiles);
539
540     // 2. set initial tile types based on either random cosine series noise or white
541     //     noise (decided by coin toss)
542     int noise_idx = 0;
543
544     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
545     std::map<double, HexTile*>::iterator hex_map_iter_y;
546     for (
547         hex_map_iter_x = this->hex_map.begin();
548         hex_map_iter_x != this->hex_map.end();
549         hex_map_iter_x++
550     ) {
551         for (
552             hex_map_iter_y = hex_map_iter_x->second.begin();
553             hex_map_iter_y != hex_map_iter_x->second.end();
554             hex_map_iter_y++
555         ) {
556             if ((double)rand() / RAND_MAX > 0.5) {
557                 hex_map_iter_y->second->setTileType(noise_vec[noise_idx]);

```

```

558         }
559         else {
560             hex_map_iter_y->second->setTileType((double)rand() / RAND_MAX);
561         }
562         noise_idx++;
563     }
564 }
565
566 // 3. smooth tile types (majority rules)
567 this->__smoothTileTypes();
568
569 // 4. set border tile type to ocean
570 for (size_t i = 0; i < this->border_tiles_vec.size(); i++) {
571     this->border_tiles_vec[i]->setTileType(TileType :: OCEAN);
572 }
573
574 // 5. enforce ocean continuity (i.e. all lake tiles touching ocean become ocean)
575 this->__enforceOceanContinuity();
576
577 // 6. decorate tiles
578 for (
579     hex_map_iter_x = this->hex_map.begin();
580     hex_map_iter_x != this->hex_map.end();
581     hex_map_iter_x++
582 ) {
583     for (
584         hex_map_iter_y = hex_map_iter_x->second.begin();
585         hex_map_iter_y != hex_map_iter_x->second.end();
586         hex_map_iter_y++
587     ) {
588         hex_map_iter_y->second->decorateTile();
589     }
590 }
591
592 return;
593 } /* __procedurallyGenerateTileTypes() */

```

4.6.3.19 __sendNoTileSelectedMessage()

```

void HexMap::__sendNoTileSelectedMessage (
    void ) [private]

```

Helper method to format and send message on no tile selected.

```

1190 {
1191     Message no_tile_selected_message;
1192
1193     no_tile_selected_message.channel = NO_TILE_SELECTED_CHANNEL;
1194     no_tile_selected_message.subject = "no tile selected";
1195
1196     this->message_hub_ptr->sendMessage(no_tile_selected_message);
1197
1198     std::cout << "No tile selected message sent by " << this << std::endl;
1199     return;
1200 } /* __sendNoTileSelectedMessage() */

```

4.6.3.20 __setUpGlassScreen()

```

void HexMap::__setUpGlassScreen (
    void ) [private]

```

Helper method to set up glass screen effect (drawable).

```

68 {
69     this->glass_screen.setSize(sf::Vector2f(GAME_WIDTH, GAME_HEIGHT));
70     this->glass_screen.setFillColor(sf::Color(MONOCROME_SCREEN_BACKGROUND));
71
72     return;
73 } /* __setUpGlassScreen() */

```


4.6.3.21 __setUpInitialDraw()

```
void HexMap::__setUpInitialDraw (
    void ) [private]
```

Helper method to set up initial map draw (scale all tiles to zero, to support tile wave animation).

```
342 {
343     double alpha = 0;
344     sf::Color tile_colour(255, 255, 255, 255);
345
346     for (size_t i = 0; i < this->hex_draw_order_vec.size(); i++) {
347         tile_colour = this->hex_draw_order_vec[i]->tile_sprite.getFillColor();
348         tile_colour.a = alpha;
349
350         this->hex_draw_order_vec[i]->tile_sprite.setFillColor(tile_colour);
351
352         this->hex_draw_order_vec[i]->tile_decoration_sprite.setColor(
353             sf::Color(255, 255, 255, 0)
354         );
355     }
356
357     return;
358 } /* __setUpInitialDraw() */
```

4.6.3.22 __smoothTileTypes()

```
void HexMap::__smoothTileTypes (
    void ) [private]
```

Helper method to smooth tile types using a majority rules approach.

```
797 {
798     std::cout << "smoothing ..." << std::endl;
799
800     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
801     std::map<double, HexTile*>::iterator hex_map_iter_y;
802     HexTile* hex_ptr;
803     TileType majority_tile_type;
804
805     for (
806         hex_map_iter_x = this->hex_map.begin();
807         hex_map_iter_x != this->hex_map.end();
808         hex_map_iter_x++
809     ) {
810         for (
811             hex_map_iter_y = hex_map_iter_x->second.begin();
812             hex_map_iter_y != hex_map_iter_x->second.end();
813             hex_map_iter_y++
814         ) {
815             hex_ptr = hex_map_iter_y->second;
816             majority_tile_type = this->__getMajorityTileType(hex_ptr);
817
818             if (majority_tile_type != hex_ptr->tile_type) {
819                 hex_ptr->setTileType(majority_tile_type);
820             }
821         }
822     }
823
824     return;
825 } /* __smoothTileTypes() */
```

4.6.3.23 assess()

```
void HexMap::assess (
    void )
```

Method to assess the resource of the selected tile.

```

1475 {
1476     HexTile* selected_tile_ptr = this->__getSelectedTile();
1477     if (selected_tile_ptr != NULL) {
1478         selected_tile_ptr->assess();
1479     }
1480
1481     return;
1482 } /* assess() */

```

4.6.3.24 clear()

```

void HexMap::clear (
    void )

```

Method to clear the hex map.

```

1754 {
1755     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
1756     std::map<double, HexTile*>::iterator hex_map_iter_y;
1757     for (
1758         hex_map_iter_x = this->hex_map.begin();
1759         hex_map_iter_x != this->hex_map.end();
1760         hex_map_iter_x++
1761     ) {
1762         for (
1763             hex_map_iter_y = hex_map_iter_x->second.begin();
1764             hex_map_iter_y != hex_map_iter_x->second.end();
1765             hex_map_iter_y++
1766         ) {
1767             delete hex_map_iter_y->second;
1768         }
1769     }
1770     this->hex_map.clear();
1771
1772     this->tile_position_x_vec.clear();
1773     this->tile_position_y_vec.clear();
1774     this->border_tiles_vec.clear();
1775
1776     return;
1777 } /* clear() */

```

4.6.3.25 draw()

```

void HexMap::draw (
    void )

```

Method to draw the hex map to the render window. To be called once per frame.

```

1673 {
1674     // 1. draw background
1675     sf::Color glass_screen_colour = this->glass_screen.getFillColor();
1676     glass_screen_colour.a = 255;
1677     this->glass_screen.setFillColor(glass_screen_colour);
1678
1679     this->render_window_ptr->draw(this->glass_screen);
1680
1681     // 2. draw tiles (other than the selected tile) in drawing order
1682     for (size_t i = 0; i < this->hex_draw_order_vec.size(); i++) {
1683         if (not this->hex_draw_order_vec[i]->is_selected) {
1684             this->hex_draw_order_vec[i]->draw();
1685         }
1686     }
1687
1688     // 3. draw total production / dispatch overlay
1689     if (this->settlement_position_logged) {
1690         this->__drawTotalDispatch();
1691     }
1692
1693     // 4. draw selected tile
1694     HexTile* selected_tile_ptr = this->__getSelectedTile();
1695     if (selected_tile_ptr != NULL) {

```

```

1696         selected_tile_ptr->draw();
1697
1698         if (
1699             (selected_tile_ptr->has_improvement) and
1700             (selected_tile_ptr->tile_improvement_ptr->tile_improvement_type ==
1701              TileImprovementType :: SETTLEMENT)
1702         ) {
1703             this->__drawTotalDispatch();
1704         }
1705     }
1706
1707     // 5. draw resource overlay text indication
1708     if (this->show_resource) {
1709         sf::Text resource_overlay_text (
1710             "**** RENEWABLE RESOURCE OVERLAY ****",
1711             *(this->assets_manager_ptr->getFont ("Glass_TTY_VT220")),
1712             16
1713         );
1714
1715         resource_overlay_text.setPosition(
1716             (800 - resource_overlay_text.getLocalBounds().width) / 2,
1717             GAME_HEIGHT - 70
1718         );
1719
1720         resource_overlay_text.setFillColor(MONOCROME_TEXT_GREEN);
1721
1722         this->render_window_ptr->draw(resource_overlay_text);
1723     }
1724
1725     // 6. draw glass screen
1726     glass_screen_colour = this->glass_screen.getFillColor();
1727     glass_screen_colour.a = 40;
1728     this->glass_screen.setFillColor(glass_screen_colour);
1729
1730     this->render_window_ptr->draw(this->glass_screen);
1731
1732     // 7. handle initial draw (tile wave animation)
1733     if (this->just_constructed) {
1734         this->__handleInitialDraw();
1735     }
1736
1737     this->frame++;
1738     return;
1739 } /* draw() */

```

4.6.3.26 processEvent()

```

void HexMap::processEvent (
    void )

```

Method to process [HexMap](#). To be called once per event.

```

1560 {
1561     // 1. process HexTile events
1562     std::map<double, std::map<double, HexTile*>>::iterator hex_map_iter_x;
1563     std::map<double, HexTile*>::iterator hex_map_iter_y;
1564     for (
1565         hex_map_iter_x = this->hex_map.begin();
1566         hex_map_iter_x != this->hex_map.end();
1567         hex_map_iter_x++
1568     ) {
1569         for (
1570             hex_map_iter_y = hex_map_iter_x->second.begin();
1571             hex_map_iter_y != hex_map_iter_x->second.end();
1572             hex_map_iter_y++
1573         ) {
1574             hex_map_iter_y->second->processEvent();
1575         }
1576     }
1577
1578     // 2. process HexMap events
1579     if (this->event_ptr->type == sf::Event::KeyPressed) {
1580         this->__handleKeyPressEvents();
1581     }
1582
1583     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1584         this->__handleMouseButtonEvents();
1585     }
1586
1587     return;
1588 } /* processEvent() */

```

4.6.3.27 processMessage()

```
void HexMap::processMessage (
    void )
```

Method to process [HexMap](#). To be called once per message.

```
1603 {
1604     // 1. process HexTile messages
1605     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
1606     std::map<double, HexTile*>::iterator hex_map_iter_y;
1607     for (
1608         hex_map_iter_x = this->hex_map.begin();
1609         hex_map_iter_x != this->hex_map.end();
1610         hex_map_iter_x++
1611     ) {
1612         for (
1613             hex_map_iter_y = hex_map_iter_x->second.begin();
1614             hex_map_iter_y != hex_map_iter_x->second.end();
1615             hex_map_iter_y++
1616         ) {
1617             hex_map_iter_y->second->processMessage();
1618         }
1619     }
1620
1621     // 2. process HexMap messages
1622     if (not this->message_hub_ptr->isEmpty(HEX_MAP_CHANNEL)) {
1623         Message hex_map_message = this->message_hub_ptr->receiveMessage(
1624             HEX_MAP_CHANNEL
1625         );
1626
1627         if (hex_map_message.subject == "assess neighbours") {
1628             HexTile* hex_ptr = this->__getSelectedTile();
1629             this->__assessNeighbours(hex_ptr);
1630
1631             std::cout << "Assess neighbours message received by " << this << std::endl;
1632             this->message_hub_ptr->popMessage(HEX_MAP_CHANNEL);
1633         }
1634     }
1635
1636     if (not this->message_hub_ptr->isEmpty(GAME_STATE_CHANNEL)) {
1637         Message game_state_message = this->message_hub_ptr->receiveMessage(
1638             GAME_STATE_CHANNEL
1639         );
1640
1641         if (game_state_message.subject == "game state") {
1642             this->demand_MWh = game_state_message.int_payload["demand_MWh"];
1643
1644             this->message_hub_ptr->incrementMessageRead(GAME_STATE_CHANNEL);
1645
1646             std::cout << "Game state message read and passed by " << this <<
1647                 " (demand: " << this->demand_MWh << " MWh)" << std::endl;
1648         }
1649     }
1650
1651     // 3. log settlement position (if applicable)
1652     if (not this->settlement_position_logged) {
1653         this->__logSettlementPosition();
1654     }
1655
1656     return;
1657 } /* processMessage() */
```

4.6.3.28 reroll()

```
void HexMap::reroll (
    void )
```

Method to re-roll the hex map.

```
1497 {
1498     this->clear();
1499     this->__assembleHexMap();
1500
1501     return;
1502 } /* reroll() */
```

4.6.3.29 toggleResourceOverlay()

```
void HexMap::toggleResourceOverlay (
    void )
```

Method to toggle the hex map resource overlay.

```
1517 {
1518     std::map<double, std::map<double, HexTile*>>::iterator hex_map_iter_x;
1519     std::map<double, HexTile*>::iterator hex_map_iter_y;
1520     for (
1521         hex_map_iter_x = this->hex_map.begin();
1522         hex_map_iter_x != this->hex_map.end();
1523         hex_map_iter_x++
1524     ) {
1525         for (
1526             hex_map_iter_y = hex_map_iter_x->second.begin();
1527             hex_map_iter_y != hex_map_iter_x->second.end();
1528             hex_map_iter_y++
1529         ) {
1530             hex_map_iter_y->second->toggleResourceOverlay();
1531         }
1532     }
1533
1534     if (this->show_resource) {
1535         this->show_resource = false;
1536         this->assets_manager_ptr->getSound("resource overlay toggle off")->play();
1537     }
1538
1539     else {
1540         this->show_resource = true;
1541         this->assets_manager_ptr->getSound("resource overlay toggle on")->play();
1542     }
1543
1544     return;
1545 } /* toggleResourceOverlay() */
```

4.6.4 Member Data Documentation

4.6.4.1 assets_manager_ptr

```
AssetsManager* HexMap::assets_manager_ptr [private]
```

A pointer to the assets manager.

4.6.4.2 border_tiles_vec

```
std::vector<HexTile*> HexMap::border_tiles_vec
```

A vector of pointers to the border tiles.

4.6.4.3 dalpha

```
double HexMap::dalpha
```

The change in tile alpha (for the tile wave animation).

4.6.4.4 demand_MWh

```
int HexMap::demand_MWh
```

Current energy demand [MWh].

4.6.4.5 event_ptr

```
sf::Event* HexMap::event_ptr [private]
```

A pointer to the event class.

4.6.4.6 frame

```
unsigned long long int HexMap::frame
```

The current frame of this object.

4.6.4.7 glass_screen

```
sf::RectangleShape HexMap::glass_screen
```

To give the effect of an old glass screen over the hex map.

4.6.4.8 hex_draw_order_vec

```
std::vector<HexTile*> HexMap::hex_draw_order_vec
```

A vector of hex tiles, in drawing order.

4.6.4.9 hex_map

```
std::map<double, std::map<double, HexTile*> > HexMap::hex_map
```

A position-indexed, nested map of hex tiles.

4.6.4.10 initial_draw_tile_idx

```
size_t HexMap::initial_draw_tile_idx
```

The current tile idx (for the initial draw tile wave animation).

4.6.4.11 just_constructed

```
bool HexMap::just_constructed
```

A boolean which indicates if the [HexMap](#) has just been constructed.

4.6.4.12 message_hub_ptr

```
MessageHub* HexMap::message_hub_ptr [private]
```

A pointer to the message hub.

4.6.4.13 n_layers

```
int HexMap::n_layers
```

The number of layers in the hex map.

4.6.4.14 n_tiles

```
int HexMap::n_tiles
```

The number of tiles in the hex map.

4.6.4.15 position_x

```
double HexMap::position_x
```

The x position of the hex map's origin (i.e. central) tile.

4.6.4.16 position_y

```
double HexMap::position_y
```

The y position of the hex map's origin (i.e. central) tile.

4.6.4.17 render_window_ptr

```
sf::RenderWindow* HexMap::render_window_ptr [private]
```

A pointer to the render window.

4.6.4.18 settlement_position_logged

```
bool HexMap::settlement_position_logged
```

A boolean which indicates if the settlement position has been logged.

4.6.4.19 settlement_position_x

```
double HexMap::settlement_position_x
```

The x position of the settlement.

4.6.4.20 settlement_position_y

```
double HexMap::settlement_position_y
```

The y position of the settlement.

4.6.4.21 show_resource

```
bool HexMap::show_resource
```

A boolean which indicates whether or not to show resource value.

4.6.4.22 tile_position_x_vec

```
std::vector<double> HexMap::tile_position_x_vec
```

A vector of tile x positions.

4.6.4.23 tile_position_y_vec

```
std::vector<double> HexMap::tile_position_y_vec
```

A vector of tile y position.

4.6.4.24 tile_selected

```
bool HexMap::tile_selected
```

A boolean which indicates if a tile is currently selected.

The documentation for this class was generated from the following files:

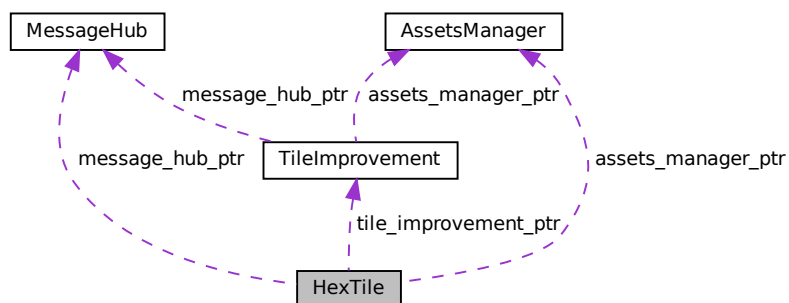
- header/[HexMap.h](#)
- source/[HexMap.cpp](#)

4.7 HexTile Class Reference

A class which defines a hex tile of the hex map.

```
#include <HexTile.h>
```

Collaboration diagram for HexTile:



Public Member Functions

- [HexTile](#) (double, double, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [HexTile](#) class.
- void [setTileType](#) ([TileType](#))
Method to set the tile type (by enum value).
- void [setTileType](#) (double)
Method to set the tile type (by numeric input).
- void [setTileResource](#) ([TileResource](#))
Method to set the tile resource (by enum value).
- void [setTileResource](#) (double)
Method to set the tile resource (by numeric input).
- void [decorateTile](#) (void)
Method to decorate tile.
- void [toggleResourceOverlay](#) (void)
Method to toggle the tile resource overlay.
- void [assess](#) (void)
Method to assess the tile's resource.
- void [processEvent](#) (void)
Method to process [HexTile](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [HexTile](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- [~HexTile](#) (void)
Destructor for the [HexTile](#) class.

Public Attributes

- [TileType](#) [tile_type](#)
The terrain type of the tile.
- [TileResource](#) [tile_resource](#)
The renewable resource quality of the tile.
- bool [show_node](#)
A boolean which indicates whether or not to show the tile node.
- bool [show_resource](#)
A boolean which indicates whether or not to show resource value.
- bool [resource_assessed](#)
A boolean which indicates whether or not the resource has been assessed.
- bool [resource_assessment](#)
A boolean which triggers a resource assessment notification.
- bool [is_selected](#)
A boolean which indicates whether or not the tile is selected.
- bool [draw_explosion](#)
A boolean which indicates whether or not to draw a tile explosion.
- bool [decoration_cleared](#)
A boolean which indicates if the tile decoration has been cleared.
- bool [has_improvement](#)
A boolean which indicates if tile has improvement or not.
- [TileImprovement](#) * [tile_improvement_ptr](#)

- A pointer to the improvement for this tile.*

 - bool [build_menu_open](#)

A boolean which indicates if the tile build menu is open.
 - size_t [explosion_frame](#)

The current frame of the explosion animation.
 - unsigned long long int [frame](#)

The current frame of this object.
 - int [credits](#)

The current balance of credits.
 - int [scrap_improvement_frame](#)

A frame for key-hold to confirm scrapping.
 - double [position_x](#)

The x position of the tile.
 - double [position_y](#)

The y position of the tile.
 - double [major_radius](#)

The radius of the smallest bounding circle.
 - double [minor_radius](#)

The radius of the largest inscribed circle.
 - std::string [game_phase](#)

The current phase of the game.
 - sf::CircleShape [node_sprite](#)

A circle shape to mark the tile node.
 - sf::ConvexShape [tile_sprite](#)

A convex shape which represents the tile.
 - sf::ConvexShape [select_outline_sprite](#)

A convex shape which outlines the tile when selected.
 - sf::CircleShape [resource_chip_sprite](#)

A circle shape which represents a resource chip.
 - sf::Text [resource_text](#)

A text representation of the resource.
 - sf::Sprite [tile_decoration_sprite](#)

A tile decoration sprite.
 - sf::Sprite [magnifying_glass_sprite](#)

A magnifying glass sprite.
 - std::vector< sf::Sprite > [explosion_sprite_reel](#)

A reel of sprites for a tile explosion animation.
 - sf::RectangleShape [build_menu_backing](#)

A backing for the tile build menu.
 - sf::Text [build_menu_backing_text](#)

A text label for the build menu.
 - std::vector< std::vector< sf::Sprite > > [build_menu_options_vec](#)

A vector of sprites for illustrating the tile build options.
 - std::vector< sf::Text > [build_menu_options_text_vec](#)

A vector of text for the tile build options.

Private Member Functions

- void [__setUpNodeSprite](#) (void)
Helper method to set up node sprite.
- void [__setUpTileSprite](#) (void)
Helper method to set up tile sprite.
- void [__setUpSelectOutlineSprite](#) (void)
Helper method to set up select outline sprite.
- void [__setUpResourceChipSprite](#) (void)
Helper method to set up resource chip sprite.
- void [__setResourceText](#) (void)
Helper method to set up resource text.
- void [__setUpMagnifyingGlassSprite](#) (void)
Helper method to set up and position magnifying glass sprite.
- void [__setUpTileExplosionReel](#) (void)
Helper method to set up tile explosion sprite reel.
- void [__setUpBuildOption](#) (std::string, std::string)
Helper method to set up and position the sprite and text for a build option.
- void [__setUpDieselGeneratorBuildOption](#) (void)
Helper method to set up and position the diesel generator build option.
- void [__setUpWindTurbineBuildOption](#) (bool=false, bool=false)
Helper method to set up and position the wind turbine build option.
- void [__setUpSolarPVBuildOption](#) (bool=false)
Helper method to set up and position the solar PV array build option.
- void [__setUpTidalTurbineBuildOption](#) (void)
Helper method to set up and position the tidal turbine build option.
- void [__setUpWaveEnergyConverterBuildOption](#) (void)
Helper method to set up and position the wave energy converter build option.
- void [__setUpEnergyStorageSystemBuildOption](#) (void)
Helper method to set up and position the wave energy converter build option.
- void [__setUpBuildMenu](#) (void)
Helper method to set up and place build menu assets (drawable).
- void [__setIsSelected](#) (bool)
Helper method to set the is selected attribute (of tile and improvement).
- void [__clearDecoration](#) (void)
Helper method to clear tile decoration.
- bool [__isClicked](#) (void)
Helper method to determine if tile was clicked on.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleKeyReleaseEvents](#) (void)
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__openBuildMenu](#) (void)
Helper method to open the tile improvement build menu.
- void [__closeBuildMenu](#) (void)
Helper method to close the tile improvement build menu.
- void [__buildSettlement](#) (void)
Helper method to build a settlement on this tile.
- void [__buildDieselGenerator](#) (void)
Helper method to build a diesel generator on this tile.

- void [__buildSolarPV](#) (void)
Helper method to build a solar PV array on this tile.
- void [__buildWindTurbine](#) (void)
Helper method to build a wind turbine on this tile.
- void [__buildTidalTurbine](#) (void)
Helper method to build a tidal turbine on this tile.
- void [__buildWaveEnergyConverter](#) (void)
Helper method to build a wave energy converter on this tile.
- void [__buildEnergyStorage](#) (void)
Helper method to build an energy storage system on this tile. DEPRECATED.
- void [__scrapImprovement](#) (void)
Helper method to scrap the tile improvement ([Settlement](#) cannot be scrapped). Requires the mapped key to be held continuously to confirm.
- void [__sendTileSelectedMessage](#) (void)
Helper method to format and send message on tile selection.
- std::string [__getTileCoordsSubstring](#) (void)
Helper method to assemble and return tile coordinates substring.
- std::string [__getTileTypeSubstring](#) (void)
Helper method to assemble and return tile type substring.
- std::string [__getTileResourceSubstring](#) (void)
Helper method to assemble and return tile resource substring.
- std::string [__getTileImprovementSubstring](#) (void)
Helper method to assemble and return the tile improvement substring.
- std::string [__getTileOptionsSubstring](#) (void)
Helper method to assemble and return tile options substring.
- void [__sendTileStateMessage](#) (void)
Helper method to format and send tile state message.
- void [__sendAssessNeighboursMessage](#) (void)
Helper method to format and send assess neighbours message.
- void [__sendGameStateRequest](#) (void)
Helper method to format and send a game state request (message).
- void [__sendUpdateGamePhaseMessage](#) (std::string)
Helper method to format and send update game phase message.
- void [__sendCreditsSpentMessage](#) (int)
Helper method to format and send a credits spent message.
- void [__sendInsufficientCreditsMessage](#) (void)
Helper method to format and send an insufficient credits message.

Private Attributes

- sf::Event * [event_ptr](#)
A pointer to the event class.
- sf::RenderWindow * [render_window_ptr](#)
A pointer to the render window.
- [AssetsManager](#) * [assets_manager_ptr](#)
A pointer to the assets manager.
- [MessageHub](#) * [message_hub_ptr](#)
A pointer to the message hub.

4.7.1 Detailed Description

A class which defines a hex tile of the hex map.

4.7.2 Constructor & Destructor Documentation

4.7.2.1 HexTile()

```
HexTile::HexTile (
    double position_x,
    double position_y,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [HexTile](#) class.

Ref: [Wikipedia \[2023\]](#)

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```
2334 {
2335     // 1. set attributes
2336
2337     // 1.1. private
2338     this->event_ptr = event_ptr;
2339     this->render_window_ptr = render_window_ptr;
2340
2341     this->assets_manager_ptr = assets_manager_ptr;
2342     this->message_hub_ptr = message_hub_ptr;
2343
2344     // 1.2. public
2345     this->show_node = false;
2346     this->show_resource = false;
2347     this->resource_assessed = false;
2348     this->resource_assessment = false;
2349     this->is_selected = false;
2350     this->draw_explosion = false;
2351
2352     this->decoration_cleared = false;
2353     this->has_improvement = false;
2354     this->tile_improvement_ptr = NULL;
2355
2356     this->build_menu_open = false;
2357
2358     this->explosion_frame = 0;
2359
2360     this->frame = 0;
2361     this->credits = 0;
2362
2363     this->scrap_improvement_frame = 0;
2364 }
```

```

2365     this->position_x = position_x;
2366     this->position_y = position_y;
2367
2368     this->major_radius = 32;
2369     this->minor_radius = (sqrt(3) / 2) * this->major_radius;
2370
2371     this->game_phase = "build settlement";
2372
2373     // 2. set up and position drawable attributes
2374     this->__setUpNodeSprite();
2375     this->__setUpTileSprite();
2376     this->__setUpSelectOutlineSprite();
2377     this->__setUpResourceChipSprite();
2378     this->__setUpResourceText();
2379     this->__setUpMagnifyingGlassSprite();
2380     this->__setUpTileExplosionReel();
2381
2382     // 3. set tile type and resource (default to none type and average)
2383     this->setTileType(TileType :: NONE_TYPE);
2384     this->setTileResource(TileResource :: AVERAGE);
2385
2386     std::cout << "HexTile constructed at " << this << std::endl;
2387
2388     return;
2389 } /* HexTile() */

```

4.7.2.2 ~HexTile()

```

HexTile::~HexTile (
    void )

```

Destructor for the [HexTile](#) class.

```

2957 {
2958     if (this->tile_improvement_ptr != NULL) {
2959         delete this->tile_improvement_ptr;
2960     }
2961
2962     std::cout << "HexTile at " << this << " destroyed" << std::endl;
2963
2964     return;
2965 } /* ~HexTile() */

```

4.7.3 Member Function Documentation

4.7.3.1 __buildDieselGenerator()

```

void HexTile::__buildDieselGenerator (
    void ) [private]

```

Helper method to build a diesel generator on this tile.

```

1411 {
1412     int build_cost = DIESEL_GENERATOR_BUILD_COST;
1413
1414     if (this->credits < build_cost) {
1415         std::cout << "Cannot build diesel generator: insufficient credits (need "
1416             << build_cost << " K)" << std::endl;
1417
1418         this->__sendInsufficientCreditsMessage();
1419         return;
1420     }
1421
1422     this->tile_improvement_ptr = new DieselGenerator(
1423         this->position_x,
1424         this->position_y,
1425         this->tile_resource,

```

```

1426         this->event_ptr,
1427         this->render_window_ptr,
1428         this->assets_manager_ptr,
1429         this->message_hub_ptr
1430     );
1431
1432     this->has_improvement = true;
1433     this->__closeBuildMenu();
1434
1435     if (not this->resource_assessed) {
1436         this->assess();
1437     }
1438
1439     this->__sendCreditsSpentMessage(build_cost);
1440     this->__sendTileStateMessage();
1441     this->__sendGameStateRequest();
1442
1443     return;
1444 } /* __buildDieselGenerator() */

```

4.7.3.2 __buildEnergyStorage()

```

void HexTile::__buildEnergyStorage (
    void ) [private]

```

Helper method to build an energy storage system on this tile. DEPRECATED.

```

1679 {
1680     /*
1681     int build_cost = ENERGY_STORAGE_SYSTEM_BUILD_COST;
1682
1683     if (this->credits < build_cost) {
1684         std::cout << "Cannot build energy storage system: insufficient credits (need "
1685             << build_cost << " K)" << std::endl;
1686
1687         this->__sendInsufficientCreditsMessage();
1688         return;
1689     }
1690
1691     this->tile_improvement_ptr = new EnergyStorageSystem(
1692         this->position_x,
1693         this->position_y,
1694         this->event_ptr,
1695         this->render_window_ptr,
1696         this->assets_manager_ptr,
1697         this->message_hub_ptr
1698     );
1699
1700     this->has_improvement = true;
1701     this->__closeBuildMenu();
1702
1703     if (not this->resource_assessed) {
1704         this->assess();
1705     }
1706
1707     this->__sendCreditsSpentMessage(build_cost);
1708     this->__sendTileStateMessage();
1709     this->__sendGameStateRequest();
1710     */
1711     return;
1712 } /* __buildEnergyStorage() */

```

4.7.3.3 __buildSettlement()

```

void HexTile::__buildSettlement (
    void ) [private]

```

Helper method to build a settlement on this tile.

```

1364 {
1365     if (this->credits < BUILD_SETTLEMENT_COST) {

```



```

1366         std::cout << "Cannot build settlement: insufficient credits (need "
1367             << BUILD_SETTLEMENT_COST << " K)" << std::endl;
1368
1369         this->__sendInsufficientCreditsMessage();
1370         return;
1371     }
1372
1373     this->__clearDecoration();
1374
1375     this->tile_improvement_ptr = new Settlement(
1376         this->position_x,
1377         this->position_y,
1378         this->tile_resource,
1379         this->event_ptr,
1380         this->render_window_ptr,
1381         this->assets_manager_ptr,
1382         this->message_hub_ptr
1383     );
1384
1385     this->has_improvement = true;
1386
1387     this->assess();
1388     this->__sendAssessNeighboursMessage();
1389
1390     this->__sendUpdateGamePhaseMessage("system management");
1391     this->__sendCreditsSpentMessage(BUILD_SETTLEMENT_COST);
1392     this->__sendTileStateMessage();
1393     this->__sendGameStateRequest();
1394
1395     return;
1396 } /* __buildSettlement() */

```

4.7.3.4 __buildSolarPV()

```

void HexTile::__buildSolarPV (
    void ) [private]

```

Helper method to build a solar PV array on this tile.

```

1459 {
1460     int build_cost = SOLAR_PV_BUILD_COST;
1461
1462     if (this->tile_type == TileType::LAKE) {
1463         build_cost *= SOLAR_PV_WATER_BUILD_MULTIPLIER;
1464     }
1465
1466     if (this->credits < build_cost) {
1467         std::cout << "Cannot build solar PV array: insufficient credits (need "
1468             << build_cost << " K)" << std::endl;
1469
1470         this->__sendInsufficientCreditsMessage();
1471         return;
1472     }
1473
1474     this->tile_improvement_ptr = new SolarPV(
1475         this->position_x,
1476         this->position_y,
1477         this->tile_resource,
1478         this->event_ptr,
1479         this->render_window_ptr,
1480         this->assets_manager_ptr,
1481         this->message_hub_ptr
1482     );
1483
1484     this->has_improvement = true;
1485     this->__closeBuildMenu();
1486
1487     if (not this->resource_assessed) {
1488         this->assess();
1489     }
1490
1491     if (this->tile_type == TileType::LAKE) {
1492         this->decoration_cleared = true;
1493         this->assets_manager_ptr->getSound("splash")->play();
1494     }
1495
1496     this->__sendCreditsSpentMessage(build_cost);
1497     this->__sendTileStateMessage();
1498     this->__sendGameStateRequest();

```

```

1499
1500     return;
1501 } /* __buildSolarPV() */

```

4.7.3.5 __buildTidalTurbine()

```

void HexTile::__buildTidalTurbine (
    void ) [private]

```

Helper method to build a tidal turbine on this tile.

```

1579 {
1580     int build_cost = TIDAL_TURBINE_BUILD_COST;
1581
1582     if (this->credits < build_cost) {
1583         std::cout << "Cannot build tidal turbine: insufficient credits (need "
1584             << build_cost << " K)" << std::endl;
1585
1586         this->__sendInsufficientCreditsMessage();
1587         return;
1588     }
1589
1590     this->tile_improvement_ptr = new TidalTurbine(
1591         this->position_x,
1592         this->position_y,
1593         this->tile_resource,
1594         this->event_ptr,
1595         this->render_window_ptr,
1596         this->assets_manager_ptr,
1597         this->message_hub_ptr
1598     );
1599
1600     this->has_improvement = true;
1601     this->decoration_cleared = true;
1602     this->assets_manager_ptr->getSound("splash")->play();
1603     this->__closeBuildMenu();
1604
1605     if (not this->resource_assessed) {
1606         this->assess();
1607     }
1608
1609     this->__sendCreditsSpentMessage(build_cost);
1610     this->__sendTileStateMessage();
1611     this->__sendGameStateRequest();
1612
1613     return;
1614 } /* __buildTidalTurbine() */

```

4.7.3.6 __buildWaveEnergyConverter()

```

void HexTile::__buildWaveEnergyConverter (
    void ) [private]

```

Helper method to build a wave energy converter on this tile.

```

1629 {
1630     int build_cost = WAVE_ENERGY_CONVERTER_BUILD_COST;
1631
1632     if (this->credits < build_cost) {
1633         std::cout << "Cannot build wave energy converter: insufficient credits (need "
1634             << build_cost << " K)" << std::endl;
1635
1636         this->__sendInsufficientCreditsMessage();
1637         return;
1638     }
1639
1640     this->tile_improvement_ptr = new WaveEnergyConverter(
1641         this->position_x,
1642         this->position_y,
1643         this->tile_resource,
1644         this->event_ptr,

```

```

1645         this->render_window_ptr,
1646         this->assets_manager_ptr,
1647         this->message_hub_ptr
1648     );
1649
1650     this->has_improvement = true;
1651     this->decoration_cleared = true;
1652     this->assets_manager_ptr->getSound("splash")->play();
1653     this->__closeBuildMenu();
1654
1655     if (not this->resource_assessed) {
1656         this->assess();
1657     }
1658
1659     this->__sendCreditsSpentMessage(build_cost);
1660     this->__sendTileStateMessage();
1661     this->__sendGameStateRequest();
1662
1663     return;
1664 } /* __buildWaveEnergyConverter() */

```

4.7.3.7 __buildWindTurbine()

```

void HexTile::__buildWindTurbine (
    void ) [private]

```

Helper method to build a wind turbine on this tile.

```

1516 {
1517     int build_cost = WIND_TURBINE_BUILD_COST;
1518
1519     if (
1520         (this->tile_type == TileType :: LAKE) or
1521         (this->tile_type == TileType :: OCEAN)
1522     ) {
1523         build_cost *= WIND_TURBINE_WATER_BUILD_MULTIPLIER;
1524     }
1525
1526     if (this->credits < build_cost) {
1527         std::cout << "Cannot build wind turbine: insufficient credits (need "
1528             << build_cost << " K)" << std::endl;
1529
1530         this->__sendInsufficientCreditsMessage();
1531         return;
1532     }
1533
1534     this->tile_improvement_ptr = new WindTurbine(
1535         this->position_x,
1536         this->position_y,
1537         this->tile_resource,
1538         this->event_ptr,
1539         this->render_window_ptr,
1540         this->assets_manager_ptr,
1541         this->message_hub_ptr
1542     );
1543
1544     this->has_improvement = true;
1545     this->__closeBuildMenu();
1546
1547     if (not this->resource_assessed) {
1548         this->assess();
1549     }
1550
1551     if (
1552         (this->tile_type == TileType :: LAKE) or
1553         (this->tile_type == TileType :: OCEAN)
1554     ) {
1555         this->decoration_cleared = true;
1556         this->assets_manager_ptr->getSound("splash")->play();
1557     }
1558
1559     this->__sendCreditsSpentMessage(build_cost);
1560     this->__sendTileStateMessage();
1561     this->__sendGameStateRequest();
1562
1563     return;
1564 } /* __buildWindTurbine() */

```

4.7.3.8 __clearDecoration()

```
void HexTile::__clearDecoration (
    void ) [private]
```

Helper method to clear tile decoration.

```
791 {
792     this->decoration_cleared = true;
793     this->draw_explosion = true;
794
795     switch (this->tile_type) {
796         case (TileType :: FOREST): {
797             this->assets_manager_ptr->getSound("clear non-mountains tile")->play();
798             break;
799         }
800
801
802         case (TileType :: MOUNTAINS): {
803             this->assets_manager_ptr->getSound("clear mountains tile")->play();
804             break;
805         }
806
807         case (TileType :: PLAINS): {
808             this->assets_manager_ptr->getSound("clear non-mountains tile")->play();
809             break;
810         }
811
812         default: {
813             // do nothing!
814             break;
815         }
816     }
817
818     return;
819 } /* __clearDecoration() */
```

4.7.3.9 __closeBuildMenu()

```
void HexTile::__closeBuildMenu (
    void ) [private]
```

Helper method to close the tile improvement build menu.

```
1339 {
1340     if (not this->build_menu_open) {
1341         return;
1342     }
1343
1344     this->build_menu_open = false;
1345     this->assets_manager_ptr->getSound("build menu close")->play();
1346
1347     return;
1348 } /* __closeBuildMenu() */
```

4.7.3.10 __getTileCoordsSubstring()

```
std::string HexTile::__getTileCoordsSubstring (
    void ) [private]
```

Helper method to assemble and return tile coordinates substring.

Returns

Tile coordinates substring.

```

1829 {
1830     std::string coords_substring = "TILE COORDS:  ";
1831     coords_substring += std::to_string(int(this->position_x - 400));
1832     coords_substring += ", ";
1833     coords_substring += std::to_string(int(this->position_y - 400));
1834     coords_substring += "\n";
1835
1836     return coords_substring;
1837 } /* __getTileCoordsSubstring() */

```

4.7.3.11 __getTileImprovementSubstring()

```

std::string HexTile::__getTileImprovementSubstring (
    void ) [private]

```

Helper method to assemble and return the tile improvement substring.

Returns

Tile improvement substring.

```

1988 {
1989     std::string improvement_substring = "TILE IMPROVEMENT:  ";
1990
1991     if (this->has_improvement) {
1992         improvement_substring += this->tile_improvement_ptr->tile_improvement_string;
1993         improvement_substring += "\n";
1994     }
1995
1996     else {
1997         improvement_substring += "NONE\n";
1998     }
1999
2000     return improvement_substring;
2001 } /* __getTileImprovementSubstring() */

```

4.7.3.12 __getTileOptionsSubstring()

```

std::string HexTile::__getTileOptionsSubstring (
    void ) [private]

```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

```

2018 {
2019     // 32 char x 17 line console "-----\n";
2020     std::string options_substring = "      **** TILE OPTIONS **** \n";
2021     options_substring += " \n";
2022
2023     if (this->game_phase == "build settlement") {
2024         if (
2025             (this->tile_type != TileType :: OCEAN) and
2026             (this->tile_type != TileType :: LAKE)
2027         ) {
2028             options_substring += "[B]:  BUILD SETTLEMENT (";
2029             options_substring += std::to_string(BUILD_SETTLEMENT_COST);
2030             options_substring += " K)\n";
2031         }

```

```

2032     }
2033
2034
2035     else if (this->game_phase == "system management") {
2036         if (this->has_improvement) {
2037             options_substring.clear();
2038             options_substring = this->tile_improvement_ptr->getTileOptionsSubstring();
2039         }
2040
2041
2042         else if (not this->resource_assessed) {
2043             options_substring += "[A]: ASSESS RESOURCE (";
2044             options_substring += std::to_string(RESOURCE_ASSESSMENT_COST);
2045             options_substring += " K)\n";
2046         }
2047
2048
2049         else if (
2050             (not this->decoration_cleared) and
2051             (this->tile_type != TileType :: OCEAN) and
2052             (this->tile_type != TileType :: LAKE)
2053         ) {
2054             options_substring += "[C]: CLEAR TILE (";
2055
2056             switch (this->tile_type) {
2057                 case (TileType :: FOREST): {
2058                     options_substring += std::to_string(CLEAR_FOREST_COST);
2059
2060                     break;
2061                 }
2062
2063                 case (TileType :: MOUNTAINS): {
2064                     options_substring += std::to_string(CLEAR_MOUNTAINS_COST);
2065
2066                     break;
2067                 }
2068
2069                 case (TileType :: PLAINS): {
2070                     options_substring += std::to_string(CLEAR_PLAINS_COST);
2071
2072                     break;
2073                 }
2074
2075                 default: {
2076                     //do nothing!
2077
2078                     break;
2079                 }
2080             }
2081
2082             options_substring += " K)\n";
2083         }
2084
2085         else if (
2086             (this->decoration_cleared) or
2087             (this->tile_type == TileType :: OCEAN) or
2088             (this->tile_type == TileType :: LAKE)
2089         ) {
2090             options_substring += "[B]: OPEN BUILD MENU\n";
2091         }
2092
2093     }
2094
2095     else if (this->game_phase == "victory") {
2096         options_substring += "      **** VICTORY ****      \n";
2097     }
2098
2099     else {
2100         options_substring += "      **** LOSS ****      \n";
2101     }
2102
2103     return options_substring;
2104 } /* __getTileOptionsString() */

```

4.7.3.13 __getTileResourceSubstring()

```
std::string HexTile::__getTileResourceSubstring (
```

```
void ) [private]
```

Helper method to assemble and return tile resource substring.

Returns

Tile resource substring.

```

1918 {
1919     std::string resource_substring = "TILE RESOURCE: ";
1920
1921     if (this->resource_assessed) {
1922         switch (this->tile_resource) {
1923             case (TileResource :: POOR): {
1924                 resource_substring += "POOR\n";
1925
1926                 break;
1927             }
1928
1929             case (TileResource ::BELOW_AVERAGE): {
1930                 resource_substring += "BELOW AVERAGE\n";
1931
1932                 break;
1933             }
1934
1935             case (TileResource :: AVERAGE): {
1936                 resource_substring += "AVERAGE\n";
1937
1938                 break;
1939             }
1940
1941             case (TileResource :: ABOVE_AVERAGE): {
1942                 resource_substring += "ABOVE AVERAGE\n";
1943
1944                 break;
1945             }
1946
1947             case (TileResource :: GOOD): {
1948                 resource_substring += "GOOD\n";
1949
1950                 break;
1951             }
1952
1953             default: {
1954                 resource_substring += "???\n";
1955
1956                 break;
1957             }
1958         }
1959     }
1960
1961     else {
1962         resource_substring += "???\n";
1963     }
1964
1965     return resource_substring;
1966 }
1967
1968 /* __getTileResourceSubstring() */
1969
1970
1971

```

4.7.3.14 __getTileTypeSubstring()

```

std::string HexTile::__getTileTypeSubstring (
    void ) [private]

```

Helper method to assemble and return tile type substring.

Returns

Tile type substring.

```

1854 {
1855     std::string type_substring = "TILE TYPE:      ";
1856
1857     switch (this->tile_type) {
1858         case (TileType :: FOREST): {
1859             type_substring += "FOREST\n";
1860
1861             break;
1862         }
1863
1864
1865         case (TileType :: LAKE): {
1866             type_substring += "LAKE\n";
1867
1868             break;
1869         }
1870
1871
1872         case (TileType :: MOUNTAINS): {
1873             type_substring += "MOUNTAINS\n";
1874
1875             break;
1876         }
1877
1878
1879         case (TileType :: OCEAN): {
1880             type_substring += "OCEAN\n";
1881
1882             break;
1883         }
1884
1885
1886         case (TileType :: PLAINS): {
1887             type_substring += "PLAINS\n";
1888
1889             break;
1890         }
1891
1892
1893         default: {
1894             type_substring += "???\n";
1895
1896             break;
1897         }
1898     }
1899
1900     return type_substring;
1901 } /* __getTileTypeSubstring() */

```

4.7.3.15 __handleKeyPressEvents()

```

void HexTile::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

876 {
877     if (not this->is_selected) {
878         return;
879     }
880
881
882     if (this->event_ptr->key.code == sf::Keyboard::Escape) {
883         this->__setIsSelected(false);
884     }
885
886
887     if (this->build_menu_open) {
888         switch (this->tile_type) {
889             case (TileType :: FOREST): {
890                 switch (this->event_ptr->key.code) {
891                     case (sf::Keyboard::D): {
892                         this->__buildDieselGenerator();
893
894                         break;

```



```
895         }
896
897
898         case (sf::Keyboard::S): {
899             this->__buildSolarPV();
900
901             break;
902         }
903
904
905         case (sf::Keyboard::W): {
906             this->__buildWindTurbine();
907
908             break;
909         }
910
911
912         case (sf::Keyboard::E): {
913             this->__buildEnergyStorage();
914
915             break;
916         }
917
918
919         default: {
920             // do nothing!
921
922             break;
923         }
924     }
925
926     break;
927 }
928
929
930 case (TileType :: LAKE): {
931     switch (this->event_ptr->key.code) {
932         case (sf::Keyboard::S): {
933             this->__buildSolarPV();
934
935             break;
936         }
937
938
939         case (sf::Keyboard::W): {
940             this->__buildWindTurbine();
941
942             break;
943         }
944
945
946         default: {
947             // do nothing!
948
949             break;
950         }
951     }
952
953     break;
954 }
955
956
957 case (TileType :: MOUNTAINS): {
958     switch (this->event_ptr->key.code) {
959         case (sf::Keyboard::D): {
960             this->__buildDieselGenerator();
961
962             break;
963         }
964
965
966         case (sf::Keyboard::S): {
967             this->__buildSolarPV();
968
969             break;
970         }
971
972
973         case (sf::Keyboard::W): {
974             this->__buildWindTurbine();
975
976             break;
977         }
978
979
980         case (sf::Keyboard::E): {
981             this->__buildEnergyStorage();
```

```
982
983         break;
984     }
985
986     default: {
987         // do nothing!
988
989         break;
990     }
991 }
992
993 break;
994 }
995 }
996
997 case (TileType :: OCEAN): {
998     switch (this->event_ptr->key.code) {
999         case (sf::Keyboard::W): {
1000             this->__buildWindTurbine();
1001
1002             break;
1003         }
1004
1005         case (sf::Keyboard::T): {
1006             this->__buildTidalTurbine();
1007
1008             break;
1009         }
1010
1011         case (sf::Keyboard::A): {
1012             this->__buildWaveEnergyConverter();
1013
1014             break;
1015         }
1016
1017         default: {
1018             // do nothing!
1019
1020             break;
1021         }
1022     }
1023
1024     break;
1025 }
1026
1027 case (TileType :: PLAINS): {
1028     switch (this->event_ptr->key.code) {
1029         case (sf::Keyboard::D): {
1030             this->__buildDieselGenerator();
1031
1032             break;
1033         }
1034
1035         case (sf::Keyboard::S): {
1036             this->__buildSolarPV();
1037
1038             break;
1039         }
1040
1041         case (sf::Keyboard::W): {
1042             this->__buildWindTurbine();
1043
1044             break;
1045         }
1046
1047         case (sf::Keyboard::E): {
1048             this->__buildEnergyStorage();
1049
1050             break;
1051         }
1052
1053         default: {
1054             // do nothing!
1055
1056             break;
1057         }
1058     }
1059
1060     break;
1061 }
1062
1063 }
```

```

1069         break;
1070     }
1071
1072     default: {
1073         //do nothing!
1074
1075         break;
1076     }
1077 }
1078
1079 }
1080
1081
1082 if (this->game_phase == "build settlement") {
1083     if (
1084         (this->tile_type != TileType :: OCEAN) and
1085         (this->tile_type != TileType :: LAKE)
1086     ) {
1087         if (this->event_ptr->key.code == sf::Keyboard::B) {
1088             this->__buildSettlement();
1089         }
1090     }
1091 }
1092
1093
1094 else if (this->game_phase == "system management") {
1095     if (this->has_improvement) {
1096         if (this->tile_improvement_ptr->tile_improvement_type != TileImprovementType :: SETTLEMENT)
1097     {
1098         if (this->event_ptr->key.code == sf::Keyboard::P) {
1099             this->__scrapImprovement();
1100         }
1101     }
1102
1103     /*
1104     * All other inputs will be caught and handled by
1105     * this->tile_improvement_ptr->processEvent()
1106     */
1107 }
1108
1109 else if (not this->resource_assessed) {
1110     if (this->event_ptr->key.code == sf::Keyboard::A) {
1111         if (this->credits < RESOURCE_ASSESSMENT_COST) {
1112             std::cout << "Cannot assess resource: insufficient credits (need "
1113                 << RESOURCE_ASSESSMENT_COST << " K)" << std::endl;
1114
1115             this->__sendInsufficientCreditsMessage();
1116         }
1117
1118         else {
1119             this->assess();
1120             this->__sendCreditsSpentMessage(RESOURCE_ASSESSMENT_COST);
1121             this->__sendTileStateMessage();
1122             this->__sendGameStateRequest();
1123         }
1124     }
1125 }
1126
1127
1128 else if (
1129     (not this->decoration_cleared) and
1130     (this->tile_type != TileType :: OCEAN) and
1131     (this->tile_type != TileType :: LAKE)
1132 ) {
1133     if (this->event_ptr->key.code == sf::Keyboard::C) {
1134         int clear_cost = 0;
1135
1136         switch (this->tile_type) {
1137             case (TileType :: FOREST): {
1138                 clear_cost = CLEAR_FOREST_COST;
1139
1140                 break;
1141             }
1142
1143             case (TileType :: MOUNTAINS): {
1144                 clear_cost = CLEAR_MOUNTAINS_COST;
1145
1146                 break;
1147             }
1148
1149             case (TileType :: PLAINS): {
1150                 clear_cost = CLEAR_PLAINS_COST;
1151
1152                 break;
1153             }
1154         }

```

```

1155         }
1156
1157
1158         default: {
1159             // do nothing!
1160
1161             break;
1162         }
1163     }
1164
1165     if (this->credits < clear_cost) {
1166         std::cout << "Cannot clear tile: insufficient credits (need "
1167             << clear_cost << " K)" << std::endl;
1168
1169         this->__sendInsufficientCreditsMessage();
1170     }
1171
1172     else {
1173         this->__clearDecoration();
1174         this->__sendCreditsSpentMessage(clear_cost);
1175         this->__sendTileStateMessage();
1176         this->__sendGameStateRequest();
1177     }
1178 }
1179
1180
1181
1182     else if (
1183         (this->decoration_cleared) or
1184         (this->tile_type == TileType :: OCEAN) or
1185         (this->tile_type == TileType :: LAKE)
1186     ) {
1187         if (this->event_ptr->key.code == sf::Keyboard::B) {
1188             this->__openBuildMenu();
1189         }
1190     }
1191 }
1192
1193 return;
1194 } /* __handleKeyPressEvents() */

```

4.7.3.16 __handleKeyReleaseEvents()

```

void HexTile::__handleKeyReleaseEvents (
    void ) [private]

1200 {
1201     if (not this->is_selected) {
1202         return;
1203     }
1204
1205
1206     switch (this->event_ptr->key.code) {
1207         case (sf::Keyboard::P): {
1208             if (this->has_improvement) {
1209                 this->scrap_improvement_frame = 0;
1210
1211                 if (
1212                     this->tile_improvement_ptr->tile_improvement_sprite_static.getTexture() != NULL
1213                 ) {
1214                     this->tile_improvement_ptr->tile_improvement_sprite_static.setColor(
1215                         sf::Color(255, 255, 255, 255)
1216                     );
1217                 }
1218
1219                 else {
1220                     for (
1221                         size_t i = 0;
1222                         i < this->tile_improvement_ptr->tile_improvement_sprite_animated.size();
1223                         i++
1224                     ) {
1225                         this->tile_improvement_ptr->tile_improvement_sprite_animated[i].setColor(
1226                             sf::Color(255, 255, 255, 255)
1227                         );
1228                     }
1229                 }
1230             }
1231
1232             break;
1233

```

```

1234         }
1235
1236
1237         default: {
1238             // do nothing!
1239
1240             break;
1241         }
1242     }
1243
1244     /*
1245     if (this->event_ptr->key.code == sf::Keyboard::P) {
1246     }
1247     */
1248
1249     return;
1250 } /* __handleKeyReleaseEvents() */

```

4.7.3.17 __handleMouseButtonEvents()

```

void HexTile::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

1264 {
1265     switch (this->event_ptr->mouseButton.button) {
1266     case (sf::Mouse::Left): {
1267         if (this->__isClicked()) {
1268             std::cout << "Tile (" << this->position_x << ", " <<
1269                 this->position_y << ") was selected" << std::endl;
1270
1271             this->__setIsSelected(true);
1272
1273             this->__sendTileSelectedMessage();
1274             this->__sendTileStateMessage();
1275         }
1276
1277         else {
1278             this->__setIsSelected(false);
1279         }
1280
1281         break;
1282     }
1283
1284     case (sf::Mouse::Right): {
1285         this->__setIsSelected(false);
1286
1287         break;
1288     }
1289
1290     default: {
1291         // do nothing!
1292
1293         break;
1294     }
1295 }
1296
1297 return;
1298 } /* __handleMouseButtonEvents() */

```

4.7.3.18 __isClicked()

```

bool HexTile::__isClicked (
    void ) [private]

```

Helper method to determine if tile was clicked on.

Returns

Boolean indicating whether or not tile was clicked on.

```

842 {
843     sf::Vector2f mouse_position = this->render_window_ptr->mapPixelToCoords(
844         sf::Mouse::getPosition(*this->render_window_ptr))
845     );
846
847     double mouse_x = mouse_position.x;
848     double mouse_y = mouse_position.y;
849
850     double distance = sqrt(
851         pow(this->position_x - mouse_x, 2) +
852         pow(this->position_y - mouse_y, 2)
853     );
854
855     if (distance < this->minor_radius) {
856         return true;
857     }
858     else {
859         return false;
860     }
861 } /* __isClicked() */

```

4.7.3.19 __openBuildMenu()

```

void HexTile::__openBuildMenu (
    void ) [private]

```

Helper method to open the tile improvement build menu.

```

1315 {
1316     if (this->build_menu_open) {
1317         return;
1318     }
1319
1320     this->build_menu_open = true;
1321     this->assets_manager_ptr->getSound("build menu open")->play();
1322
1323     return;
1324 } /* __openBuildMenu() */

```

4.7.3.20 __scrapImprovement()

```

void HexTile::__scrapImprovement (
    void ) [private]

```

Helper method to scrap the tile improvement ([Settlement](#) cannot be scrapped). Requires the mapped key to be held continuously to confirm.

```

1728 {
1729     // 1. implement key hold confirmation
1730     if (this->scrap_improvement_frame <= FRAMES_PER_SECOND) {
1731         double colour_scalar =
1732             1 - ((double)(this->scrap_improvement_frame) / (FRAMES_PER_SECOND));
1733
1734         if (
1735             this->tile_improvement_ptr->tile_improvement_sprite_static.getTexture() != NULL
1736         ) {
1737             this->tile_improvement_ptr->tile_improvement_sprite_static.setColor(
1738                 sf::Color(255, 255 * colour_scalar, 255 * colour_scalar, 255)
1739             );
1740         }
1741
1742         else {
1743             for (
1744                 size_t i = 0;
1745                 i < this->tile_improvement_ptr->tile_improvement_sprite_animated.size();
1746                 i++
1747             ) {

```

```

1748         this->tile_improvement_ptr->tile_improvement_sprite_animated[i].setColor(
1749             sf::Color(255, 255 * colour_scalar, 255 * colour_scalar, 255)
1750         );
1751     }
1752 }
1753
1754 this->scrap_improvement_frame += 4;
1755 }
1756
1757 // 2. carry out scrapping
1758 else {
1759     this->draw_explosion = true;
1760     this->assets_manager_ptr->getSound("clear non-mountains tile")->play();
1761
1762     if (this->tile_improvement_ptr->production_menu_open) {
1763         this->tile_improvement_ptr->production_menu_open = false;
1764         this->assets_manager_ptr->getSound("build menu close")->play();
1765     }
1766
1767     delete this->tile_improvement_ptr;
1768     this->tile_improvement_ptr = NULL;
1769
1770     this->has_improvement = false;
1771
1772     this->scrap_improvement_frame = 0;
1773
1774     if (
1775         (this->tile_type == TileType :: LAKE) or
1776         (this->tile_type == TileType :: OCEAN)
1777     ) {
1778         this->decoration_cleared = false;
1779     }
1780
1781     this->__sendCreditsSpentMessage(SCRAP_COST);
1782     this->__sendTileStateMessage();
1783     this->__sendGameStateRequest();
1784 }
1785
1786 return;
1787 } /* __scrapImprovement() */

```

4.7.3.21 __sendAssessNeighboursMessage()

```

void HexTile::__sendAssessNeighboursMessage (
    void ) [private]

```

Helper method to format and send assess neighbours message.

```

2165 {
2166     Message assess_neighbours_message;
2167
2168     assess_neighbours_message.channel = HEX_MAP_CHANNEL;
2169     assess_neighbours_message.subject = "assess neighbours";
2170
2171     this->message_hub_ptr->sendMessage(assess_neighbours_message);
2172
2173     std::cout << "Assess neighbours message sent by " << this << std::endl;
2174
2175     return;
2176 } /* __sendAssessNeighboursMessage() */

```

4.7.3.22 __sendCreditsSpentMessage()

```

void HexTile::__sendCreditsSpentMessage (
    int credits_spent ) [private]

```

Helper method to format and send a credits spent message.

Parameters

<i>credits_spent</i>	The number of credits that were spent.
----------------------	--

```

2248 {
2249     Message credits_spent_message;
2250
2251     credits_spent_message.channel = GAME_CHANNEL;
2252     credits_spent_message.subject = "credits spent";
2253
2254     credits_spent_message.int_payload["credits spent"] = credits_spent;
2255
2256     this->message_hub_ptr->sendMessage(credits_spent_message);
2257
2258     std::cout << "Credits spent (" << credits_spent << ") message sent by " << this
2259               << std::endl;
2260     return;
2261 } /* __sendCreditsSpentMessage() */

```

4.7.3.23 __sendGameStateRequest()

```

void HexTile::__sendGameStateRequest (
    void ) [private]

```

Helper method to format and send a game state request (message).

```

2191 {
2192     Message game_state_request;
2193
2194     game_state_request.channel = GAME_CHANNEL;
2195     game_state_request.subject = "state request";
2196
2197     this->message_hub_ptr->sendMessage(game_state_request);
2198
2199     std::cout << "Game state request message sent by " << this << std::endl;
2200     return;
2201 } /* __sendGameStateRequest() */

```

4.7.3.24 __sendInsufficientCreditsMessage()

```

void HexTile::__sendInsufficientCreditsMessage (
    void ) [private]

```

Helper method to format and send an insufficient credits message.

```

2276 {
2277     Message insufficient_credits_message;
2278
2279     insufficient_credits_message.channel = GAME_CHANNEL;
2280     insufficient_credits_message.subject = "insufficient credits";
2281
2282     this->message_hub_ptr->sendMessage(insufficient_credits_message);
2283
2284     std::cout << "Insufficient credits message sent by " << this << std::endl;
2285
2286     return;
2287 } /* __sendInsufficientCreditsMessage() */

```


4.7.3.25 __sendTileSelectedMessage()

```
void HexTile::__sendTileSelectedMessage (
    void ) [private]
```

Helper method to format and send message on tile selection.

```
1803 {
1804     Message tile_selected_message;
1805
1806     tile_selected_message.channel = TILE_SELECTED_CHANNEL;
1807     tile_selected_message.subject = "tile selected";
1808
1809     this->message_hub_ptr->sendMessage(tile_selected_message);
1810
1811     return;
1812 } /* __sendTileSelectedMessage() */
```

4.7.3.26 __sendTileStateMessage()

```
void HexTile::__sendTileStateMessage (
    void ) [private]
```

Helper method to format and send tile state message.

```
2124 {
2125     Message tile_state_message;
2126
2127     tile_state_message.channel = TILE_STATE_CHANNEL;
2128     tile_state_message.subject = "tile state";
2129
2130
2131     //          32 char x 17 line console "-----\n";
2132     std::string console_string = "      **** TILE INFO ****      \n";
2133
2134     console_string += this->__getTileCoordsSubstring();
2135     console_string += "      \n";
2136
2137     console_string += this->__getTileTypeSubstring();
2138     console_string += this->__getTileResourceSubstring();
2139     console_string += this->__getTileImprovementSubstring();
2140     console_string += "      \n";
2141
2142     console_string += this->__getTileOptionsSubstring();
2143
2144     tile_state_message.string_payload["console string"] = console_string;
2145
2146     this->message_hub_ptr->sendMessage(tile_state_message);
2147
2148     std::cout << "Tile state message sent by " << this << std::endl;
2149     return;
2150 } /* __sendTileStateMessage() */
```

4.7.3.27 __sendUpdateGamePhaseMessage()

```
void HexTile::__sendUpdateGamePhaseMessage (
    std::string game_phase ) [private]
```

Helper method to format and send update game phase message.

Parameters

<i>game_phase</i>	The updated game phase.
-------------------	-------------------------

```

2218 {
2219     Message update_game_phase_message;
2220
2221     update_game_phase_message.channel = GAME_CHANNEL;
2222     update_game_phase_message.subject = "update game phase";
2223
2224     update_game_phase_message.string_payload["game phase"] = game_phase;
2225
2226     this->message_hub_ptr->sendMessage(update_game_phase_message);
2227
2228     std::cout << "Update game phase message sent by " << this << std::endl;
2229
2230     return;
2231 } /* __sendUpdateGamePhaseMessage() */

```

4.7.3.28 __setIsSelected()

```

void HexTile::__setIsSelected (
    bool is_selected ) [private]

```

Helper method to set the is selected attribute (of tile and improvement).

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

```

764 {
765     this->is_selected = is_selected;
766
767     if (this->tile_improvement_ptr != NULL) {
768         this->tile_improvement_ptr->setIsSelected(is_selected);
769     }
770
771     if ((not is_selected) and this->build_menu_open) {
772         this->__closeBuildMenu();
773     }
774
775     return;
776 } /* __setIsSelected() */

```

4.7.3.29 __setResourceText()

```

void HexTile::__setResourceText (
    void ) [private]

```

Helper method to set up resource text.

```

193 {
194     this->resource_text.setFont(*(assets_manager_ptr->getFont("DroidSansMono")));
195
196     this->resource_text.setFillColor(sf::Color(0, 0, 0, 255));
197
198     if (this->resource_assessed) {
199         switch (this->tile_resource) {
200             case (TileResource :: POOR): {
201                 this->resource_text.setString("-2");
202                 this->resource_text.setFillColor(MONOCHROME_TEXT_RED);
203
204                 break;
205             }
206
207             case (TileResource :: BELOW_AVERAGE): {
208                 this->resource_text.setString("-1");
209                 this->resource_text.setFillColor(MONOCHROME_TEXT_RED);
210
211                 break;
212             }

```

```

213
214         case (TileResource :: AVERAGE): {
215             this->resource_text.setString("+0");
216
217             break;
218         }
219
220         case (TileResource :: ABOVE_AVERAGE): {
221             this->resource_text.setString("+1");
222             this->resource_text.setFillColor(MONOCROME_TEXT_GREEN);
223
224             break;
225         }
226
227         case (TileResource :: GOOD): {
228             this->resource_text.setString("+2");
229             this->resource_text.setFillColor(MONOCROME_TEXT_GREEN);
230
231             break;
232         }
233
234         default: {
235             this->resource_text.setString("");
236
237             break;
238         }
239     }
240 }
241
242 else {
243     this->resource_text.setString("");
244 }
245
246 this->resource_text.setCharacterSize(20);
247
248 this->resource_text.setOrigin(
249     this->resource_text.getLocalBounds().width / 2,
250     this->resource_text.getLocalBounds().height / 2
251 );
252
253 this->resource_text.setPosition(
254     this->position_x,
255     this->position_y - 4
256 );
257
258 this->resource_text.setOutlineThickness(1);
259 this->resource_text.setOutlineColor(sf::Color(0, 0, 0, 255));
260
261 return;
262 } /* __setResourceText() */

```

4.7.3.30 __setUpBuildMenu()

```

void HexTile::__setUpBuildMenu (
    void ) [private]

```

Helper method to set up and place build menu assets (drawable).

```

667 {
668     this->build_menu_options_vec.clear();
669     this->build_menu_options_text_vec.clear();
670
671     // 1. set up and place build menu backing and text
672     this->build_menu_backing.setSize(sf::Vector2f(600, 256));
673     this->build_menu_backing.setOrigin(300, 128);
674     this->build_menu_backing.setPosition(400, 400);
675     this->build_menu_backing.setFillColor(MONOCROME_SCREEN_BACKGROUND);
676     this->build_menu_backing.setOutlineColor(MENU_FRAME_GREY);
677     this->build_menu_backing.setOutlineThickness(4);
678
679     this->build_menu_backing_text.setString("**** BUILD MENU ****");
680     this->build_menu_backing_text.setFont(
681         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220"))
682     );
683     this->build_menu_backing_text.setCharacterSize(16);
684     this->build_menu_backing_text.setFillColor(MONOCROME_TEXT_GREEN);
685     this->build_menu_backing_text.setOrigin(
686         this->build_menu_backing_text.getLocalBounds().width / 2, 0
687     );

```

```

688     this->build_menu_backing_text.setPosition(400, 400 - 128 + 4);
689
690     // 2. set up and place build menu option sprites and text
691     switch (this->tile_type) {
692     case (TileType :: FOREST): {
693         this->__setUpDieselGeneratorBuildOption();
694         this->__setUpSolarPVBuildOption();
695         this->__setUpWindTurbineBuildOption();
696         //this->__setUpEnergyStorageSystemBuildOption();
697
698         break;
699     }
700
701
702     case (TileType :: LAKE): {
703         this->__setUpSolarPVBuildOption(true);
704         this->__setUpWindTurbineBuildOption(true);
705
706         break;
707     }
708
709
710     case (TileType :: MOUNTAINS): {
711         this->__setUpDieselGeneratorBuildOption();
712         this->__setUpSolarPVBuildOption();
713         this->__setUpWindTurbineBuildOption();
714         //this->__setUpEnergyStorageSystemBuildOption();
715
716         break;
717     }
718
719
720     case (TileType :: OCEAN): {
721         this->__setUpWindTurbineBuildOption(false, true);
722         this->__setUpTidalTurbineBuildOption();
723         this->__setUpWaveEnergyConverterBuildOption();
724
725         break;
726     }
727
728
729     case (TileType :: PLAINS): {
730         this->__setUpDieselGeneratorBuildOption();
731         this->__setUpSolarPVBuildOption();
732         this->__setUpWindTurbineBuildOption();
733         //this->__setUpEnergyStorageSystemBuildOption();
734
735         break;
736     }
737
738
739     default: {
740         // do nothing!
741
742         break;
743     }
744 }
745
746 return;
747 } /* __setUpBuildMenu() */

```

4.7.3.31 __setUpBuildOption()

```

void HexTile::__setUpBuildOption (
    std::string texture_key,
    std::string option_string ) [private]

```

Helper method to set up and position the sprite and text for a build option.

Parameters

<i>texture_key</i>	The key for the appropriate illustration asset for the build option.
<i>option_string</i>	A string for the build option.

```

357 {
358     size_t n_options = this->build_menu_options_vec.size();
359
360     // 1. set up option sprite(s)
361     this->build_menu_options_vec.push_back({});
362
363     if (not texture_key.empty()) {
364         sf::Sprite texture_sheet(
365             *(this->assets_manager_ptr->getTexture(texture_key))
366         );
367
368         int sheet_height = texture_sheet.getLocalBounds().height;
369         int n_subrects = sheet_height / 64;
370
371         for (int i = 0; i < n_subrects; i++) {
372             this->build_menu_options_vec.back().push_back(
373                 sf::Sprite(
374                     *(this->assets_manager_ptr->getTexture(texture_key)),
375                     sf::IntRect(0, i * 64, 64, 64)
376                 )
377             );
378
379             this->build_menu_options_vec.back().back().setOrigin(
380                 this->build_menu_options_vec.back().back().getLocalBounds().width / 2,
381                 this->build_menu_options_vec.back().back().getLocalBounds().height
382             );
383
384             this->build_menu_options_vec.back().back().setPosition(
385                 400 - 300 + 75 + n_options * 150,
386                 400 - 32
387             );
388         }
389     }
390
391     else {
392         this->build_menu_options_vec.back().push_back(sf::Sprite());
393     }
394
395
396     // 2. set up option text
397     this->build_menu_options_text_vec.push_back(
398         sf::Text(
399             option_string,
400             *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
401             16
402         )
403     );
404
405     this->build_menu_options_text_vec.back().setOrigin(
406         this->build_menu_options_text_vec.back().getLocalBounds().width / 2,
407         0
408     );
409
410     this->build_menu_options_text_vec.back().setPosition(
411         400 - 300 + 75 + n_options * 150,
412         400 - 16 - 4
413     );
414
415     this->build_menu_options_text_vec.back().setFillColor(MONOCHROME_TEXT_GREEN);
416
417     return;
418 } /* __setUpBuildOption() */

```

4.7.3.32 __setUpDieselGeneratorBuildOption()

```

void HexTile::__setUpDieselGeneratorBuildOption (
    void ) [private]

```

Helper method to set up and position the diesel generator build option.

```

433 {
434     // 1. set up option sprite(s)
435     std::string texture_key = "diesel generator";
436
437     // 2. set up option string (up to 16 chars wide)
438     // "-----\n"
439     std::string diesel_generator_string = "DIESEL GENERATOR\n";
440     diesel_generator_string += "\n";
441     diesel_generator_string += "CAPACITY: 200 kW\n";

```

```

442     diesel_generator_string      += "COST:      ";
443     diesel_generator_string      += std::to_string(DIESEL_GENERATOR_BUILD_COST);
444     diesel_generator_string      += " K\n\n";
445     diesel_generator_string      += "BUILD:      [D]   \n";
446
447     // 3. call general method
448     this->__setUpBuildOption(texture_key, diesel_generator_string);
449
450     return;
451 } /* __setUpDieselGeneratorBuildOption() */

```

4.7.3.33 __setUpEnergyStorageSystemBuildOption()

```

void HexTile::__setUpEnergyStorageSystemBuildOption (
    void ) [private]

```

Helper method to set up and position the wave energy converter build option.

```

633 {
634     /*
635     // 1. set up option sprite(s)
636     std::string texture_key = "energy storage system";
637
638     // 2. set up option string (up to 16 chars wide)
639     //
640     std::string energy_storage_system_string      = "-----\n"
641     energy_storage_system_string                  = " ENERGY STORAGE \n";
642     energy_storage_system_string                  += " \n";
643     energy_storage_system_string                  += "CAPCTY:   1 MWh\n";
644     energy_storage_system_string                  += "COST:      ";
645     energy_storage_system_string                  += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
646     energy_storage_system_string                  += " K\n\n";
647     energy_storage_system_string                  += "BUILD:      [E]   \n";
648
649     // 3. call general method
650     this->__setUpBuildOption(texture_key, energy_storage_system_string);
651     */
652 } /* __setUpEnergyStorageSystemBuildOption() */

```

4.7.3.34 __setUpMagnifyingGlassSprite()

```

void HexTile::__setUpMagnifyingGlassSprite (
    void ) [private]

```

Helper method to set up and position magnifying glass sprite.

```

277 {
278     this->magnifying_glass_sprite.setTexture(
279     * (this->assets_manager_ptr->getTexture("magnifying_glass_64x64_1"))
280     );
281
282     this->magnifying_glass_sprite.setOrigin(
283     this->magnifying_glass_sprite.getLocalBounds().width / 2,
284     this->magnifying_glass_sprite.getLocalBounds().height / 2
285     );
286
287     this->magnifying_glass_sprite.setPosition(
288     this->position_x,
289     this->position_y
290     );
291
292     return;
293 } /* __setUpMagnifyingGlassSprite() */

```

4.7.3.35 __setUpNodeSprite()

```
void HexTile::__setUpNodeSprite (
    void ) [private]
```

Helper method to set up node sprite.

```
68 {
69     this->node_sprite.setRadius(4);
70
71     this->node_sprite.setOrigin(
72         this->node_sprite.getLocalBounds().width / 2,
73         this->node_sprite.getLocalBounds().height / 2
74     );
75
76     this->node_sprite.setPosition(this->position_x, this->position_y);
77
78     this->node_sprite.setFillColor(sf::Color(255, 0, 0, 255));
79
80     return;
81 } /* __setUpNodeSprite() */
```

4.7.3.36 __setUpResourceChipSprite()

```
void HexTile::__setUpResourceChipSprite (
    void ) [private]
```

Helper method to set up resource chip sprite.

```
166 {
167     this->resource_chip_sprite.setRadius(2 * this->minor_radius / 3);
168
169     this->resource_chip_sprite.setOrigin(
170         this->resource_chip_sprite.getLocalBounds().width / 2,
171         this->resource_chip_sprite.getLocalBounds().height / 2
172     );
173
174     this->resource_chip_sprite.setPosition(this->position_x, this->position_y);
175
176     this->resource_chip_sprite.setFillColor(RESOURCE_CHIP_GREY);
177
178     return;
179 } /* __setUpResourceChip() */
```

4.7.3.37 __setUpSelectOutlineSprite()

```
void HexTile::__setUpSelectOutlineSprite (
    void ) [private]
```

Helper method to set up select outline sprite.

```
130 {
131     int n_points = 6;
132
133     this->select_outline_sprite.setPointCount(n_points);
134
135     for (int i = 0; i < n_points; i++) {
136         this->select_outline_sprite.setPoint(
137             i,
138             sf::Vector2f(
139                 this->position_x + this->major_radius * cos((30 + 60 * i) * (M_PI / 180)),
140                 this->position_y + this->major_radius * sin((30 + 60 * i) * (M_PI / 180))
141             )
142         );
143     }
144
145     this->select_outline_sprite.setOutlineThickness(4);
146     this->select_outline_sprite.setOutlineColor(MONOCHROME_TEXT_RED);
147
148     this->select_outline_sprite.setFillColor(sf::Color(0, 0, 0, 0));
149
150     return;
151 } /* __setUpSelectOutline() */
```

4.7.3.38 __setUpSolarPVBuildOption()

```
void HexTile::__setUpSolarPVBuildOption (
    bool is_lake = false ) [private]
```

Helper method to set up and position the solar PV array build option.

Parameters

<i>is_lake</i>	If being built on a lake.
----------------	---------------------------

```
521 {
522     // 1. set up option sprite(s)
523     std::string texture_key = "solar PV array";
524
525     // 2. set up option string (up to 16 chars wide)
526     int build_cost = SOLAR_PV_BUILD_COST;
527     if (is_lake) {
528         build_cost *= SOLAR_PV_WATER_BUILD_MULTIPLIER;
529     }
530
531     // ----- \n"
532     std::string solar_PV_string = " SOLAR PV ARRAY \n";
533     solar_PV_string += " \n";
534     solar_PV_string += "CAPACITY: 100 kW\n";
535     solar_PV_string += "COST: ";
536     solar_PV_string += std::to_string(build_cost);
537     solar_PV_string += " K";
538
539     if (is_lake) {
540         solar_PV_string += "\n** LAKE BUILD **\n\n";
541     }
542     else {
543         solar_PV_string += "\n\n\n";
544     }
545
546     solar_PV_string += "BUILD: [S] \n";
547
548     // 3. call general method
549     this->__setUpBuildOption(texture_key, solar_PV_string);
550
551     return;
552 } /* __setUpSolarPVBuildOption() */
```

4.7.3.39 __setUpTidalTurbineBuildOption()

```
void HexTile::__setUpTidalTurbineBuildOption (
    void ) [private]
```

Helper method to set up and position the tidal turbine build option.

```
567 {
568     // 1. set up option sprite(s)
569     std::string texture_key = "tidal turbine";
570
571     // 2. set up option string (up to 16 chars wide)
572     // ----- \n"
573     std::string tidal_turbine_string = " TIDAL TURBINE \n";
574     tidal_turbine_string += " \n";
575     tidal_turbine_string += "CAPACITY: 100 kW\n";
576     tidal_turbine_string += "COST: ";
577     tidal_turbine_string += std::to_string(TIDAL_TURBINE_BUILD_COST);
578     tidal_turbine_string += " K\n\n";
579     tidal_turbine_string += "BUILD: [T] \n";
580
581     // 3. call general method
582     this->__setUpBuildOption(texture_key, tidal_turbine_string);
583
584     return;
585 } /* __setUpTidalTurbineBuildOption() */
```


4.7.3.40 __setUpTileExplosionReel()

```
void HexTile::__setUpTileExplosionReel (
    void ) [private]
```

Helper method to set up tile explosion sprite reel.

```
308 {
309     for (int i = 0; i < 4; i++) {
310         for (int j = 0; j < 4; j++) {
311             this->explosion_sprite_reel.push_back(
312                 sf::Sprite(
313                     *(this->assets_manager_ptr->getTexture("tile clear explosion")),
314                     sf::IntRect(j * 64, i * 64, 64, 64)
315                 )
316             );
317             this->explosion_sprite_reel.back().setOrigin(
318                 this->explosion_sprite_reel.back().getLocalBounds().width / 2,
319                 this->explosion_sprite_reel.back().getLocalBounds().height / 2
320             );
321             this->explosion_sprite_reel.back().setPosition(
322                 this->position_x,
323                 this->position_y
324             );
325         }
326     }
327 }
328 }
329 return;
330 }
331 } /* __setUpTileExplosionReel() */
```

4.7.3.41 __setUpTileSprite()

```
void HexTile::__setUpTileSprite (
    void ) [private]
```

Helper method to set up tile sprite.

```
96 {
97     int n_points = 6;
98     this->tile_sprite.setPointCount(n_points);
99     for (int i = 0; i < n_points; i++) {
100         this->tile_sprite.setPoint(
101             i,
102             sf::Vector2f(
103                 this->position_x + this->major_radius * cos((30 + 60 * i) * (M_PI / 180)),
104                 this->position_y + this->major_radius * sin((30 + 60 * i) * (M_PI / 180))
105             )
106         );
107     }
108     this->tile_sprite.setOutlineThickness(1);
109     this->tile_sprite.setOutlineColor(sf::Color(175, 175, 175, 255));
110     return;
111 }
112 } /* __setUpTileSprite() */
```

4.7.3.42 __setUpWaveEnergyConverterBuildOption()

```
void HexTile::__setUpWaveEnergyConverterBuildOption (
    void ) [private]
```

Helper method to set up and position the wave energy converter build option.

```
600 {
601     // 1. set up option sprite(s)
```

```

602     std::string texture_key = "wave energy converter";
603
604     // 2. set up option string (up to 16 chars wide)
605     // -----
606     std::string wave_energy_converter_string = "WAVE ENERGY CVTR\n";
607     wave_energy_converter_string += " \n";
608     wave_energy_converter_string += "CAPACITY: 100 kW\n";
609     wave_energy_converter_string += "COST: ";
610     wave_energy_converter_string += std::to_string(WAVE_ENERGY_CONVERTER_BUILD_COST);
611     wave_energy_converter_string += " K\n\n";
612     wave_energy_converter_string += "BUILD: [A] \n";
613
614     // 3. call general method
615     this->__setUpBuildOption(texture_key, wave_energy_converter_string);
616
617     return;
618 } /* __setUpWaveEnergyConverterBuildOption() */

```

4.7.3.43 __setUpWindTurbineBuildOption()

```

void HexTile::__setUpWindTurbineBuildOption (
    bool is_lake = false,
    bool is_ocean = false ) [private]

```

Helper method to set up and position the wind turbine build option.

Parameters

<i>is_lake</i>	If being built on a lake tile.
<i>is_ocean</i>	If being built on an ocean tile.

```

470 {
471     // 1. set up option sprite(s)
472     std::string texture_key = "wind turbine";
473
474     // 2. set up option string (up to 16 chars wide)
475     int build_cost = WIND_TURBINE_BUILD_COST;
476     if (is_lake or is_ocean) {
477         build_cost *= WIND_TURBINE_WATER_BUILD_MULTIPLIER;
478     }
479
480     // -----
481     std::string wind_turbine_string = " WIND TURBINE \n";
482     wind_turbine_string += " \n";
483     wind_turbine_string += "CAPACITY: 100 kW\n";
484     wind_turbine_string += "COST: ";
485     wind_turbine_string += std::to_string(build_cost);
486     wind_turbine_string += " K";
487
488     if (is_lake) {
489         wind_turbine_string += "\n** LAKE BUILD **\n\n";
490     }
491     else if (is_ocean) {
492         wind_turbine_string += "\n* OCEAN BUILD * \n\n";
493     }
494     else {
495         wind_turbine_string += "\n\n\n";
496     }
497
498     wind_turbine_string += "BUILD: [W] \n";
499
500     // 3. call general method
501     this->__setUpBuildOption(texture_key, wind_turbine_string);
502
503     return;
504 } /* __setUpWindTurbineBuildOption() */

```

4.7.3.44 assess()

```
void HexTile::assess (
    void )
```

Method to assess the tile's resource.

```
2710 {
2711     this->resource_assessed = true;
2712     this->resource_assessment = true;
2713
2714     this->assets_manager_ptr->getSound("resource assessment")->play();
2715
2716     this->__setResourceText();
2717     this->__sendTileStateMessage();
2718
2719     return;
2720 } /* assess() */
```

4.7.3.45 decorateTile()

```
void HexTile::decorateTile (
    void )
```

Method to decorate tile.

```
2588 {
2589     switch (this->tile_type) {
2590     case (TileType :: FOREST): {
2591         this->tile_decoration_sprite.setTexture(
2592             *(this->assets_manager_ptr->getTexture("pine_tree_64x64_1"))
2593         );
2594
2595         break;
2596     }
2597
2598     case (TileType :: LAKE): {
2599         this->tile_decoration_sprite.setTexture(
2600             *(this->assets_manager_ptr->getTexture("water_shimmer_64x64_1"))
2601         );
2602
2603         break;
2604     }
2605
2606     case (TileType :: MOUNTAINS): {
2607         this->tile_decoration_sprite.setTexture(
2608             *(this->assets_manager_ptr->getTexture("mountain_64x64_1"))
2609         );
2610
2611         break;
2612     }
2613
2614     case (TileType :: OCEAN): {
2615         this->tile_decoration_sprite.setTexture(
2616             *(this->assets_manager_ptr->getTexture("water_waves_64x64_1"))
2617         );
2618
2619         break;
2620     }
2621
2622     case (TileType :: PLAINS): {
2623         this->tile_decoration_sprite.setTexture(
2624             *(this->assets_manager_ptr->getTexture("wheat_64x64_1"))
2625         );
2626
2627         break;
2628     }
2629
2630     default: {
2631         // do nothing!
2632
2633         break;
2634     }
2635 }
2636
2637
2638 if (this->tile_type == TileType :: OCEAN or this->tile_type == TileType :: LAKE) {
```

```

2639         this->tile_decoration_sprite.setOrigin(
2640             this->tile_decoration_sprite.getLocalBounds().width / 2,
2641             this->tile_decoration_sprite.getLocalBounds().height / 2
2642         );
2643
2644         this->tile_decoration_sprite.setPosition(
2645             this->position_x,
2646             this->position_y
2647         );
2648
2649         if ((double)rand() / RAND_MAX > 0.5) {
2650             this->tile_decoration_sprite.setScale(sf::Vector2f(-1, 1));
2651         }
2652     }
2653
2654     else {
2655         this->tile_decoration_sprite.setOrigin(
2656             this->tile_decoration_sprite.getLocalBounds().width / 2,
2657             this->tile_decoration_sprite.getLocalBounds().height
2658         );
2659
2660         this->tile_decoration_sprite.setPosition(
2661             this->position_x,
2662             this->position_y + 12
2663         );
2664
2665         if ((double)rand() / RAND_MAX > 0.5) {
2666             this->tile_decoration_sprite.setScale(sf::Vector2f(-1, 1));
2667         }
2668     }
2669
2670     return;
2671 } /* decorateTile(void) */

```

4.7.3.46 draw()

```

void HexTile::draw (
    void )

```

Method to draw the hex tile to the render window. To be called once per frame.

```

2851 {
2852     // 1. draw hex
2853     this->render_window_ptr->draw(this->tile_sprite);
2854
2855     // 2. draw node
2856     if (this->show_node) {
2857         this->render_window_ptr->draw(this->node_sprite);
2858     }
2859
2860     // 3. draw tile decoration
2861     if (not this->decoration_cleared) {
2862         this->render_window_ptr->draw(this->tile_decoration_sprite);
2863     }
2864
2865     // 4. draw selection outline
2866     if (this->is_selected) {
2867         sf::Color outline_colour = this->select_outline_sprite.getOutlineColor();
2868
2869         outline_colour.a =
2870             255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2);
2871
2872         this->select_outline_sprite.setOutlineColor(outline_colour);
2873
2874         this->render_window_ptr->draw(this->select_outline_sprite);
2875     }
2876
2877     // 5. draw tile improvement
2878     if (this->has_improvement) {
2879         if (not this->tile_improvement_ptr->just_built) {
2880             this->tile_improvement_ptr->draw();
2881         }
2882     }
2883
2884     // 6. draw resource
2885     if (this->show_resource) {
2886         this->render_window_ptr->draw(this->resource_chip_sprite);
2887         this->render_window_ptr->draw(this->resource_text);
2888     }

```

```

2889
2890 // 7. draw resource assessment notification
2891 if (this->resource_assessment) {
2892     int alpha = this->magnifying_glass_sprite.getColor().a;
2893
2894     alpha -= 0.05 * FRAMES_PER_SECOND;
2895     if (alpha < 0) {
2896         alpha = 0;
2897         this->resource_assessment = false;
2898     }
2899
2900     this->magnifying_glass_sprite.setColor(
2901         sf::Color(255, 255, 255, alpha)
2902     );
2903
2904     this->render_window_ptr->draw(this->magnifying_glass_sprite);
2905 }
2906
2907 // 8. draw explosion, then settlement placement
2908 if (this->draw_explosion) {
2909     this->render_window_ptr->draw(this->explosion_sprite_reel[this->explosion_frame]);
2910
2911     if (this->frame % (FRAMES_PER_SECOND / 20) == 0) {
2912         this->explosion_frame++;
2913     }
2914
2915     if (this->explosion_frame >= this->explosion_sprite_reel.size()) {
2916         this->draw_explosion = false;
2917         this->explosion_frame = 0;
2918     }
2919 }
2920
2921 else if (this->has_improvement) {
2922     if (this->tile_improvement_ptr->just_built) {
2923         this->tile_improvement_ptr->draw();
2924     }
2925 }
2926
2927 // 9. build menu
2928 if (this->build_menu_open) {
2929     this->render_window_ptr->draw(this->build_menu_backing);
2930     this->render_window_ptr->draw(this->build_menu_backing_text);
2931
2932     for (size_t i = 0; i < this->build_menu_options_vec.size(); i++) {
2933         for (size_t j = 0; j < this->build_menu_options_vec[i].size(); j++) {
2934             this->render_window_ptr->draw(this->build_menu_options_vec[i][j]);
2935         }
2936         this->render_window_ptr->draw(this->build_menu_options_text_vec[i]);
2937     }
2938 }
2939
2940 this->frame++;
2941 return;
2942 } /* draw() */

```

4.7.3.47 processEvent()

```

void HexTile::processEvent (
    void )

```

Method to process [HexTile](#). To be called once per event.

```

2735 {
2736     // 1. process TileImprovement events
2737     if (
2738         this->is_selected and
2739         this->tile_improvement_ptr != NULL
2740     ) {
2741         this->tile_improvement_ptr->processEvent();
2742     }
2743
2744     // 2. process HexTile events
2745     if (this->event_ptr->type == sf::Event::KeyPressed) {
2746         this->__handleKeyPressEvents();
2747     }
2748
2749     if (this->event_ptr->type == sf::Event::KeyReleased) {
2750         this->__handleKeyReleaseEvents();
2751     }

```

```

2752
2753     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
2754         this->__handleMouseButtonEvents();
2755     }
2756
2757     return;
2758 } /* processEvent() */

```

4.7.3.48 processMessage()

```

void HexTile::processMessage (
    void )

```

Method to process [HexTile](#). To be called once per message.

```

2773 {
2774     // 1. process TileImprovement messages
2775     if (this->tile_improvement_ptr != NULL) {
2776         this->tile_improvement_ptr->processMessage();
2777     }
2778
2779     // 2. process HexTile messages
2780     if (this->is_selected) {
2781         if (not this->message_hub_ptr->isEmpty(TILE_STATE_CHANNEL)) {
2782             Message tile_state_message = this->message_hub_ptr->receiveMessage(
2783                 TILE_STATE_CHANNEL
2784             );
2785
2786             if (tile_state_message.subject == "state request") {
2787                 this->__sendTileStateMessage();
2788
2789                 std::cout << "Tile state request received by " << this << std::endl;
2790                 this->message_hub_ptr->popMessage(TILE_STATE_CHANNEL);
2791             }
2792         }
2793
2794         std::cout << "Current credits (HexTile): " << this->credits << " K" <<
2795             std::endl;
2796     }
2797
2798     if (not this->message_hub_ptr->isEmpty(GAME_STATE_CHANNEL)) {
2799         Message game_state_message = this->message_hub_ptr->receiveMessage(
2800             GAME_STATE_CHANNEL
2801         );
2802
2803         if (game_state_message.subject == "game state") {
2804             this->credits = game_state_message.int_payload["credits"];
2805             this->game_phase = game_state_message.string_payload["game phase"];
2806
2807             if (this->tile_improvement_ptr != NULL) {
2808                 this->tile_improvement_ptr->credits = this->credits;
2809                 this->tile_improvement_ptr->game_phase = this->game_phase;
2810
2811                 this->tile_improvement_ptr->month =
2812                     game_state_message.int_payload["month"];
2813
2814                 this->tile_improvement_ptr->demand_MWh =
2815                     game_state_message.int_payload["demand_MWh"];
2816
2817                 this->tile_improvement_ptr->demand_vec_MWh =
2818                     game_state_message.vector_payload["demand_vec_MWh"];
2819
2820                 this->tile_improvement_ptr->update();
2821             }
2822
2823             this->message_hub_ptr->incrementMessageRead(GAME_STATE_CHANNEL);
2824
2825             std::cout << "Game state message read and passed by " << this <<
2826                 " (credits: " << this->credits << " K)" << std::endl;
2827
2828             if (this->is_selected) {
2829                 this->__sendTileStateMessage();
2830             }
2831         }
2832     }
2833
2834     return;
2835 } /* processMessage() */

```

4.7.3.49 setTitleResource() [1/2]

```
void HexTile::setTitleResource (
    double input_value )
```

Method to set the tile resource (by numeric input).

Parameters

<i>input_value</i>	A numerical input in the closed interval [0, 1].
--------------------	--

```
2537 {
2538     // 1. check input
2539     if (input_value < 0 or input_value > 1) {
2540         std::string error_str = "ERROR HexTile::setTitleResource() given input value is ";
2541         error_str += "not in the closed interval [0, 1]";
2542
2543         #ifdef _WIN32
2544             std::cout << error_str << std::endl;
2545         #endif /* _WIN32 */
2546
2547         throw std::runtime_error(error_str);
2548     }
2549
2550     // 2. convert input value to tile resource
2551     TileResource tile_resource;
2552
2553     if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[0]) {
2554         tile_resource = TileResource :: POOR;
2555     }
2556     else if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[1]) {
2557         tile_resource = TileResource :: BELOW_AVERAGE;
2558     }
2559     else if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[2]) {
2560         tile_resource = TileResource :: AVERAGE;
2561     }
2562     else if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[3]) {
2563         tile_resource = TileResource :: ABOVE_AVERAGE;
2564     }
2565     else {
2566         tile_resource = TileResource :: GOOD;
2567     }
2568
2569     // 3. call alternate method
2570     this->setTitleResource(tile_resource);
2571
2572     return;
2573 } /* setTitleResource(double) */
```

4.7.3.50 setTitleResource() [2/2]

```
void HexTile::setTitleResource (
    TileResource tile_resource )
```

Method to set the tile resource (by enum value).

Parameters

<i>tile_resource</i>	The resource (TileResource) value to attribute to the tile.
----------------------	---

```
2515 {
2516     this->tile_resource = tile_resource;
2517     this->__setResourceText();
2518
2519     return;
2520 } /* setTitleResource(TileResource) */
```

4.7.3.51 setTileType() [1/2]

```
void HexTile::setTileType (
    double input_value )
```

Method to set the tile type (by numeric input).

Parameters

<i>input_value</i>	A numerical input in the closed interval [0, 1].
--------------------	--

```
2465 {
2466     // 1. check input
2467     if (input_value < 0 or input_value > 1) {
2468         std::string error_str = "ERROR HexTile::setTileType() given input value is ";
2469         error_str += "not in the closed interval [0, 1]";
2470
2471         #ifdef _WIN32
2472             std::cout << error_str << std::endl;
2473         #endif /* _WIN32 */
2474
2475         throw std::runtime_error(error_str);
2476     }
2477
2478     // 2. convert input value to tile type
2479     TileType tile_type;
2480
2481     if (input_value <= TILE_TYPE_CUMULATIVE_PROBABILITIES[0]) {
2482         tile_type = TileType :: LAKE;
2483     }
2484     else if (input_value <= TILE_TYPE_CUMULATIVE_PROBABILITIES[1]) {
2485         tile_type = TileType :: PLAINS;
2486     }
2487     else if (input_value <= TILE_TYPE_CUMULATIVE_PROBABILITIES[2]) {
2488         tile_type = TileType :: FOREST;
2489     }
2490     else {
2491         tile_type = TileType :: MOUNTAINS;
2492     }
2493
2494     // 3. call alternate method
2495     this->setTileType(tile_type);
2496
2497     return;
2498 } /* setTileType(double) */
```

4.7.3.52 setTileType() [2/2]

```
void HexTile::setTileType (
    TileType tile_type )
```

Method to set the tile type (by enum value).

Parameters

<i>tile_type</i>	The type (TileType) to set the tile to.
------------------	---

```
2404 {
2405     this->tile_type = tile_type;
2406
2407     switch (this->tile_type) {
2408         case (TileType :: FOREST): {
2409             this->tile_sprite.setFillColor(FOREST_GREEN);
2410
2411             break;
2412         }
2413
2414         case (TileType :: LAKE): {
```



```

2415         this->tile_sprite.setFillColor(LAKE_BLUE);
2416
2417         break;
2418     }
2419
2420     case (TileType :: MOUNTAINS): {
2421         this->tile_sprite.setFillColor(MOUNTAINS_GREY);
2422
2423         break;
2424     }
2425
2426     case (TileType :: OCEAN): {
2427         this->tile_sprite.setFillColor(OCEAN_BLUE);
2428
2429         break;
2430     }
2431
2432     case (TileType :: PLAINS): {
2433         this->tile_sprite.setFillColor(PLAINS_YELLOW);
2434
2435         break;
2436     }
2437
2438     default: {
2439         // do nothing!
2440
2441         break;
2442     }
2443 }
2444
2445 this->__setUpBuildMenu();
2446
2447 return;
2448 } /* setTileType(TileType) */

```

4.7.3.53 toggleResourceOverlay()

```

void HexTile::toggleResourceOverlay (
    void )

```

Method to toggle the tile resource overlay.

```

2686 {
2687     if (this->show_resource) {
2688         this->show_resource = false;
2689     }
2690     else {
2691         this->show_resource = true;
2692     }
2693
2694     return;
2695 } /* toggleResourceOverlay() */

```

4.7.4 Member Data Documentation

4.7.4.1 assets_manager_ptr

```
AssetsManager* HexTile::assets_manager_ptr [private]
```

A pointer to the assets manager.

4.7.4.2 build_menu_backing

```
sf::RectangleShape HexTile::build_menu_backing
```

A backing for the tile build menu.

4.7.4.3 build_menu_backing_text

```
sf::Text HexTile::build_menu_backing_text
```

A text label for the build menu.

4.7.4.4 build_menu_open

```
bool HexTile::build_menu_open
```

A boolean which indicates if the tile build menu is open.

4.7.4.5 build_menu_options_text_vec

```
std::vector<sf::Text> HexTile::build_menu_options_text_vec
```

A vector of text for the tile build options.

4.7.4.6 build_menu_options_vec

```
std::vector<std::vector<sf::Sprite> > HexTile::build_menu_options_vec
```

A vector of sprites for illustrating the tile build options.

4.7.4.7 credits

```
int HexTile::credits
```

The current balance of credits.

4.7.4.8 decoration_cleared

```
bool HexTile::decoration_cleared
```

A boolean which indicates if the tile decoration has been cleared.

4.7.4.9 draw_explosion

```
bool HexTile::draw_explosion
```

A boolean which indicates whether or not to draw a tile explosion.

4.7.4.10 event_ptr

```
sf::Event* HexTile::event_ptr [private]
```

A pointer to the event class.

4.7.4.11 explosion_frame

```
size_t HexTile::explosion_frame
```

The current frame of the explosion animation.

4.7.4.12 explosion_sprite_reel

```
std::vector<sf::Sprite> HexTile::explosion_sprite_reel
```

A reel of sprites for a tile explosion animation.

4.7.4.13 frame

```
unsigned long long int HexTile::frame
```

The current frame of this object.

4.7.4.14 game_phase

```
std::string HexTile::game_phase
```

The current phase of the game.

4.7.4.15 has_improvement

```
bool HexTile::has_improvement
```

A boolean which indicates if tile has improvement or not.

4.7.4.16 is_selected

```
bool HexTile::is_selected
```

A boolean which indicates whether or not the tile is selected.

4.7.4.17 magnifying_glass_sprite

```
sf::Sprite HexTile::magnifying_glass_sprite
```

A magnifying glass sprite.

4.7.4.18 major_radius

```
double HexTile::major_radius
```

The radius of the smallest bounding circle.

4.7.4.19 message_hub_ptr

```
MessageHub* HexTile::message_hub_ptr [private]
```

A pointer to the message hub.

4.7.4.20 minor_radius

```
double HexTile::minor_radius
```

The radius of the largest inscribed circle.

4.7.4.21 node_sprite

```
sf::CircleShape HexTile::node_sprite
```

A circle shape to mark the tile node.

4.7.4.22 position_x

```
double HexTile::position_x
```

The x position of the tile.

4.7.4.23 position_y

```
double HexTile::position_y
```

The y position of the tile.

4.7.4.24 render_window_ptr

```
sf::RenderWindow* HexTile::render_window_ptr [private]
```

A pointer to the render window.

4.7.4.25 resource_assessed

```
bool HexTile::resource_assessed
```

A boolean which indicates whether or not the resource has been assessed.

4.7.4.26 resource_assessment

```
bool HexTile::resource_assessment
```

A boolean which triggers a resource assessment notification.

4.7.4.27 resource_chip_sprite

```
sf::CircleShape HexTile::resource_chip_sprite
```

A circle shape which represents a resource chip.

4.7.4.28 resource_text

```
sf::Text HexTile::resource_text
```

A text representation of the resource.

4.7.4.29 scrap_improvement_frame

```
int HexTile::scrap_improvement_frame
```

A frame for key-hold to confirm scrapping.

4.7.4.30 select_outline_sprite

```
sf::ConvexShape HexTile::select_outline_sprite
```

A convex shape which outlines the tile when selected.

4.7.4.31 show_node

```
bool HexTile::show_node
```

A boolean which indicates whether or not to show the tile node.

4.7.4.32 show_resource

```
bool HexTile::show_resource
```

A boolean which indicates whether or not to show resource value.

4.7.4.33 tile_decoration_sprite

```
sf::Sprite HexTile::tile_decoration_sprite
```

A tile decoration sprite.

4.7.4.34 tile_improvement_ptr

```
TileImprovement* HexTile::tile_improvement_ptr
```

A pointer to the improvement for this tile.

4.7.4.35 tile_resource

```
TileResource HexTile::tile_resource
```

The renewable resource quality of the tile.

4.7.4.36 tile_sprite

```
sf::ConvexShape HexTile::tile_sprite
```

A convex shape which represents the tile.

4.7.4.37 tile_type

```
TileType HexTile::tile_type
```

The terrain type of the tile.

The documentation for this class was generated from the following files:

- header/[HexTile.h](#)
- source/[HexTile.cpp](#)

4.8 Message Struct Reference

A structure which defines a standard message format.

```
#include <MessageHub.h>
```

Public Attributes

- `std::string channel = ""`
A string identifying the appropriate channel for this message.
- `std::string subject = ""`
A string describing the message subject.
- `unsigned int number_of_reads = 0`
The number of times the message has been read.
- `std::map< std::string, bool > bool_payload = {}`
A boolean payload.
- `std::map< std::string, int > int_payload = {}`
An int payload.
- `std::map< std::string, double > double_payload = {}`
A double payload.
- `std::map< std::string, std::vector< double > > vector_payload = {}`
A vector (double) payload.
- `std::map< std::string, std::string > string_payload = {}`
A string payload.

4.8.1 Detailed Description

A structure which defines a standard message format.

4.8.2 Member Data Documentation

4.8.2.1 bool_payload

```
std::map<std::string, bool> Message::bool_payload = {}
```

A boolean payload.

4.8.2.2 channel

```
std::string Message::channel = ""
```

A string identifying the appropriate channel for this message.

4.8.2.3 double_payload

```
std::map<std::string, double> Message::double_payload = {}
```

A double payload.

4.8.2.4 int_payload

```
std::map<std::string, int> Message::int_payload = {}
```

An int payload.

4.8.2.5 number_of_reads

```
unsigned int Message::number_of_reads = 0
```

The number of times the message has been read.

4.8.2.6 string_payload

```
std::map<std::string, std::string> Message::string_payload = {}
```

A string payload.

4.8.2.7 subject

```
std::string Message::subject = ""
```

A string describing the message subject.

4.8.2.8 vector_payload

```
std::map<std::string, std::vector<double> > Message::vector_payload = {}
```

A vector (double) payload.

The documentation for this struct was generated from the following file:

- header/ESC_core/[MessageHub.h](#)

4.9 MessageHub Class Reference

A class which acts as a central hub for inter-object message traffic.

```
#include <MessageHub.h>
```

Public Member Functions

- [MessageHub](#) (void)
Constructor for the [MessageHub](#) class.
- bool [hasTraffic](#) (void)
Method to determine if there remains any message traffic.
- void [addChannel](#) (std::string)
Method to add channel to message map.
- void [removeChannel](#) (std::string)
Method to remove channel from message map.
- void [printStats](#) (void)
Method for printing message hub state information (mostly for troubleshooting message deadlocks).
- void [sendMessage](#) ([Message](#))
Method to send a message to the message map. Channels are implemented in a first in, first out manner (i.e. message queue).
- bool [isEmpty](#) (std::string)
Method to check if channel is empty.
- [Message](#) [receiveMessage](#) (std::string)
Method to receive the first message in the channel. Channels are implemented in a first in, first out manner (i.e. message queue).
- void [incrementMessageRead](#) (std::string)
Method to increment the number of times the first message in the channel has been read. Channels are implemented in a first in, first out manner (i.e. message queue).
- void [popMessage](#) (std::string)
Method to pop first message off of the given channel. Channels are implemented in a first in, first out manner (i.e. message queue).
- void [clearMessages](#) (void)
Method to clear messages from the [MessageHub](#).
- void [clear](#) (void)
Method to clear the [MessageHub](#).
- [~MessageHub](#) (void)
Destructor for the [MessageHub](#) class.

Private Attributes

- std::map< std::string, std::list< [Message](#) > > [message_map](#)
A map <string, list of [Message](#)> for sending and receiving messages. Here the key is the channel, and each channel maintains a list (history) of messages.

4.9.1 Detailed Description

A class which acts as a central hub for inter-object message traffic.

4.9.2 Constructor & Destructor Documentation

4.9.2.1 MessageHub()

```
MessageHub::MessageHub (
    void )
```

Constructor for the [MessageHub](#) class.

```
78 {
79     //...
80
81     std::cout << "MessageHub constructed at " << this << std::endl;
82
83     return;
84 } /* MessageHub() */
```

4.9.2.2 ~MessageHub()

```
MessageHub::~MessageHub (
    void )
```

Destructor for the [MessageHub](#) class.

```
526 {
527     this->clear();
528
529     std::cout << "MessageHub at " << this << " destroyed" << std::endl;
530
531     return;
532 } /* ~MessageHub() */
```

4.9.3 Member Function Documentation

4.9.3.1 addChannel()

```
void MessageHub::addChannel (
    std::string channel )
```

Method to add channel to message map.

Parameters

<i>channel</i>	The key for the message channel being added.
----------------	--

```
129 {
130     // 1. check if channel is in map (if so, throw error)
131     if (this->message_map.count(channel) > 0) {
132         std::string error_str = "ERROR MessageHub::addChannel() channel ";
133         error_str += channel;
134         error_str += " is already in message map";
135     }
```

```

136         #ifdef _WIN32
137             std::cout << error_str << std::endl;
138         #endif /* _WIN32 */
139
140         throw std::runtime_error(error_str);
141     }
142
143     // 2. add channel to map
144     this->message_map[channel] = {};
145
146     std::cout << "Channel " << channel << " added to message hub" << std::endl;
147
148     return;
149 } /* addChannel() */

```

4.9.3.2 clear()

```

void MessageHub::clear (
    void )

```

Method to clear the [MessageHub](#).

```

506 {
507
508     this->clearMessages();
509     this->message_map.clear();
510
511     return;
512 } /* clear() */

```

4.9.3.3 clearMessages()

```

void MessageHub::clearMessages (
    void )

```

Method to clear messages from the [MessageHub](#).

```

480 {
481     std::map<std::string, std::list<Message>::iterator map_iter;
482     for (
483         map_iter = this->message_map.begin();
484         map_iter != this->message_map.end();
485         map_iter++
486     ) {
487         map_iter->second.clear();
488     }
489
490     return;
491 } /* clearMessages() */

```

4.9.3.4 hasTraffic()

```

bool MessageHub::hasTraffic (
    void )

```

Method to determine if there remains any message traffic.

```

99 {
100     std::map<std::string, std::list<Message>::iterator map_iter;
101     for (
102         map_iter = this->message_map.begin();
103         map_iter != this->message_map.end();
104         map_iter++
105     ) {
106         if (not map_iter->second.empty()) {
107             return true;
108         }
109     }
110
111     return false;
112 } /* hasTraffic() */

```

4.9.3.5 incrementMessageRead()

```
void MessageHub::incrementMessageRead (
    std::string channel )
```

Method to increment the number of times the first message in the channel has been read. Channels are implemented in a first in, first out manner (i.e. message queue).

Parameters

<i>channel</i>	The key for the message channel being received from.
----------------	--

```
385 {
386     // 1. check if channel is in map (if not, throw error)
387     if (this->message_map.count(channel) <= 0) {
388         std::string error_str = "ERROR MessageHub::incrementMessageRead() channel ";
389         error_str += channel;
390         error_str += " is not in message map";
391
392         #ifdef _WIN32
393             std::cout << error_str << std::endl;
394         #endif /* _WIN32 */
395
396         throw std::runtime_error(error_str);
397     }
398
399     // 2. check if channel is empty (if so, throw error)
400     if (this->message_map[channel].empty()) {
401         std::string error_str = "ERROR MessageHub::incrementMessageRead() channel ";
402         error_str += channel;
403         error_str += " is empty";
404
405         #ifdef _WIN32
406             std::cout << error_str << std::endl;
407         #endif /* _WIN32 */
408
409         throw std::runtime_error(error_str);
410     }
411
412     // 3. increment number of reads
413     this->message_map[channel].front().number_of_reads++;
414
415     return;
416 } /* incrementMessageRead( */
```

4.9.3.6 isEmpty()

```
bool MessageHub::isEmpty (
    std::string channel )
```

Method to check if channel is empty.

Parameters

<i>channel</i>	The key for the message channel being checked.
----------------	--

Returns

A boolean indicating whether the channel is empty or not.

```
295 {
296     // 1. check if channel is in map (if not, throw error)
297     if (this->message_map.count(channel) <= 0) {
298         std::string error_str = "ERROR MessageHub::isEmpty() channel ";
```

```

299         error_str += channel;
300         error_str += " is not in message map";
301
302         #ifdef _WIN32
303             std::cout << error_str << std::endl;
304         #endif /* _WIN32 */
305         throw std::runtime_error(error_str);
306     }
307
308     if (this->message_map[channel].empty()) {
309         return true;
310     }
311     else {
312         return false;
313     }
314 } /* isEmpty() */
315 }

```

4.9.3.7 popMessage()

```

void MessageHub::popMessage (
    std::string channel )

```

Method to pop first message off of the given channel. Channels are implemented in a first in, first out manner (i.e. message queue).

Parameters

<i>channel</i>	The key for the message channel being popped.
----------------	---

```

434 {
435     // 1. check if channel is in map (if not, throw error)
436     if (this->message_map.count(channel) <= 0) {
437         std::string error_str = "ERROR MessageHub::receiveMessage() channel ";
438         error_str += channel;
439         error_str += " is not in message map";
440
441         #ifdef _WIN32
442             std::cout << error_str << std::endl;
443         #endif /* _WIN32 */
444
445         throw std::runtime_error(error_str);
446     }
447
448     // 2. check if channel is empty (if so, throw error)
449     if (this->message_map[channel].empty()) {
450         std::string error_str = "ERROR MessageHub::receiveMessage() channel ";
451         error_str += channel;
452         error_str += " is empty";
453
454         #ifdef _WIN32
455             std::cout << error_str << std::endl;
456         #endif /* _WIN32 */
457
458         throw std::runtime_error(error_str);
459     }
460
461     // 3. pop message
462     this->message_map[channel].pop_front();
463
464     return;
465 } /* popMessage() */

```

4.9.3.8 printState()

```

void MessageHub::printState (
    void )

```

Method for printing message hub state information (mostly for troubleshooting message deadlocks).

```

203 {
204     std::cout << "\n\n    **** MESSAGE HUB STATE ****    \n" << std::endl;
205
206     std::map<std::string, std::list<Message>::iterator> channel_iterator;
207
208     for (
209         channel_iterator = this->message_map.begin();
210         channel_iterator != this->message_map.end();
211         channel_iterator++
212     ) {
213         std::string channel = channel_iterator->first;
214         std::list<Message> message_queue = channel_iterator->second;
215
216         std::cout << "-----" << std::endl;
217         std::cout << "\tCHANNEL: " << channel << std::endl;
218         std::cout << "\tMESSAGE QUEUE LENGTH: " << message_queue.size() << std::endl;
219         std::cout << std::endl;
220
221         std::list<Message>::iterator message_queue_iterator;
222
223         for (
224             message_queue_iterator = message_queue.begin();
225             message_queue_iterator != message_queue.end();
226             message_queue_iterator++
227         ) {
228             std::cout << "\tSUBJECT: " << (*message_queue_iterator).subject <<
229                 std::endl;
230         }
231
232         std::cout << std::endl;
233     }
234
235     std::cout << std::endl;
236
237     return;
238 } /* printState() */

```

4.9.3.9 receiveMessage()

```

Message MessageHub::receiveMessage (
    std::string channel )

```

Method to receive the first message in the channel. Channels are implemented in a first in, first out manner (i.e. message queue).

Parameters

<i>channel</i>	The key for the message channel being received from.
----------------	--

Returns

The first message in the given channel.

```

335 {
336     // 1. check if channel is in map (if not, throw error)
337     if (this->message_map.count(channel) <= 0) {
338         std::string error_str = "ERROR MessageHub::receiveMessage() channel ";
339         error_str += channel;
340         error_str += " is not in message map";
341
342         #ifdef _WIN32
343             std::cout << error_str << std::endl;
344         #endif /* _WIN32 */
345
346         throw std::runtime_error(error_str);
347     }
348
349     // 2. check if channel is empty (if so, throw error)
350     if (this->message_map[channel].empty()) {
351         std::string error_str = "ERROR MessageHub::receiveMessage() channel ";

```

```

352         error_str += channel;
353         error_str += " is empty";
354
355         #ifdef _WIN32
356             std::cout << error_str << std::endl;
357         #endif /* _WIN32 */
358
359         throw std::runtime_error(error_str);
360     }
361
362     // 3. receive message
363     Message message = this->message_map[channel].front();
364
365     return message;
366 } /* receiveMessage() */

```

4.9.3.10 removeChannel()

```

void MessageHub::removeChannel (
    std::string channel )

```

Method to remove channel from message map.

Parameters

<i>channel</i>	The key for the message channel being removed.
----------------	--

```

166 {
167     // 1. check if channel is in map (if not, throw error)
168     if (this->message_map.count(channel) <= 0) {
169         std::string error_str = "ERROR MessageHub::removeChannel() channel ";
170         error_str += channel;
171         error_str += " is not in message map";
172
173         #ifdef _WIN32
174             std::cout << error_str << std::endl;
175         #endif /* _WIN32 */
176
177         throw std::runtime_error(error_str);
178     }
179
180     // 2. remove channel from map
181     this->message_map[channel].clear();
182     this->message_map.erase(channel);
183
184     std::cout << "Channel " << channel << " removed from message hub" << std::endl;
185
186     return;
187 } /* removeChannel() */

```

4.9.3.11 sendMessage()

```

void MessageHub::sendMessage (
    Message message )

```

Method to send a message to the message map. Channels are implemented in a first in, first out manner (i.e. message queue).

Parameters

<i>message</i>	The message to be sent.
----------------	-------------------------


```

256 {
257     // 1. check if channel is in map (if not, throw error)
258     std::string channel = message.channel;
259
260     if (this->message_map.count(channel) <= 0) {
261         std::string error_str = "ERROR MessageHub::sendMessage() channel ";
262         error_str += channel;
263         error_str += " is not in message map";
264
265         #ifdef _WIN32
266             std::cout << error_str << std::endl;
267         #endif /* _WIN32 */
268
269         throw std::runtime_error(error_str);
270     }
271
272     // 2. send message to message map
273     this->message_map[channel].push_back(message);
274
275     return;
276 } /* sendMessage() */

```

4.9.4 Member Data Documentation

4.9.4.1 message_map

```
std::map<std::string, std::list<Message> > MessageHub::message_map [private]
```

A map <string, list of [Message](#)> for sending and receiving messages. Here the key is the channel, and each channel maintains a list (history) of messages.

The documentation for this class was generated from the following files:

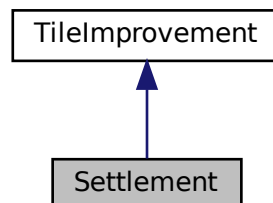
- header/ESC_core/[MessageHub.h](#)
- source/ESC_core/[MessageHub.cpp](#)

4.10 Settlement Class Reference

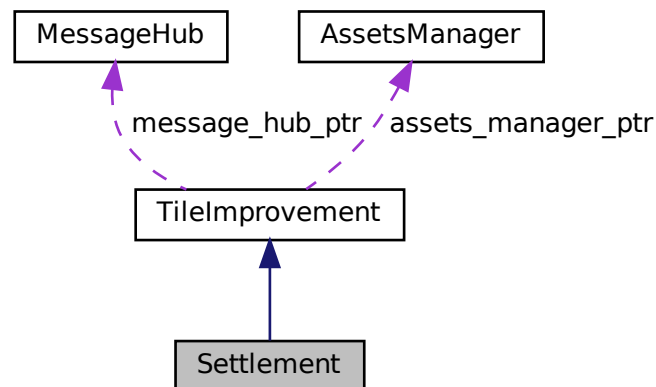
A settlement class (child class of [TileImprovement](#)).

```
#include <Settlement.h>
```

Inheritance diagram for Settlement:



Collaboration diagram for Settlement:



Public Member Functions

- `Settlement` (double, double, int, sf::Event *, sf::RenderWindow *, `AssetsManager` *, `MessageHub` *)
Constructor for the `Settlement` class.
- void `setIsSelected` (bool)
Method to set the is selected attribute.
- std::string `getTileOptionsSubstring` (void)
Helper method to assemble and return tile options substring.
- void `processEvent` (void)
Method to process `Settlement`. To be called once per event.
- void `processMessage` (void)
Method to process `Settlement`. To be called once per message.
- void `draw` (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual `~Settlement` (void)
Destructor for the `Settlement` class.

Public Attributes

- bool `draw_coin`
Boolean indicating whether or not to draw credits earned coin.
- double `smoke_da`
The per frame delta in smoke particle alpha value.
- double `smoke_dx`
The per frame delta in smoke particle x position.
- double `smoke_dy`
The per frame delta in smoke particle y position.
- double `smoke_prob`
The probability of spawning a new smoke prob in any given frame.
- std::list< sf::Sprite > `smoke_sprite_list`
A list of smoke sprite (for chimney animation).
- sf::Sprite `coin_sprite`
A coin sprite (for credits earned animation).

Private Member Functions

- void [__setUpTileImprovementSpriteStatic](#) (void)
Helper method to set up tile improvement sprite (static).
- void [__setUpCoinSprite](#) (void)
Helper method to set up and place coin sprite.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.

Additional Inherited Members

4.10.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

4.10.2 Constructor & Destructor Documentation

4.10.2.1 Settlement()

```
Settlement::Settlement (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [Settlement](#) class.

Ref: [Wikipedia](#) [2023]

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>tile_resource</i>	The renewable resource quality of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```
241 :
242 TileImprovement (
```

```

243     position_x,
244     position_y,
245     tile_resource,
246     event_ptr,
247     render_window_ptr,
248     assets_manager_ptr,
249     message_hub_ptr
250 )
251 {
252     // 1. set attributes
253
254     // 1.1. private
255     //...
256
257     // 1.2. public
258     this->tile_improvement_type = TileImprovementType :: SETTLEMENT;
259
260     this->draw_coin = false;
261
262     this->smoke_da = SECONDS_PER_FRAME / 4;
263     this->smoke_dx = 5 * SECONDS_PER_FRAME;
264     this->smoke_dy = -10 * SECONDS_PER_FRAME;
265     this->smoke_prob = 3 * SECONDS_PER_FRAME;
266
267     this->smoke_sprite_list = {};
268
269     this->tile_improvement_string = "SETTLEMENT";
270
271     this->__setUpTileImprovementSpriteStatic();
272     this->__setUpCoinSprite();
273
274     this->message_hub_ptr->addChannel(SETTLEMENT_CHANNEL);
275
276     std::cout << "Settlement constructed at " << this << std::endl;
277
278     return;
279 } /* Settlement() */

```

4.10.2.2 ~Settlement()

```

Settlement::~Settlement (
    void ) [virtual]

```

Destructor for the [Settlement](#) class.

```

502 {
503     std::cout << "Settlement at " << this << " destroyed" << std::endl;
504
505     return;
506 } /* ~Settlement() */

```

4.10.3 Member Function Documentation

4.10.3.1 __handleKeyPressEvents()

```

void Settlement::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

131 {
132     if (this->just_built) {
133         return;
134     }
135
136     switch (this->event_ptr->key.code) {
137         //...

```

```

138
139
140         default: {
141             // do nothing!
142
143             break;
144         }
145     }
146
147     return;
148 } /* __handleKeyPressEvents() */

```

4.10.3.2 __handleMouseButtonEvents()

```

void Settlement::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

163 {
164     if (this->just_built) {
165         return;
166     }
167
168     switch (this->event_ptr->mouseButton.button) {
169         case (sf::Mouse::Left): {
170             //...
171
172             break;
173         }
174
175         case (sf::Mouse::Right): {
176             //...
177
178             break;
179         }
180     }
181
182     default: {
183         // do nothing!
184
185         break;
186     }
187 }
188
189 return;
191 } /* __handleMouseButtonEvents() */

```

4.10.3.3 __setUpCoinSprite()

```

void Settlement::__setUpCoinSprite (
    void ) [private]

```

Helper method to set up and place coin sprite.

```

103 {
104     this->coin_sprite.setTexture(
105         *(this->assets_manager_ptr->getTexture("coin"))
106     );
107
108     this->coin_sprite.setOrigin(
109         this->coin_sprite.getLocalBounds().width / 2,
110         this->coin_sprite.getLocalBounds().height / 2
111     );
112
113     this->coin_sprite.setPosition(this->position_x, this->position_y);
114
115     return;
116 } /* __setUpCoinSprite() */

```

4.10.3.4 __setUpTileImprovementSpriteStatic()

```
void Settlement::__setUpTileImprovementSpriteStatic (
    void ) [private]
```

Helper method to set up tile improvement sprite (static).

```
68 {
69     this->tile_improvement_sprite_static.setTexture(
70         *(this->assets_manager_ptr->getTexture("brick_house_64x64_1"))
71     );
72
73     this->tile_improvement_sprite_static.setOrigin(
74         this->tile_improvement_sprite_static.getLocalBounds().width / 2,
75         this->tile_improvement_sprite_static.getLocalBounds().height
76     );
77
78     this->tile_improvement_sprite_static.setPosition(
79         this->position_x,
80         this->position_y - 32
81     );
82
83     this->tile_improvement_sprite_static.setColor(
84         sf::Color(255, 255, 255, 0)
85     );
86
87     return;
88 } /* __setUpTileImprovementSpriteStatic() */
```

4.10.3.5 draw()

```
void Settlement::draw (
    void ) [virtual]
```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```
409 {
410     // 1. if just built, call base method and return
411     if (this->just_built) {
412         TileImprovement :: draw();
413
414         return;
415     }
416
417     // 2. draw static sprite and chimney smoke effects
418     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
419
420     std::list<sf::Sprite>::iterator iter = this->smoke_sprite_list.begin();
421
422     double alpha = 255;
423
424     while (iter != this->smoke_sprite_list.end()) {
425         this->render_window_ptr->draw(*iter);
426
427         alpha = (*iter).getColor().a;
428
429         alpha -= this->smoke_da;
430
431         if (alpha <= 0) {
432             iter = this->smoke_sprite_list.erase(iter);
433             continue;
434         }
435
436         (*iter).setColor(sf::Color(255, 255, 255, alpha));
437
438         (*iter).move(
439             this->smoke_dx + 2 * (((double)rand() / RAND_MAX) - 1) / FRAMES_PER_SECOND,
440             this->smoke_dy
441         );
442
443         (*iter).rotate((((double)rand() / RAND_MAX)));
444
445         iter++;
446     }
```

```

447
448
449     if ((double)rand() / RAND_MAX < smoke_prob) {
450         this->smoke_sprite_list.push_back(
451             sf::Sprite(*(this->assets_manager_ptr->getTexture("emissions")))
452         );
453
454         this->smoke_sprite_list.back().setOrigin(
455             this->smoke_sprite_list.back().getLocalBounds().width / 2,
456             this->smoke_sprite_list.back().getLocalBounds().height / 2
457         );
458
459         this->smoke_sprite_list.back().setPosition(
460             this->position_x + 9 + 4 * ((double)rand() / RAND_MAX) - 2,
461             this->position_y - 33
462         );
463     }
464
465
466
467     // 4. draw coin
468     if (this->draw_coin) {
469         double alpha = this->coin_sprite.getColor().a;
470
471         alpha -= this->smoke_da;
472
473         if (alpha <= 0) {
474             this->coin_sprite.setColor(sf::Color(255, 255, 255, 255));
475             this->coin_sprite.setPosition(this->position_x, this->position_y);
476             this->draw_coin = false;
477         }
478
479         this->coin_sprite.move(0, this->smoke_dy);
480         this->coin_sprite.setColor(sf::Color(255, 255, 255, alpha));
481
482         this->render_window_ptr->draw(this->coin_sprite);
483     }
484
485     this->frame++;
486     return;
487 } /* draw() */

```

4.10.3.6 getTileOptionsSubstring()

```

std::string Settlement::getTileOptionsSubstring (
    void ) [virtual]

```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

321 {
322     //          32 char x 17 line console "-----\n";
323     std::string options_substring = "    **** SETTLEMENT OPTIONS **** \n";
324     options_substring += " \n";
325     options_substring += " \n";
326     options_substring += " \n";
327     options_substring += " \n";
328     options_substring += " \n";
329     options_substring += " \n";
330     options_substring += " \n";
331
332     return options_substring;
333 } /* getTileOptionsSubstring() */

```

4.10.3.7 processEvent()

```
void Settlement::processEvent (
    void ) [virtual]
```

Method to process [Settlement](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```
348 {
349     TileImprovement :: processEvent();
350
351     if (this->event_ptr->type == sf::Event::KeyPressed) {
352         this->__handleKeyPressEvents();
353     }
354
355     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
356         this->__handleMouseButtonEvents();
357     }
358
359     return;
360 } /* processEvent() */
```

4.10.3.8 processMessage()

```
void Settlement::processMessage (
    void ) [virtual]
```

Method to process [Settlement](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```
375 {
376     TileImprovement :: processMessage();
377
378     if (not this->message_hub_ptr->isEmpty(SETTLEMENT_CHANNEL)) {
379         Message settlement_message = this->message_hub_ptr->receiveMessage(
380             SETTLEMENT_CHANNEL
381         );
382
383         if (settlement_message.subject == "credits earned") {
384             this->draw_coin = true;
385             this->assets_manager_ptr->getSound("coin ring")->play();
386
387             std::cout << "Credits earned message received by " << this << std::endl;
388             this->message_hub_ptr->popMessage(SETTLEMENT_CHANNEL);
389         }
390     }
391
392     return;
393 } /* processMessage() */
```

4.10.3.9 setIsSelected()

```
void Settlement::setIsSelected (
    bool is_selected ) [virtual]
```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```
296 {
297     TileImprovement :: setIsSelected(is_selected);
298
299     if (this->is_selected) {
300         this->assets_manager_ptr->getSound("people and children")->play();
301     }
302
303     return;
304 } /* setIsSelected() */
```

4.10.4 Member Data Documentation

4.10.4.1 coin_sprite

`sf::Sprite Settlement::coin_sprite`

A coin sprite (for credits earned animation).

4.10.4.2 draw_coin

`bool Settlement::draw_coin`

Boolean indicating whether or not to draw credits earned coin.

4.10.4.3 smoke_da

`double Settlement::smoke_da`

The per frame delta in smoke particle alpha value.

4.10.4.4 smoke_dx

`double Settlement::smoke_dx`

The per frame delta in smoke particle x position.

4.10.4.5 smoke_dy

`double Settlement::smoke_dy`

The per frame delta in smoke particle y position.

4.10.4.6 smoke_prob

```
double Settlement::smoke_prob
```

The probability of spawning a new smoke prob in any given frame.

4.10.4.7 smoke_sprite_list

```
std::list<sf::Sprite> Settlement::smoke_sprite_list
```

A list of smoke sprite (for chimney animation).

The documentation for this class was generated from the following files:

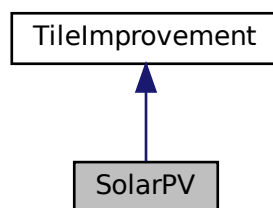
- header/[Settlement.h](#)
- source/[Settlement.cpp](#)

4.11 SolarPV Class Reference

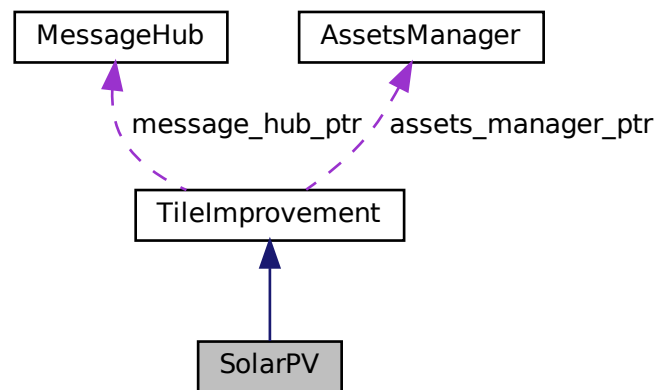
A settlement class (child class of [TileImprovement](#)).

```
#include <SolarPV.h>
```

Inheritance diagram for SolarPV:



Collaboration diagram for SolarPV:



Public Member Functions

- [SolarPV](#) (double, double, int, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [SolarPV](#) class.
- std::string [getTileOptionsSubstring](#) (void)
Helper method to assemble and return tile options substring.
- void [setIsSelected](#) (bool)
Method to set the is selected attribute.
- void [advanceTurn](#) (void)
Method to handle turn advance.
- void [update](#) (void)
Method to trigger production and dispatchable updates.
- void [processEvent](#) (void)
Method to process [SolarPV](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [SolarPV](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual [~SolarPV](#) (void)
Destructor for the [SolarPV](#) class.

Public Attributes

- int [capacity_kW](#)
The rated production capacity [kW] of the solar PV array.
- int [production_MWh](#)
The current production [MWh] of the solar PV array.
- int [dispatch_MWh](#)
The current dispatch [MWh] of the solar PV array.

- int [dispatchable_MWh](#)
The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).
- double [max_daily_production_MWh](#)
The maximum daily production [MWh] of the solar PV array.
- std::vector< double > [capacity_factor_vec](#)
A vector of daily capacity factors for the current month.
- std::vector< double > [production_vec_MWh](#)
A vector of daily production [MWh] for the current month.
- std::vector< double > [dispatch_vec_MWh](#)
A vector of daily dispatch [MWh] for the current month.

Private Member Functions

- void [__setUpTileImprovementSpriteStatic](#) (void)
Helper method to set up tile improvement sprite (static).
- void [__drawProductionMenu](#) (void)
Helper method to draw production menu assets.
- void [__upgradePowerCapacity](#) (void)
Helper method to upgrade power capacity.
- void [__computeProductionCosts](#) (void)
Helper method to compute production costs (O&M) based on current production level.
- void [__breakdown](#) (void)
Helper method to trigger an equipment breakdown.
- void [__repair](#) (void)
Helper method to repair the solar PV array.
- void [__computeCapacityFactors](#) (void)
Helper method to compute capacity factors.
- void [__computeProduction](#) (void)
Helper method to compute production values.
- void [__computeDispatch](#) (void)
Helper method to compute dispatch values.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__drawUpgradeOptions](#) (void)
Helper method to set up and draw upgrade options.
- void [__sendImprovementStateMessage](#) (void)
Helper method to format and sent improvement state message.

Additional Inherited Members

4.11.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

4.11.2 Constructor & Destructor Documentation

4.11.2.1 SolarPV()

```
SolarPV::SolarPV (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [SolarPV](#) class.

Ref: [Wikipedia \[2023\]](#)

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>tile_resource</i>	The renewable resource quality of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```
759 :
760 TileImprovement (
761     position_x,
762     position_y,
763     tile_resource,
764     event_ptr,
765     render_window_ptr,
766     assets_manager_ptr,
767     message_hub_ptr
768 )
769 {
770     // 1. set attributes
771
772     // 1.1. private
773     //...
774
775     // 1.2. public
776     this->tile_improvement_type = TileImprovementType :: SOLAR_PV;
777
778     this->is_running = false;
779
780     this->health = 100;
781
782     this->capacity_kW = 100;
783     this->upgrade_level = 1;
784
785     this->storage_kWh = 0;
786     this->storage_level = 0;
787
788     this->production_MWh = 0;
789     this->dispatch_MWh = 0;
790     this->dispatchable_MWh = 0;
791
792     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
793
794     this->capacity_factor_vec.resize(30, 0);
795     this->production_vec_MWh.resize(30, 0);
```

```

796     this->dispatch_vec_MWh.resize(30, 0);
797
798     this->tile_improvement_string = "SOLAR PV ARRAY";
799
800     this->__setUpTileImprovementSpriteStatic();
801     this->__computeCapacityFactors();
802     this->update();
803
804     std::cout << "SolarPV constructed at " << this << std::endl;
805
806     return;
807 } /* SolarPV() */

```

4.11.2.2 ~SolarPV()

```

SolarPV::~~SolarPV (
    void ) [virtual]

```

Destructor for the [SolarPV](#) class.

```

1147 {
1148     std::cout << "SolarPV at " << this << " destroyed" << std::endl;
1149
1150     return;
1151 } /* ~SolarPV() */

```

4.11.3 Member Function Documentation

4.11.3.1 __breakdown()

```

void SolarPV::__breakdown (
    void ) [private]

```

Helper method to trigger an equipment breakdown.

```

233 {
234     TileImprovement :: __breakdown();
235
236     this->production_MWh = 0;
237     this->dispatch_MWh = 0;
238     this->dispatchable_MWh = 0;
239     this->operation_maintenance_cost = 0;
240
241     return;
242 } /* __breakdown() */

```

4.11.3.2 __computeCapacityFactors()

```
void SolarPV::__computeCapacityFactors (
    void ) [private]
```

Helper method to compute capacity factors.

```
290 {
291     if (this->is_broken) {
292         return;
293     }
294
295     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
296     std::default_random_engine generator(seed);
297
298     double mean =
299         this->tile_resource_scalar * MEAN_DAILY_SOLAR_CAPACITY_FACTORS[this->month - 1];
300
301     double stdev = STDEV_DAILY_SOLAR_CAPACITY_FACTORS[this->month - 1];
302
303     if (this->tile_resource_scalar > 1) {
304         stdev /= this->tile_resource_scalar;
305     }
306
307     std::normal_distribution<double> normal_dist(mean, stdev);
308
309     double capacity_factor = 0;
310
311     for (int i = 0; i < 30; i++) {
312         capacity_factor = normal_dist(generator);
313
314         if (capacity_factor < 0) {
315             capacity_factor = 0;
316         }
317
318         this->capacity_factor_vec[i] = capacity_factor;
319     }
320
321     return;
322 } /* __computeCapacityFactors() */
```

4.11.3.3 __computeDispatch()

```
void SolarPV::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
370 {
371     if (this->is_broken) {
372         this->dispatchable_MWh = 0;
373         return;
374     }
375
376     double stored_energy_MWh = 0;
377     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
378
379     double demand_MWh = 0;
380     double production_MWh = 0;
381     double dispatchable_MWh = 0;
382     double difference_MWh = 0;
383
384     double room_MWh = 0;
385
386     for (int i = 0; i < 30; i++) {
387         demand_MWh = this->demand_vec_MWh[i];
388         production_MWh = this->production_vec_MWh[i];
389
390         if (production_MWh <= demand_MWh) {
391             this->dispatch_vec_MWh[i] = production_MWh;
392             dispatchable_MWh += this->dispatch_vec_MWh[i];
393
394             difference_MWh = demand_MWh - production_MWh;
395
396             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
397                 if (difference_MWh > stored_energy_MWh) {
398                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
```

```

399         dispatchable_MWh += stored_energy_MWh;
400         stored_energy_MWh = 0;
401     }
402
403     else {
404         this->dispatch_vec_MWh[i] += difference_MWh;
405         dispatchable_MWh += difference_MWh;
406         stored_energy_MWh -= difference_MWh;
407     }
408 }
409 }
410
411 else {
412     this->dispatch_vec_MWh[i] = demand_MWh;
413     dispatchable_MWh += this->dispatch_vec_MWh[i];
414
415     difference_MWh = production_MWh - demand_MWh;
416
417     if (
418         (storage_capacity_MWh > 0) and
419         (stored_energy_MWh < storage_capacity_MWh)
420     ) {
421         room_MWh = storage_capacity_MWh - stored_energy_MWh;
422
423         if (difference_MWh > room_MWh) {
424             stored_energy_MWh += room_MWh;
425         }
426
427         else {
428             stored_energy_MWh += difference_MWh;
429         }
430     }
431 }
432 }
433
434 this->dispatchable_MWh = round(dispatchable_MWh);
435
436 if (this->dispatch_MWh != this->dispatchable_MWh) {
437     this->dispatch_MWh = this->dispatchable_MWh;
438 }
439
440 return;
441 } /* __computeDispatch() */

```

4.11.3.4 __computeProduction()

```

void SolarPV::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

337 {
338     if (this->is_broken) {
339         this->production_MWh = 0;
340         return;
341     }
342
343     double production_MWh = 0;
344
345     for (int i = 0; i < 30; i++) {
346         this->production_vec_MWh[i] =
347             this->max_daily_production_MWh * this->capacity_factor_vec[i];
348
349         production_MWh += this->production_vec_MWh[i];
350     }
351
352     this->production_MWh = round(production_MWh);
353
354     return;
355 } /* __computeProduction() */

```


4.11.3.5 __computeProductionCosts()

```
void SolarPV::__computeProductionCosts (
    void ) [private]
```

Helper method to compute production costs (O&M) based on current production level.

```
212 {
213     double operation_maintenance_cost =
214         (this->production_MWh * SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
215     this->operation_maintenance_cost = round(operation_maintenance_cost);
216
217     return;
218 } /* __computeProductionCosts() */
```

4.11.3.6 __drawProductionMenu()

```
void SolarPV::__drawProductionMenu (
    void ) [private]
```

Helper method to draw production menu assets.

```
103 {
104     // 1. draw static sprite
105     sf::Vector2f initial_position = this->tile_improvement_sprite_static.getPosition();
106     this->tile_improvement_sprite_static.setPosition(400 - 138, 400 + 16);
107
108     sf::Color initial_colour = this->tile_improvement_sprite_static.getColor();
109     this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
110
111     sf::Vector2f initial_scale = this->tile_improvement_sprite_static.getScale();
112     this->tile_improvement_sprite_static.setScale(sf::Vector2f(1, 1));
113
114     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
115
116     this->tile_improvement_sprite_static.setPosition(initial_position);
117     this->tile_improvement_sprite_static.setColor(initial_colour);
118     this->tile_improvement_sprite_static.setScale(initial_scale);
119
120     // 2. draw production text
121     std::string production_string = "[W]: INCREASE DISPATCH\n";
122     production_string += "[S]: DECREASE DISPATCH\n";
123     production_string += "\n";
124
125     production_string += "DISPATCH: ";
126     production_string += std::to_string(this->dispatch_MWh);
127     production_string += " MWh (MAX ";
128     production_string += std::to_string(this->dispatchable_MWh);
129     production_string += ")\n";
130
131     production_string += "O&M COST: ";
132     production_string += std::to_string(this->operation_maintenance_cost);
133     production_string += " K\n";
134
135     sf::Text production_text(
136         production_string,
137         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
138         16
139     );
140
141     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
142     production_text.setFillColor(MONOCROME_TEXT_GREEN);
143
144     production_text.setPosition(400 + 30, 400 - 45);
145
146     this->render_window_ptr->draw(production_text);
147
148     return;
149 } /* __drawProductionMenu() */
```

4.11.3.7 __drawUpgradeOptions()

```
void SolarPV::__drawUpgradeOptions (
    void ) [private]
```

Helper method to set up and draw upgrade options.

```
582 {
583     // 1. draw power capacity upgrade sprite
584     sf::Vector2f initial_position = this->tile_improvement_sprite_static.getPosition();
585     this->tile_improvement_sprite_static.setPosition(400 - 100, 400 - 32);
586
587     sf::Color initial_colour = this->tile_improvement_sprite_static.getColor();
588     this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
589
590     sf::Vector2f initial_scale = this->tile_improvement_sprite_static.getScale();
591     this->tile_improvement_sprite_static.setScale(sf::Vector2f(1, 1));
592
593     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
594
595     this->tile_improvement_sprite_static.setPosition(initial_position);
596     this->tile_improvement_sprite_static.setColor(initial_colour);
597     this->tile_improvement_sprite_static.setScale(initial_scale);
598
599     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
600
601
602     // 2. draw power capacity upgrade text
603     // 16 char line = "                                \n"
604     std::string power_upgrade_string = "POWER CAPACITY \n";
605     power_upgrade_string += "                                \n";
606
607     power_upgrade_string += "CAPACITY: ";
608     power_upgrade_string += std::to_string(this->capacity_kW);
609     power_upgrade_string += " kW\n";
610
611     power_upgrade_string += "LEVEL: ";
612     power_upgrade_string += std::to_string(this->upgrade_level);
613     power_upgrade_string += "\n\n";
614
615     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
616         power_upgrade_string += "[W]: + 100 kW (";
617         power_upgrade_string += std::to_string(SOLAR_PV_BUILD_COST);
618         power_upgrade_string += " K)\n";
619     }
620
621     else {
622         power_upgrade_string += " * MAX LEVEL * \n";
623     }
624
625     sf::Text power_upgrade_text = sf::Text(
626         power_upgrade_string,
627         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
628         16
629     );
630
631     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
632     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
633     power_upgrade_text.setFill_color(MONOCROME_TEXT_GREEN);
634
635     this->render_window_ptr->draw(power_upgrade_text);
636
637
638     // 3. draw energy capacity (storage) upgrade sprite
639     this->render_window_ptr->draw(this->storage_upgrade_sprite);
640     this->render_window_ptr->draw(this->upgrade_plus_sprite);
641
642
643     // 4. draw energy capacity (storage) upgrade text
644     // 16 char line = "                                \n"
645     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
646     energy_upgrade_string += "                                \n";
647
648     energy_upgrade_string += "CAPACITY: ";
649     energy_upgrade_string += std::to_string(this->storage_level * 200);
650     energy_upgrade_string += " kWh\n";
651
652     energy_upgrade_string += "LEVEL: ";
653     energy_upgrade_string += std::to_string(this->storage_level);
654     energy_upgrade_string += "\n\n";
655
656     if (this->storage_level < MAX_STORAGE_LEVELS) {
657         energy_upgrade_string += "[D]: + 200 kWh (";
658         energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
659         energy_upgrade_string += " K)\n";
660     }
```

```

660     }
661
662     else {
663         energy_upgrade_string += " * MAX LEVEL * \n";
664     }
665
666     sf::Text energy_upgrade_text = sf::Text(
667         energy_upgrade_string,
668         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
669         16
670     );
671
672     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
673     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
674     energy_upgrade_text.setFillColor(MONOCHROME_TEXT_GREEN);
675
676     this->render_window_ptr->draw(energy_upgrade_text);
677
678     return;
679 } /* __drawUpgradeOptions() */

```

4.11.3.8 __handleKeyPressEvents()

```

void SolarPV::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

456 {
457     if (this->just_built) {
458         return;
459     }
460
461     switch (this->event_ptr->key.code) {
462         case (sf::Keyboard::U): {
463             this->__openUpgradeMenu();
464
465             break;
466         }
467
468         case (sf::Keyboard::W): {
469             if (this->production_menu_open) {
470                 this->dispatch_MWh++;
471
472                 if (this->dispatch_MWh > this->dispatchable_MWh) {
473                     this->dispatch_MWh = 0;
474                 }
475
476                 this->__computeProductionCosts();
477                 this->assets_manager_ptr->getSound("interface click")->play();
478             }
479
480             else if (this->upgrade_menu_open) {
481                 this->__upgradePowerCapacity();
482             }
483
484             break;
485         }
486
487         case (sf::Keyboard::S): {
488             if (this->production_menu_open) {
489                 this->dispatch_MWh--;
490
491                 if (this->dispatch_MWh < 0) {
492                     this->dispatch_MWh = this->dispatchable_MWh;
493                 }
494
495                 this->__computeProductionCosts();
496                 this->assets_manager_ptr->getSound("interface click")->play();
497             }
498
499             break;
500         }
501
502         case (sf::Keyboard::D): {
503             if (this->upgrade_menu_open) {

```

```

507         this->__upgradeStorageCapacity();
508         this->__computeProduction();
509         this->__computeDispatch();
510     }
511
512     break;
513 }
514
515
516     default: {
517         // do nothing!
518
519         break;
520     }
521 }
522
523 return;
524 } /* __handleKeyPressEvents() */

```

4.11.3.9 __handleMouseButtonEvents()

```

void SolarPV::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

539 {
540     if (this->just_built) {
541         return;
542     }
543
544     switch (this->event_ptr->mouseButton.button) {
545         case (sf::Mouse::Left): {
546             //...
547
548             break;
549         }
550
551         case (sf::Mouse::Right): {
552             //...
553
554             break;
555         }
556
557         default: {
558             // do nothing!
559
560             break;
561         }
562     }
563
564     return;
565 } /* __handleMouseButtonEvents() */

```

4.11.3.10 __repair()

```

void SolarPV::__repair (
    void ) [private], [virtual]

```

Helper method to repair the solar PV array.

Reimplemented from [TileImprovement](#).

```

257 {
258     if (this->credits < SOLAR_PV_BUILD_COST) {
259         std::cout << "Cannot repair solar PV: insufficient credits (need "
260             << SOLAR_PV_BUILD_COST << " K)" << std::endl;
261     }

```

```

262         this->__sendInsufficientCreditsMessage();
263         return;
264     }
265
266     TileImprovement::__repair();
267
268     this->just_upgraded = true;
269
270     this->__sendCreditsSpentMessage(SOLAR_PV_BUILD_COST);
271     this->__sendTileStateRequest();
272     this->__sendGameStateRequest();
273
274     return;
275 } /* __repair() */

```

4.11.3.11 __sendImprovementStateMessage()

```

void SolarPV::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

694 {
695     Message improvement_state_message;
696
697     improvement_state_message.channel = GAME_CHANNEL;
698     improvement_state_message.subject = "improvement state";
699
700     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
701     improvement_state_message.int_payload["operation_maintenance_cost"] =
702         this->operation_maintenance_cost;
703
704     this->message_hub_ptr->sendMessage(improvement_state_message);
705
706     std::cout << "Improvement state message sent by " << this << std::endl;
707
708     return;
709 } /* __sendImprovementStateMessage() */

```

4.11.3.12 __setUpTileImprovementSpriteStatic()

```

void SolarPV::__setUpTileImprovementSpriteStatic (
    void ) [private]

```

Helper method to set up tile improvement sprite (static).

```

68 {
69     this->tile_improvement_sprite_static.setTexture(
70         *(this->assets_manager_ptr->getTexture("solar PV array"))
71     );
72
73     this->tile_improvement_sprite_static.setOrigin(
74         this->tile_improvement_sprite_static.getLocalBounds().width / 2,
75         this->tile_improvement_sprite_static.getLocalBounds().height
76     );
77
78     this->tile_improvement_sprite_static.setPosition(
79         this->position_x,
80         this->position_y - 32
81     );
82
83     this->tile_improvement_sprite_static.setColor(
84         sf::Color(255, 255, 255, 0)
85     );
86
87     return;
88 } /* __setUpTileImprovementSpriteStatic() */

```

4.11.3.13 __upgradePowerCapacity()

```
void SolarPV::__upgradePowerCapacity (
    void ) [private]
```

Helper method to upgrade power capacity.

```
164 {
165     if (this->credits < SOLAR_PV_BUILD_COST) {
166         std::cout << "Cannot upgrade solar PV: insufficient credits (need "
167             << SOLAR_PV_BUILD_COST << " K)" << std::endl;
168
169         this->__sendInsufficientCreditsMessage();
170         return;
171     }
172
173     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
174         return;
175     }
176
177     TileImprovement :: __repair();
178
179     this->capacity_kW += 100;
180     this->upgrade_level++;
181
182     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
183
184     this->__computeProduction();
185     this->__computeDispatch();
186
187     this->just_upgraded = true;
188
189     this->assets_manager_ptr->getSound("upgrade")->play();
190
191     this->__sendCreditsSpentMessage(SOLAR_PV_BUILD_COST);
192     this->__sendTileStateRequest();
193     this->__sendGameStateRequest();
194
195     return;
196 } /* __upgradePowerCapacity() */
```

4.11.3.14 advanceTurn()

```
void SolarPV::advanceTurn (
    void ) [virtual]
```

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```
912 {
913     // 1. send improvement state message
914     this->__sendImprovementStateMessage();
915
916     // 2. update
917     this->__computeCapacityFactors();
918     this->update();
919
920     // 3. handle start/stop
921     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
922         this->is_running = true;
923     }
924
925     else if (this->is_running and (this->dispatch_MWh <= 0)) {
926         this->is_running = false;
927     }
928
929     // 4. handle equipment health and breakdowns
930     if (this->is_running) {
931         this->health--;
932
933         if (this->health <= 50) {
934             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
935
936             if ((double)rand() / RAND_MAX <= breakdown_prob) {
937                 this->health = 0;
```

```

938         }
939     }
940
941     if (this->health <= 0) {
942         this->__breakdown();
943     }
944 }
945
946 // 5. send tile state request (if selected)
947 if (this->is_selected) {
948     this->__sendTileStateRequest();
949 }
950
951 return;
952 } /* advanceTurn() */

```

4.11.3.15 draw()

```

void SolarPV::draw (
    void ) [virtual]

```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```

1041 {
1042     // 1. if just built, call base method and return
1043     if (this->just_built) {
1044         TileImprovement :: draw();
1045
1046         return;
1047     }
1048
1049
1050     // 2. handle upgrade effects
1051     if (this->just_upgraded) {
1052         this->tile_improvement_sprite_static.setColor(
1053             sf::Color(
1054                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1055                 255,
1056                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1057                 255
1058             )
1059         );
1060
1061         this->tile_improvement_sprite_static.setScale(
1062             sf::Vector2f(
1063                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1064                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1065             )
1066         );
1067
1068         this->upgrade_frame++;
1069     }
1070
1071     if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1072         this->tile_improvement_sprite_static.setColor(
1073             sf::Color(255,255,255,255)
1074         );
1075
1076         this->tile_improvement_sprite_static.setScale(sf::Vector2f(1,1));
1077
1078         this->just_upgraded = false;
1079         this->upgrade_frame = 0;
1080     }
1081
1082
1083     // 3. draw static sprite
1084     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
1085
1086
1087     // 4. draw storage upgrades
1088     for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1089         this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1090     }
1091
1092
1093     // 5. handle dispatch illustration

```

```

1094     if (this->dispatch_MWh > 0) {
1095         this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1096         this->__drawDispatch();
1097     }
1098
1099
1100     // 6. draw production menu
1101     if (this->production_menu_open) {
1102         this->render_window_ptr->draw(this->production_menu_backing);
1103         this->render_window_ptr->draw(this->production_menu_backing_text);
1104
1105         this->__drawProductionMenu();
1106     }
1107
1108
1109     // 7. draw upgrade menu
1110     if (this->upgrade_menu_open) {
1111         this->render_window_ptr->draw(this->upgrade_menu_backing);
1112         this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1113
1114         this->__drawUpgradeOptions();
1115     }
1116
1117
1118     // 10. handle broken effects
1119     if (this->is_broken) {
1120         this->tile_improvement_sprite_static.setColor(
1121             sf::Color(
1122                 255,
1123                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1124                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1125                 255
1126             )
1127         );
1128     }
1129
1130     this->frame++;
1131     return;
1132 } /* draw() */

```

4.11.3.16 getTileOptionsSubstring()

```

std::string SolarPV::getTileOptionsSubstring (
    void ) [virtual]

```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

824 {
825     // 32 char x 17 line console "-----\n";
826     std::string options_substring = "CAPACITY: ";
827     options_substring += std::to_string(this->capacity_kW);
828     options_substring += " kW (level ";
829     options_substring += std::to_string(this->upgrade_level);
830     options_substring += ")\n";
831
832     options_substring += "PRODUCTION: ";
833     options_substring += std::to_string(this->production_MWh);
834     options_substring += " MWh\n";
835
836     options_substring += "DISPATCHABLE: ";
837     options_substring += std::to_string(this->dispatchable_MWh);
838     options_substring += " MWh\n";
839
840     options_substring += "HEALTH: ";
841     options_substring += std::to_string(this->health);
842     options_substring += "/100";
843
844     if (this->health <= 0) {
845         options_substring += " ** BROKEN! **\n";

```



```

846     }
847
848     else {
849         options_substring += "\n";
850     }
851
852     options_substring += "
853     options_substring += "      **** SOLAR PV OPTIONS ****
854     options_substring += "
855
856     if (this->is_broken) {
857         options_substring += "      [R]: REPAIR (";
858         options_substring += std::to_string(SOLAR_PV_BUILD_COST);
859         options_substring += " K)\n";
860     }
861
862     else {
863         options_substring += "      [E]: OPEN PRODUCTION MENU \n";
864     }
865
866     options_substring += "      [U]: OPEN UPGRADE MENU
867     options_substring += "HOLD [P]: SCRAP (";
868     options_substring += std::to_string(SCRAP_COST);
869     options_substring += " K)";
870
871     return options_substring;
872 } /* getTileOptionsSubstring() */

```

4.11.3.17 processEvent()

```

void SolarPV::processEvent (
    void ) [virtual]

```

Method to process [SolarPV](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```

992 {
993     TileImprovement :: processEvent();
994
995     if (this->event_ptr->type == sf::Event::KeyPressed) {
996         this->__handleKeyPressEvents();
997     }
998
999     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1000         this->__handleMouseButtonEvents();
1001     }
1002
1003     return;
1004 } /* processEvent() */

```

4.11.3.18 processMessage()

```

void SolarPV::processMessage (
    void ) [virtual]

```

Method to process [SolarPV](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```

1019 {
1020     TileImprovement :: processMessage();
1021
1022     //...
1023
1024     return;
1025 } /* processMessage() */

```

4.11.3.19 setIsSelected()

```
void SolarPV::setIsSelected (
    bool is_selected ) [virtual]
```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```
889 {
890     TileImprovement :: setIsSelected(is_selected);
891
892     if (this->is_running and this->is_selected) {
893         this->assets_manager_ptr->getSound("solar hum")->play();
894     }
895
896     return;
897 } /* setIsSelected() */
```

4.11.3.20 update()

```
void SolarPV::update (
    void ) [virtual]
```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
967 {
968     this->__computeProduction();
969     this->__computeProductionCosts();
970     this->__computeDispatch();
971
972     if (this->is_selected) {
973         this->__sendTileStateRequest();
974     }
975
976     return;
977 } /* update() */
```

4.11.4 Member Data Documentation

4.11.4.1 capacity_factor_vec

```
std::vector<double> SolarPV::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

4.11.4.2 capacity_kW

```
int SolarPV::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

4.11.4.3 dispatch_MWh

```
int SolarPV::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

4.11.4.4 dispatch_vec_MWh

```
std::vector<double> SolarPV::dispatch_vec_MWh
```

A vector of daily dispatch [MWh] for the current month.

4.11.4.5 dispatchable_MWh

```
int SolarPV::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

4.11.4.6 max_daily_production_MWh

```
double SolarPV::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

4.11.4.7 production_MWh

```
int SolarPV::production_MWh
```

The current production [MWh] of the solar PV array.

4.11.4.8 production_vec_MWh

```
std::vector<double> SolarPV::production_vec_MWh
```

A vector of daily production [MWh] for the current month.

The documentation for this class was generated from the following files:

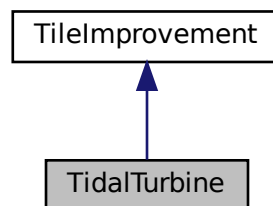
- header/[SolarPV.h](#)
- source/[SolarPV.cpp](#)

4.12 TidalTurbine Class Reference

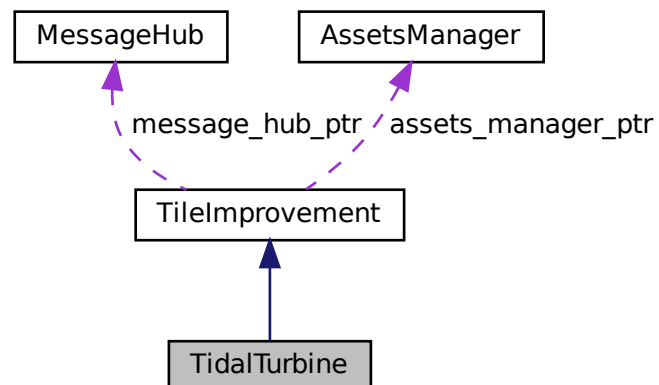
A settlement class (child class of [TileImprovement](#)).

```
#include <TidalTurbine.h>
```

Inheritance diagram for TidalTurbine:



Collaboration diagram for TidalTurbine:



Public Member Functions

- [TidalTurbine](#) (double, double, int, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [TidalTurbine](#) class.
- std::string [getTileOptionsSubstring](#) (void)
Helper method to assemble and return tile options substring.
- void [setIsSelected](#) (bool)
Method to set the is selected attribute.
- void [advanceTurn](#) (void)
Method to handle turn advance.
- void [update](#) (void)
Method to trigger production and dispatchable updates.
- void [processEvent](#) (void)
Method to process [TidalTurbine](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [TidalTurbine](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual [~TidalTurbine](#) (void)
Destructor for the [TidalTurbine](#) class.

Public Attributes

- int [capacity_kW](#)
The rated production capacity [kW] of the solar PV array.
- int [production_MWh](#)
The current production [MWh] of the solar PV array.
- int [dispatch_MWh](#)
The current dispatch [MWh] of the solar PV array.
- int [dispatchable_MWh](#)
The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).
- double [max_daily_production_MWh](#)
The maximum daily production [MWh] of the solar PV array.
- double [rotor_drotation](#)
The rotation rate of the rotor.
- double [bobbing_y](#)
The bobbing extent of the tidal turbine.
- std::vector< double > [capacity_factor_vec](#)
A vector of daily capacity factors for the current month.
- std::vector< double > [production_vec_MWh](#)
A vector of daily production [MWh] for the current month.
- std::vector< double > [dispatch_vec_MWh](#)
A vector of daily dispatch [MWh] for the current month.

Private Member Functions

- void [__setUpTileImprovementSpriteAnimated](#) (void)
Helper method to set up tile improvement sprite (static).
- void [__drawProductionMenu](#) (void)
Helper method to draw production menu assets.
- void [__upgradePowerCapacity](#) (void)
Helper method to upgrade power capacity.
- void [__computeProductionCosts](#) (void)
Helper method to compute production costs (O&M) based on current production level.
- void [__breakdown](#) (void)
Helper method to trigger an equipment breakdown.
- void [__repair](#) (void)
Helper method to repair the tidal turbine.
- void [__computeCapacityFactors](#) (void)
Helper method to compute capacity factors.
- void [__computeProduction](#) (void)
Helper method to compute production values.
- void [__computeDispatch](#) (void)
Helper method to compute dispatch values.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__drawUpgradeOptions](#) (void)
Helper method to set up and draw upgrade options.
- void [__sendImprovementStateMessage](#) (void)
Helper method to format and sent improvement state message.

Additional Inherited Members

4.12.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

4.12.2 Constructor & Destructor Documentation

4.12.2.1 TidalTurbine()

```
TidalTurbine::TidalTurbine (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [TidalTurbine](#) class.

Ref: [Wikipedia \[2023\]](#)

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>tile_resource</i>	The renewable resource quality of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```

761 :
762 TileImprovement (
763     position_x,
764     position_y,
765     tile_resource,
766     event_ptr,
767     render_window_ptr,
768     assets_manager_ptr,
769     message_hub_ptr
770 )
771 {
772     // 1. set attributes
773
774     // 1.1. private
775     //...
776
777     // 1.2. public
778     this->tile_improvement_type = TileImprovementType :: TIDAL_TURBINE;
779
780     this->is_running = false;
781
782     this->health = 100;
783
784     this->capacity_kW = 100;
785     this->upgrade_level = 1;
786
787     this->storage_kWh = 0;
788     this->storage_level = 0;
789
790     this->production_MWh = 0;
791     this->dispatch_MWh = 0;
792     this->dispatchable_MWh = 0;
793
794     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
795
796     this->rotor_drotation = 64 * SECONDS_PER_FRAME;
797     this->bobbing_y = 4;
798
799     this->capacity_factor_vec.resize(30, 0);
800     this->production_vec_MWh.resize(30, 0);
801     this->dispatch_vec_MWh.resize(30, 0);
802
803     this->tile_improvement_string = "TIDAL TURBINE";
804
805     this->__setUpTileImprovementSpriteAnimated();
806     this->__computeCapacityFactors();
807     this->update();
808
809     std::cout << "TidalTurbine constructed at " << this << std::endl;
810
811     return;
812 } /* TidalTurbine() */

```

4.12.2.2 ~TidalTurbine()

```

TidalTurbine::~TidalTurbine (
    void ) [virtual]

```

Destructor for the [TidalTurbine](#) class.

```

1178 {
1179     std::cout << "TidalTurbine at " << this << " destroyed" << std::endl;
1180
1181     return;
1182 } /* ~TidalTurbine() */

```

4.12.3 Member Function Documentation

4.12.3.1 __breakdown()

```
void TidalTurbine::__breakdown (
    void ) [private]
```

Helper method to trigger an equipment breakdown.

```
250 {
251     TileImprovement :: __breakdown();
252
253     this->production_MWh = 0;
254     this->dispatch_MWh = 0;
255     this->dispatchable_MWh = 0;
256     this->operation_maintenance_cost = 0;
257
258     return;
259 } /* __breakdown() */
```

4.12.3.2 __computeCapacityFactors()

```
void TidalTurbine::__computeCapacityFactors (
    void ) [private]
```

Helper method to compute capacity factors.

```
307 {
308     if (this->is_broken) {
309         return;
310     }
311
312     for (int i = 0; i < 30; i++) {
313         this->capacity_factor_vec[i] =
314             this->tile_resource_scalar * DAILY_TIDAL_CAPACITY_FACTOR;
315     }
316
317     return;
318 } /* __computeCapacityFactors() */
```

4.12.3.3 __computeDispatch()

```
void TidalTurbine::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
366 {
367     if (this->is_broken) {
368         this->dispatchable_MWh = 0;
369         return;
370     }
371
372     double stored_energy_MWh = 0;
373     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
374
375     double demand_MWh = 0;
376     double production_MWh = 0;
377     double dispatchable_MWh = 0;
378     double difference_MWh = 0;
379
380     double room_MWh = 0;
```



```

381
382     for (int i = 0; i < 30; i++) {
383         demand_MWh = this->demand_vec_MWh[i];
384         production_MWh = this->production_vec_MWh[i];
385
386         if (production_MWh <= demand_MWh) {
387             this->dispatch_vec_MWh[i] = production_MWh;
388             dispatchable_MWh += this->dispatch_vec_MWh[i];
389
390             difference_MWh = demand_MWh - production_MWh;
391
392             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
393                 if (difference_MWh > stored_energy_MWh) {
394                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
395                     dispatchable_MWh += stored_energy_MWh;
396                     stored_energy_MWh = 0;
397                 }
398
399                 else {
400                     this->dispatch_vec_MWh[i] += difference_MWh;
401                     dispatchable_MWh += difference_MWh;
402                     stored_energy_MWh -= difference_MWh;
403                 }
404             }
405         }
406     else {
407         this->dispatch_vec_MWh[i] = demand_MWh;
408         dispatchable_MWh += this->dispatch_vec_MWh[i];
409
410         difference_MWh = production_MWh - demand_MWh;
411
412         if (
413             (storage_capacity_MWh > 0) and
414             (stored_energy_MWh < storage_capacity_MWh)
415         ) {
416             room_MWh = storage_capacity_MWh - stored_energy_MWh;
417
418             if (difference_MWh > room_MWh) {
419                 stored_energy_MWh += room_MWh;
420             }
421
422             else {
423                 stored_energy_MWh += difference_MWh;
424             }
425         }
426     }
427 }
428
429 this->dispatchable_MWh = round(dispatchable_MWh);
430
431 if (this->dispatch_MWh != this->dispatchable_MWh) {
432     this->dispatch_MWh = this->dispatchable_MWh;
433 }
434
435 return;
436 }
437 } /* __computeDispatch() */

```

4.12.3.4 __computeProduction()

```

void TidalTurbine::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

333 {
334     if (this->is_broken) {
335         this->production_MWh = 0;
336         return;
337     }
338
339     double production_MWh = 0;
340
341     for (int i = 0; i < 30; i++) {
342         this->production_vec_MWh[i] =
343             this->max_daily_production_MWh * this->capacity_factor_vec[i];
344
345         production_MWh += this->production_vec_MWh[i];
346     }

```

```

347
348     this->production_MWh = round(production_MWh);
349
350     return;
351 } /* __computeProduction() */

```

4.12.3.5 __computeProductionCosts()

```

void TidalTurbine::__computeProductionCosts (
    void ) [private]

```

Helper method to compute production costs (O&M) based on current production level.

```

229 {
230     double operation_maintenance_cost =
231         (this->production_MWh * TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
232     this->operation_maintenance_cost = round(operation_maintenance_cost);
233
234     return;
235 } /* __computeProductionCosts() */

```

4.12.3.6 __drawProductionMenu()

```

void TidalTurbine::__drawProductionMenu (
    void ) [private]

```

Helper method to draw production menu assets.

```

114 {
115     // 1. draw static sprite
116     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
117         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
118         this->tile_improvement_sprite_animated[i].setPosition(400 - 138, 400 + 16);
119
120         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
121         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
122
123         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
124         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
125
126         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
127         this->tile_improvement_sprite_animated[i].setRotation(0);
128
129         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
130
131         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
132         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
133         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
134         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
135     }
136
137     // 2. draw production text
138     std::string production_string = "[W]: INCREASE DISPATCH\n";
139     production_string += "[S]: DECREASE DISPATCH\n";
140     production_string += "\n";
141
142     production_string += "DISPATCH: ";
143     production_string += std::to_string(this->dispatch_MWh);
144     production_string += " MWh (MAX ";
145     production_string += std::to_string(this->dispatchable_MWh);
146     production_string += ")\n";
147
148     production_string += "O&M COST: ";
149     production_string += std::to_string(this->operation_maintenance_cost);
150     production_string += " K\n";
151
152     sf::Text production_text(
153         production_string,
154         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
155         16
156     );

```

```

157
158     production_text.setOrigin(production_text.getLocalBounds().width / 2,0);
159     production_text.setFillColour(MONOCROME_TEXT_GREEN);
160
161     production_text.setPosition(400 + 30, 400 - 45);
162
163     this->render_window_ptr->draw(production_text);
164
165     return;
166 } /* __drawProductionMenu() */

```

4.12.3.7 __drawUpgradeOptions()

```

void TidalTurbine::__drawUpgradeOptions (
    void ) [private]

```

Helper method to set up and draw upgrade options.

```

578 {
579     // 1. draw power capacity upgrade sprite
580     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
581         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
582         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 32 - 8);
583
584         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
585         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
586
587         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
588         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
589
590         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
591         this->tile_improvement_sprite_animated[i].setRotation(0);
592
593         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
594
595         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
596         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
597         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
598         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
599     }
600
601     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
602
603
604     // 2. draw power capacity upgrade text
605     // 16 char line = "
606     std::string power_upgrade_string = "POWER CAPACITY \n";
607     power_upgrade_string += " \n";
608
609     power_upgrade_string += "CAPACITY: ";
610     power_upgrade_string += std::to_string(this->capacity_kW);
611     power_upgrade_string += " kW\n";
612
613     power_upgrade_string += "LEVEL: ";
614     power_upgrade_string += std::to_string(this->upgrade_level);
615     power_upgrade_string += "\n\n";
616
617     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
618         power_upgrade_string += "[W]: + 100 kW (";
619         power_upgrade_string += std::to_string(TIDAL_TURBINE_BUILD_COST);
620         power_upgrade_string += " K)\n";
621     }
622
623     else {
624         power_upgrade_string += " * MAX LEVEL * \n";
625     }
626
627     sf::Text power_upgrade_text = sf::Text(
628         power_upgrade_string,
629         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
630         16
631     );
632
633     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
634     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
635     power_upgrade_text.setFillColour(MONOCROME_TEXT_GREEN);
636
637     this->render_window_ptr->draw(power_upgrade_text);
638

```

```

639
640 // 3. draw energy capacity (storage) upgrade sprite
641 this->render_window_ptr->draw(this->storage_upgrade_sprite);
642 this->render_window_ptr->draw(this->upgrade_plus_sprite);
643
644
645 // 4. draw energy capacity (storage) upgrade text
646 // 16 char line = " \n"
647 std::string energy_upgrade_string = "ENERGY CAPACITY \n";
648 energy_upgrade_string += " \n";
649
650 energy_upgrade_string += "CAPACITY: ";
651 energy_upgrade_string += std::to_string(this->storage_level * 200);
652 energy_upgrade_string += " kWh\n";
653
654 energy_upgrade_string += "LEVEL: ";
655 energy_upgrade_string += std::to_string(this->storage_level);
656 energy_upgrade_string += "\n\n";
657
658 if (this->storage_level < MAX_STORAGE_LEVELS) {
659     energy_upgrade_string += "[D]: + 200 kWh (";
660     energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
661     energy_upgrade_string += " K)\n";
662 }
663
664 else {
665     energy_upgrade_string += " * MAX LEVEL * \n";
666 }
667
668 sf::Text energy_upgrade_text = sf::Text (
669     energy_upgrade_string,
670     *(this->assets_manager_ptr->getFont ("Glass_TTY_VT220")),
671     16
672 );
673
674 energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
675 energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
676 energy_upgrade_text.setFillColor(MONOCHROME_TEXT_GREEN);
677
678 this->render_window_ptr->draw(energy_upgrade_text);
679
680 return;
681 } /* __drawUpgradeOptions() */

```

4.12.3.8 __handleKeyPressEvents()

```

void TidalTurbine::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

452 {
453     if (this->just_built) {
454         return;
455     }
456
457     switch (this->event_ptr->key.code) {
458         case (sf::Keyboard::U): {
459             this->__openUpgradeMenu();
460
461             break;
462         }
463
464         case (sf::Keyboard::W): {
465             if (this->production_menu_open) {
466                 this->dispatch_MWh++;
467
468                 if (this->dispatch_MWh > this->dispatchable_MWh) {
469                     this->dispatch_MWh = 0;
470                 }
471
472                 this->__computeProductionCosts();
473                 this->assets_manager_ptr->getSound("interface click")->play();
474             }
475
476             else if (this->upgrade_menu_open) {
477                 this->__upgradePowerCapacity();
478             }
479         }

```

```

480
481     break;
482 }
483
484
485 case (sf::Keyboard::S): {
486     if (this->production_menu_open) {
487         this->dispatch_MWh--;
488
489         if (this->dispatch_MWh < 0) {
490             this->dispatch_MWh = this->dispatchable_MWh;
491         }
492
493         this->__computeProductionCosts();
494         this->assets_manager_ptr->getSound("interface click")->play();
495     }
496
497     break;
498 }
499
500
501 case (sf::Keyboard::D): {
502     if (this->upgrade_menu_open) {
503         this->__upgradeStorageCapacity();
504         this->__computeProduction();
505         this->__computeDispatch();
506     }
507
508     break;
509 }
510
511
512 default: {
513     // do nothing!
514
515     break;
516 }
517 }
518
519 return;
520 } /* __handleKeyPressEvents() */

```

4.12.3.9 __handleMouseButtonEvents()

```

void TidalTurbine::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

535 {
536     if (this->just_built) {
537         return;
538     }
539
540     switch (this->event_ptr->mouseButton.button) {
541         case (sf::Mouse::Left): {
542             //...
543
544             break;
545         }
546
547         case (sf::Mouse::Right): {
548             //...
549
550             break;
551         }
552
553         default: {
554             // do nothing!
555
556             break;
557         }
558     }
559
560 }
561
562 return;
563 } /* __handleMouseButtonEvents() */

```

4.12.3.10 __repair()

```
void TidalTurbine::__repair (
    void ) [private], [virtual]
```

Helper method to repair the tidal turbine.

Reimplemented from [TileImprovement](#).

```
274 {
275     if (this->credits < TIDAL_TURBINE_BUILD_COST) {
276         std::cout << "Cannot repair tidal turbine: insufficient credits (need "
277             << TIDAL_TURBINE_BUILD_COST << " K)" << std::endl;
278
279         this->__sendInsufficientCreditsMessage();
280         return;
281     }
282
283     TileImprovement :: __repair();
284
285     this->just_upgraded = true;
286
287     this->__sendCreditsSpentMessage(TIDAL_TURBINE_BUILD_COST);
288     this->__sendTileStateRequest();
289     this->__sendGameStateRequest();
290
291     return;
292 } /* __repair() */
```

4.12.3.11 __sendImprovementStateMessage()

```
void TidalTurbine::__sendImprovementStateMessage (
    void ) [private]
```

Helper method to format and sent improvement state message.

```
696 {
697     Message improvement_state_message;
698
699     improvement_state_message.channel = GAME_CHANNEL;
700     improvement_state_message.subject = "improvement state";
701
702     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
703     improvement_state_message.int_payload["operation_maintenance_cost"] =
704         this->operation_maintenance_cost;
705
706     this->message_hub_ptr->sendMessage(improvement_state_message);
707
708     std::cout << "Improvement state message sent by " << this << std::endl;
709
710     return;
711 } /* __sendImprovementStateMessage() */
```

4.12.3.12 __setUpTileImprovementSpriteAnimated()

```
void TidalTurbine::__setUpTileImprovementSpriteAnimated (
    void ) [private]
```

Helper method to set up tile improvement sprite (static).

```
68 {
69     sf::Sprite diesel_generator_sheet (
70         *(this->assets_manager_ptr->getTexture("tidal turbine"))
71     );
72
73     int n_elements = diesel_generator_sheet.getLocalBounds().height / 64;
74
75     for (int i = 0; i < n_elements; i++) {
```

```

76         this->tile_improvement_sprite_animated.push_back(
77             sf::Sprite(
78                 *(this->assets_manager_ptr->getTexture("tidal turbine")),
79                 sf::IntRect(0, i * 64, 64, 64)
80             )
81         );
82
83         this->tile_improvement_sprite_animated.back().setOrigin(
84             this->tile_improvement_sprite_animated.back().getLocalBounds().width / 2,
85             this->tile_improvement_sprite_animated.back().getLocalBounds().height
86         );
87
88         this->tile_improvement_sprite_animated.back().setPosition(
89             this->position_x,
90             this->position_y - 32
91         );
92
93         this->tile_improvement_sprite_animated.back().setColor(
94             sf::Color(255, 255, 255, 0)
95         );
96     }
97
98     return;
99 } /* __setUpTileImprovementSpriteAnimated() */

```

4.12.3.13 __upgradePowerCapacity()

```

void TidalTurbine::__upgradePowerCapacity (
    void ) [private]

```

Helper method to upgrade power capacity.

```

181 {
182     if (this->credits < TIDAL_TURBINE_BUILD_COST) {
183         std::cout << "Cannot upgrade tidal turbine: insufficient credits (need "
184             << TIDAL_TURBINE_BUILD_COST << " K)" << std::endl;
185
186         this->__sendInsufficientCreditsMessage();
187         return;
188     }
189
190     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
191         return;
192     }
193
194     TileImprovement :: __repair();
195
196     this->capacity_kW += 100;
197     this->upgrade_level++;
198
199     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
200
201     this->__computeProduction();
202     this->__computeDispatch();
203
204     this->just_upgraded = true;
205
206     this->assets_manager_ptr->getSound("upgrade")->play();
207
208     this->__sendCreditsSpentMessage(TIDAL_TURBINE_BUILD_COST);
209     this->__sendTileStateRequest();
210     this->__sendGameStateRequest();
211
212     return;
213 } /* __upgradePowerCapacity() */

```

4.12.3.14 advanceTurn()

```

void TidalTurbine::advanceTurn (
    void ) [virtual]

```

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```

918 {
919     // 1. send improvement state message
920     this->__sendImprovementStateMessage();
921
922     // 2. update
923     this->__computeCapacityFactors();
924     this->update();
925
926     // 3. handle start/stop
927     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
928         this->is_running = true;
929     }
930
931     else if (this->is_running and (this->dispatch_MWh <= 0)) {
932         this->is_running = false;
933     }
934
935     // 4. handle equipment health and breakdowns
936     if (this->is_running) {
937         this->health--;
938
939         if (this->health <= 50) {
940             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
941
942             if ((double)rand() / RAND_MAX <= breakdown_prob) {
943                 this->health = 0;
944             }
945         }
946
947         if (this->health <= 0) {
948             this->__breakdown();
949         }
950     }
951
952     // 5. send tile state request (if selected)
953     if (this->is_selected) {
954         this->__sendTileStateRequest();
955     }
956
957     return;
958 } /* advanceTurn() */

```

4.12.3.15 draw()

```

void TidalTurbine::draw (
    void ) [virtual]

```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```

1047 {
1048     // 1. if just built, call base method and return
1049     if (this->just_built) {
1050         TileImprovement :: draw();
1051
1052         return;
1053     }
1054
1055     // 2. handle upgrade effects
1056     if (this->just_upgraded) {
1057         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1058             this->tile_improvement_sprite_animated[i].setColor(
1059                 sf::Color(
1060                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1061                     255,
1062                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1063                     255
1064                 )
1065             );
1066
1067             this->tile_improvement_sprite_animated[i].setScale(
1068                 sf::Vector2f(

```



```

1070         1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1071         1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1072     )
1073 };
1074 }
1075
1076     this->upgrade_frame++;
1077 }
1078
1079     if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1080         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1081             this->tile_improvement_sprite_animated[i].setColor(
1082                 sf::Color(255,255,255,255)
1083             );
1084
1085             this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1086         }
1087
1088         this->just_upgraded = false;
1089         this->upgrade_frame = 0;
1090     }
1091
1092
1093     // 3. handle bobbing
1094     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1095         this->tile_improvement_sprite_animated[i].setPosition(
1096             this->position_x,
1097             this->position_y + this->bobbing_y * cos(
1098                 (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1099             )
1100         );
1101     }
1102
1103
1104     // 4. draw first element of animated sprite
1105     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1106
1107
1108     // 5. draw second element of animated sprite
1109     if (this->is_running) {
1110         this->tile_improvement_sprite_animated[1].rotate(this->rotor_drotation);
1111     }
1112
1113     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1114
1115
1116     // 6. draw storage upgrades
1117     for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1118         this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1119     }
1120
1121
1122     // 7. handle dispatch illustration
1123     if (this->dispatch_MWh > 0) {
1124         this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1125         this->__drawDispatch();
1126     }
1127
1128
1129     // 8. draw production menu
1130     if (this->production_menu_open) {
1131         this->render_window_ptr->draw(this->production_menu_backing);
1132         this->render_window_ptr->draw(this->production_menu_backing_text);
1133
1134         this->__drawProductionMenu();
1135     }
1136
1137
1138     // 9. draw upgrade menu
1139     if (this->upgrade_menu_open) {
1140         this->render_window_ptr->draw(this->upgrade_menu_backing);
1141         this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1142
1143         this->__drawUpgradeOptions();
1144     }
1145
1146
1147     // 10. handle broken effects
1148     if (this->is_broken) {
1149         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1150             this->tile_improvement_sprite_animated[i].setColor(
1151                 sf::Color(
1152                     255,
1153                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1154                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1155                     255
1156                 )

```

```

1157         );
1158     }
1159 }
1160
1161     this->frame++;
1162     return;
1163 } /* draw() */

```

4.12.3.16 getTileOptionsSubstring()

```

std::string TidalTurbine::getTileOptionsSubstring (
    void ) [virtual]

```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

829 {
830     //          32 char x 17 line console "-----\n";
831     std::string options_substring = "CAPACITY: ";
832     options_substring += std::to_string(this->capacity_kW);
833     options_substring += " kW (level ";
834     options_substring += std::to_string(this->upgrade_level);
835     options_substring += ")\n";
836
837     options_substring += "PRODUCTION: ";
838     options_substring += std::to_string(this->production_MWh);
839     options_substring += " MWh\n";
840
841     options_substring += "DISPATCHABLE: ";
842     options_substring += std::to_string(this->dispatchable_MWh);
843     options_substring += " MWh\n";
844
845     options_substring += "HEALTH: ";
846     options_substring += std::to_string(this->health);
847     options_substring += "/100";
848
849     if (this->health <= 0) {
850         options_substring += " ** BROKEN! **\n";
851     }
852
853     else {
854         options_substring += "\n";
855     }
856
857     options_substring += "
858     options_substring += "**** TIDAL TURBINE OPTIONS **** \n";
859     options_substring += "
860
861     if (this->is_broken) {
862         options_substring += " [R]: REPAIR (";
863         options_substring += std::to_string(TIDAL_TURBINE_BUILD_COST);
864         options_substring += " K)\n";
865     }
866
867     else {
868         options_substring += " [E]: OPEN PRODUCTION MENU \n";
869     }
870
871     options_substring += " [U]: OPEN UPGRADE MENU \n";
872     options_substring += "HOLD [P]: SCRAP (";
873     options_substring += std::to_string(SCRAP_COST);
874     options_substring += " K)";
875
876     return options_substring;
877 } /* getTileOptionsSubstring() */

```

4.12.3.17 processEvent()

```
void TidalTurbine::processEvent (
    void ) [virtual]
```

Method to process [TidalTurbine](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```
998 {
999     TileImprovement :: processEvent();
1000
1001     if (this->event_ptr->type == sf::Event::KeyPressed) {
1002         this->__handleKeyPressEvents();
1003     }
1004
1005     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1006         this->__handleMouseButtonEvents();
1007     }
1008
1009     return;
1010 } /* processEvent() */
```

4.12.3.18 processMessage()

```
void TidalTurbine::processMessage (
    void ) [virtual]
```

Method to process [TidalTurbine](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```
1025 {
1026     TileImprovement :: processMessage();
1027
1028     //...
1029
1030     return;
1031 } /* processMessage() */
```

4.12.3.19 setIsSelected()

```
void TidalTurbine::setIsSelected (
    bool is_selected ) [virtual]
```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```
894 {
895     TileImprovement :: setIsSelected(is_selected);
896
897     if (this->is_running and this->is_selected) {
898         this->assets_manager_ptr->getSound("water flow")->play();
899     }
900 }
```

```
901     return;  
902 } /* setIsSelected() */
```

4.12.3.20 update()

```
void TidalTurbine::update (  
    void ) [virtual]
```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
973 {  
974     this->__computeProduction();  
975     this->__computeProductionCosts();  
976     this->__computeDispatch();  
977  
978     if (this->is_selected) {  
979         this->__sendTileStateRequest();  
980     }  
981  
982     return;  
983 } /* update() */
```

4.12.4 Member Data Documentation

4.12.4.1 bobbing_y

```
double TidalTurbine::bobbing_y
```

The bobbing extent of the tidal turbine.

4.12.4.2 capacity_factor_vec

```
std::vector<double> TidalTurbine::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

4.12.4.3 capacity_kW

```
int TidalTurbine::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

4.12.4.4 dispatch_MWh

```
int TidalTurbine::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

4.12.4.5 dispatch_vec_MWh

```
std::vector<double> TidalTurbine::dispatch_vec_MWh
```

A vector of daily dispatch [MWh] for the current month.

4.12.4.6 dispatchable_MWh

```
int TidalTurbine::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

4.12.4.7 max_daily_production_MWh

```
double TidalTurbine::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

4.12.4.8 production_MWh

```
int TidalTurbine::production_MWh
```

The current production [MWh] of the solar PV array.

4.12.4.9 production_vec_MWh

```
std::vector<double> TidalTurbine::production_vec_MWh
```

A vector of daily production [MWh] for the current month.

4.12.4.10 rotor_drotation

```
double TidalTurbine::rotor_drotation
```

The rotation rate of the rotor.

The documentation for this class was generated from the following files:

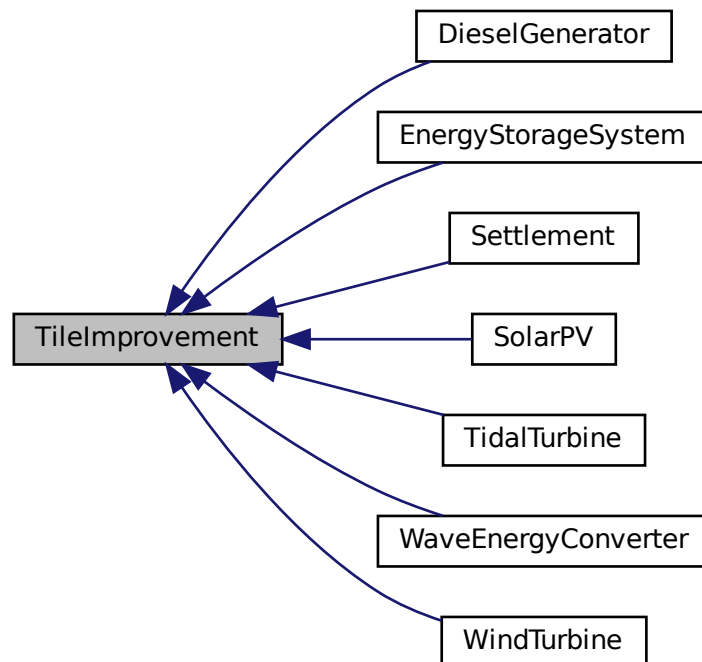
- header/[TidalTurbine.h](#)
- source/[TidalTurbine.cpp](#)

4.13 TileImprovement Class Reference

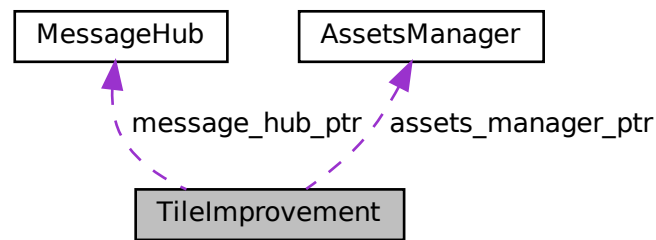
A base class for the tile improvement hierarchy.

```
#include <TileImprovement.h>
```

Inheritance diagram for TileImprovement:



Collaboration diagram for TileImprovement:



Public Member Functions

- [TileImprovement](#) (double, double, int, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [TileImprovement](#) class.
- virtual void [setIsSelected](#) (bool)
Method to set the is selected attribute.
- virtual void [advanceTurn](#) (void)
- virtual void [update](#) (void)
- virtual std::string [getTileOptionsSubstring](#) (void)
- virtual void [processEvent](#) (void)
Method to process [TileImprovement](#). To be called once per event.
- virtual void [processMessage](#) (void)
Method to process [TileImprovement](#). To be called once per message.
- virtual void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual [~TileImprovement](#) (void)
Destructor for the [TileImprovement](#) class.

Public Attributes

- [TileImprovementType](#) [tile_improvement_type](#)
The type of the tile improvement.
- bool [is_running](#)
A boolean which indicates whether or not the improvement is running.
- bool [is_selected](#)
A boolean which indicates whether or not the tile is selected.
- bool [just_built](#)
A boolean which indicates that the improvement was just built.
- bool [just_upgraded](#)
A boolean which indicates that the improvement was just upgraded.
- bool [production_menu_open](#)
A boolean which indicates whether or not the production menu is open.
- bool [upgrade_menu_open](#)
A boolean which indicates whether or not the build menu is open.

- bool [is_broken](#)
A boolean which indicated whether or not improvement is broken.
- unsigned long long int [frame](#)
The current frame of this object.
- int [credits](#)
The current balance of credits.
- int [month](#)
The current month of play.
- int [demand_MWh](#)
The current demand [MWh].
- int [health](#)
The health of the improvement.
- int [upgrade_level](#)
The upgrade level of the improvement.
- int [upgrade_frame](#)
The frame of the upgrade animation.
- int [storage_kWh](#)
The rated energy capacity [kWh] of the storage.
- int [storage_level](#)
The level of storage installed alongside the tile improvement.
- int [operation_maintenance_cost](#)
The operation and maintenance costs for this turn.
- int [tile_resource](#)
The renewable resource quality of the tile.
- double [tile_resource_scalar](#)
A scalar associated with the renewable resource quality.
- double [position_x](#)
The x position of the tile improvement.
- double [position_y](#)
The y position of the tile improvement.
- std::vector< double > [demand_vec_MWh](#)
A vector of daily demands [MWh] for the current month.
- std::string [game_phase](#)
The current phase of the game.
- std::string [tile_improvement_string](#)
A string representation of the tile improvement type.
- sf::Sprite [tile_improvement_sprite_static](#)
A static sprite, for decorating the tile.
- std::vector< sf::Sprite > [tile_improvement_sprite_animated](#)
An animated sprite, for the [ContextMenu](#) visual screen.
- sf::RectangleShape [production_menu_backing](#)
A backing for the production menu.
- sf::Text [production_menu_backing_text](#)
Text for the production menu backing.
- sf::RectangleShape [upgrade_menu_backing](#)
A backing for the upgrade menu.
- sf::Text [upgrade_menu_backing_text](#)
Text for the upgrade menu backing.
- sf::Sprite [storage_upgrade_sprite](#)
A sprite for illustrating storage (in upgrade menu).
- std::vector< sf::Sprite > [storage_upgrade_sprite_vec](#)

- A vector of sprites for illustrating the storage upgrade level (on tile).*

 - sf::Sprite [upgrade_arrow_sprite](#)
An upgrade arrow sprite.
 - sf::Sprite [upgrade_plus_sprite](#)
An upgrade plus sprite.
 - sf::CircleShape [dispatch_backing](#)
A backing circle for dispatch text illustration.
 - sf::Text [dispatch_text](#)
Text for illustrating dispatch.

Protected Member Functions

- void [__setUpProductionMenu](#) (void)
Helper method to set up and position production menu assets (drawable).
- void [__setUpUpgradeMenu](#) (void)
Helper method to set up and position upgrade menu assets (drawable).
- void [__setUpDispatchIllustration](#) (void)
Helper method to set up and position dispatch assets (drawable).
- void [__upgradeStorageCapacity](#) (void)
Helper method to upgrade storage capacity.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__openProductionMenu](#) (void)
Helper method to open the production menu.
- void [__closeProductionMenu](#) (void)
Helper method to close the production menu.
- void [__breakdown](#) (void)
Helper method to trigger an equipment breakdown.
- virtual void [__repair](#) (void)
Helper method to repair a tile improvement.
- void [__openUpgradeMenu](#) (void)
Helper method to open the upgrade menu.
- void [__closeUpgradeMenu](#) (void)
Helper method to close the build menu.
- void [__sendTileStateRequest](#) (void)
Helper method to format and send a request for the parent [HexTile](#) to send a tile state message.
- void [__sendGameStateRequest](#) (void)
Helper method to format and send a game state request (message).
- void [__sendCreditsSpentMessage](#) (int)
Helper method to format and send a credits spent message.
- void [__sendInsufficientCreditsMessage](#) (void)
Helper method to format and send an insufficient credits message.
- void [__drawDispatch](#) (void)
Helper method to draw dispatch illustration.

Protected Attributes

- `sf::Event * event_ptr`
A pointer to the event class.
- `sf::RenderWindow * render_window_ptr`
A pointer to the render window.
- `AssetsManager * assets_manager_ptr`
A pointer to the assets manager.
- `MessageHub * message_hub_ptr`
A pointer to the message hub.

4.13.1 Detailed Description

A base class for the tile improvement hierarchy.

4.13.2 Constructor & Destructor Documentation

4.13.2.1 TileImprovement()

```
TileImprovement::TileImprovement (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [TileImprovement](#) class.

Ref: [Wikipedia \[2023\]](#)

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>tile_resource</i>	The renewable resource quality of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```
727 {
728     // 1. set attributes
729
730     // 1.1. protected
731     this->event_ptr = event_ptr;
732     this->render_window_ptr = render_window_ptr;
733 }
```

```

734     this->assets_manager_ptr = assets_manager_ptr;
735     this->message_hub_ptr = message_hub_ptr;
736
737     // 1.2. public
738     this->is_selected = true;
739     this->just_built = true;
740     this->production_menu_open = false;
741     this->upgrade_menu_open = false;
742     this->is_broken = false;
743
744     this->just_upgraded = false;
745     this->upgrade_frame = 0;
746
747     this->frame = 0;
748     this->credits = 0;
749     this->month = 1;
750     this->demand_MWh = 0;
751
752     this->demand_vec_MWh.resize(30, 0);
753
754     this->operation_maintenance_cost = 0;
755
756     this->tile_resource = tile_resource;
757
758     switch (this->tile_resource) {
759     case (0): {
760         this->tile_resource_scalar = 0.85;
761
762         break;
763     }
764
765     case (1): {
766         this->tile_resource_scalar = 0.925;
767
768         break;
769     }
770
771     case (2): {
772         this->tile_resource_scalar = 1;
773
774         break;
775     }
776
777     case (3): {
778         this->tile_resource_scalar = 1.075;
779
780         break;
781     }
782
783     case (4): {
784         this->tile_resource_scalar = 1.15;
785
786         break;
787     }
788
789     default: {
790         this->tile_resource_scalar = 1;
791     }
792 }
793
794 this->position_x = position_x;
795 this->position_y = position_y;
796
797 this->game_phase = "build settlement";
798
799 this->__setUpProductionMenu();
800 this->__setUpUpgradeMenu();
801 this->__setUpDispatchIllustration();
802
803 std::cout << "TileImprovement constructed at " << this << std::endl;
804
805 return;
806 } /* TileImprovement() */

```

4.13.2.2 ~TileImprovement()

```
TileImprovement::~TileImprovement (
```

```
void ) [virtual]
```

Destructor for the [TileImprovement](#) class.

```
1044 {
1045     std::cout << "TileImprovement at " << this << " destroyed" << std::endl;
1046
1047     return;
1048 } /* ~TileImprovement() */
```

4.13.3 Member Function Documentation

4.13.3.1 __breakdown()

```
void TileImprovement::__breakdown (
    void ) [protected]
```

Helper method to trigger an equipment breakdown.

```
431 {
432     this->is_broken = true;
433     this->is_running = false;
434     this->update();
435     this->assets_manager_ptr->getSound("breakdown")->play();
436
437     return;
438 } /* __breakdown() */
```

4.13.3.2 __closeProductionMenu()

```
void TileImprovement::__closeProductionMenu (
    void ) [protected]
```

Helper method to close the production menu.

```
407 {
408     if (not this->production_menu_open) {
409         return;
410     }
411
412     this->production_menu_open = false;
413     this->assets_manager_ptr->getSound("build menu close")->play();
414
415     return;
416 } /* __closeProductionMenu() */
```

4.13.3.3 __closeUpgradeMenu()

```
void TileImprovement::__closeUpgradeMenu (
    void ) [protected]
```

Helper method to close the build menu.

```
517 {
518     if (not this->upgrade_menu_open) {
519         return;
520     }
521
522     this->upgrade_menu_open = false;
523     this->assets_manager_ptr->getSound("build menu close")->play();
524
525     return;
526 } /* __closeUpgradeMenu() */
```

4.13.3.4 __drawDispatch()

```
void TileImprovement::__drawDispatch (
    void ) [protected]
```

Helper method to draw dispatch illustration.

```
648 {
649     double alpha = 255 * pow(cos((0.5 * M_PI * this->frame) / FRAMES_PER_SECOND), 2);
650
651
652     // 1. dispatch backing
653     sf::Color backing_colour = this->dispatch_backing.getFillColor();
654     backing_colour.a = alpha;
655
656     this->dispatch_backing.setFillColor(backing_colour);
657     this->dispatch_backing.setOutlineColor(sf::Color(0, 0, 0, alpha));
658
659     this->render_window_ptr->draw(this->dispatch_backing);
660
661
662     // 2. dispatch text
663     this->dispatch_text.setOrigin(
664         this->dispatch_text.getLocalBounds().width / 2,
665         this->dispatch_text.getLocalBounds().height / 2
666     );
667
668     sf::Color text_colour = this->dispatch_text.getFillColor();
669     text_colour.a = alpha;
670
671     this->dispatch_text.setFillColor(text_colour);
672
673     this->render_window_ptr->draw(this->dispatch_text);
674
675     return;
676 } /* __drawDispatch() */
```

4.13.3.5 __handleKeyPressEvents()

```
void TileImprovement::__handleKeyPressEvents (
    void ) [protected]
```

Helper method to handle key press events.

```
277 {
278     if (this->tile_improvement_type == TileImprovementType :: SETTLEMENT) {
279         return;
280     }
281
282     if (this->just_built) {
283         return;
284     }
285
286     switch (this->event_ptr->key.code) {
287         case (sf::Keyboard::E): {
288             if (this->is_broken) {
289                 this->assets_manager_ptr->getSound("breakdown")->play();
290             }
291
292             else {
293                 this->__openProductionMenu();
294             }
295
296             break;
297         }
298
299
300         case (sf::Keyboard::R): {
301             if (this->is_broken) {
302                 this->__repair();
303             }
304
305             break;
306         }
307
308
309         default: {
```

```

310             // do nothing!
311
312             break;
313         }
314     }
315
316     return;
317 } /* __handleKeyPressEvents() */

```

4.13.3.6 __handleMouseButtonEvents()

```

void TileImprovement::__handleMouseButtonEvents (
    void ) [protected]

```

Helper method to handle mouse button events.

```

332 {
333     if (this->tile_improvement_type == TileImprovementType :: SETTLEMENT) {
334         return;
335     }
336
337     if (this->just_built) {
338         return;
339     }
340
341     switch (this->event_ptr->mouseButton.button) {
342         case (sf::Mouse::Left): {
343             //...
344
345             break;
346         }
347
348         case (sf::Mouse::Right): {
349             //...
350
351             break;
352         }
353     }
354
355     default: {
356         // do nothing!
357
358         break;
359     }
360 }
361
362 return;
363 } /* __handleMouseButtonEvents() */

```

4.13.3.7 __openProductionMenu()

```

void TileImprovement::__openProductionMenu (
    void ) [protected]

```

Helper method to open the production menu.

```

379 {
380     if (this->production_menu_open) {
381         return;
382     }
383
384     if (this->upgrade_menu_open) {
385         this->__closeUpgradeMenu();
386     }
387
388     this->production_menu_open = true;
389     this->assets_manager_ptr->getSound("build menu open")->play();
390
391     return;
392 } /* __openProductionMenu() */

```

4.13.3.8 __openUpgradeMenu()

```
void TileImprovement::__openUpgradeMenu (
    void ) [protected]
```

Helper method to open the upgrade menu.

```
489 {
490     if (this->upgrade_menu_open) {
491         return;
492     }
493     if (this->production_menu_open) {
494         this->__closeProductionMenu();
495     }
496 }
497
498 this->upgrade_menu_open = true;
499 this->assets_manager_ptr->getSound("build menu open")->play();
500
501 return;
502 } /* __openUpgradeMenu() */
```

4.13.3.9 __repair()

```
void TileImprovement::__repair (
    void ) [protected], [virtual]
```

Helper method to repair a tile improvement.

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), and [DieselGenerator](#).

```
453 {
454     this->health = 100;
455     if (this->is_broken) {
456         this->is_broken = false;
457         this->assets_manager_ptr->getSound("positive notification")->play();
458     }
459
460     if (this->tile_improvement_sprite_static.getTexture() != NULL) {
461         this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
462     }
463
464     else {
465         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
466             this->tile_improvement_sprite_animated[i].setColor(
467                 sf::Color(255, 255, 255, 255)
468             );
469         }
470     }
471 }
472
473 return;
474 } /* __repair() */
```

4.13.3.10 __sendCreditsSpentMessage()

```
void TileImprovement::__sendCreditsSpentMessage (
    int credits_spent ) [protected]
```

Helper method to format and send a credits spent message.

Parameters

<i>credits_spent</i>	The number of credits that were spent.
----------------------	--

```

594 {
595     Message credits_spent_message;
596
597     credits_spent_message.channel = GAME_CHANNEL;
598     credits_spent_message.subject = "credits spent";
599
600     credits_spent_message.int_payload["credits spent"] = credits_spent;
601
602     this->message_hub_ptr->sendMessage(credits_spent_message);
603
604     std::cout << "Credits spent (" << credits_spent << ") message sent by " << this
605               << std::endl;
606     return;
607 } /* __sendCreditsSpentMessage() */

```

4.13.3.11 __sendGameStateRequest()

```

void TileImprovement::__sendGameStateRequest (
    void ) [protected]

```

Helper method to format and send a game state request (message).

```

567 {
568     Message game_state_request;
569
570     game_state_request.channel = GAME_CHANNEL;
571     game_state_request.subject = "state request";
572
573     this->message_hub_ptr->sendMessage(game_state_request);
574
575     std::cout << "Game state request message sent by " << this << std::endl;
576     return;
577 } /* __sendGameStateRequest() */

```

4.13.3.12 __sendInsufficientCreditsMessage()

```

void TileImprovement::__sendInsufficientCreditsMessage (
    void ) [protected]

```

Helper method to format and send an insufficient credits message.

```

622 {
623     Message insufficient_credits_message;
624
625     insufficient_credits_message.channel = GAME_CHANNEL;
626     insufficient_credits_message.subject = "insufficient credits";
627
628     this->message_hub_ptr->sendMessage(insufficient_credits_message);
629
630     std::cout << "Insufficient credits message sent by " << this << std::endl;
631
632     return;
633 } /* __sendInsufficientCreditsMessage() */

```

4.13.3.13 __sendTileStateRequest()

```

void TileImprovement::__sendTileStateRequest (
    void ) [protected]

```

Helper method to format and send a request for the parent [HexTile](#) to send a tile state message.

```

542 {
543     Message tile_state_request;
544
545     tile_state_request.channel = TILE_STATE_CHANNEL;
546     tile_state_request.subject = "state request";
547
548     this->message_hub_ptr->sendMessage(tile_state_request);
549
550     std::cout << "Tile state request sent by " << this << std::endl;
551     return;
552 } /* __sendTileStateRequest() */

```


4.13.3.14 __setUpDispatchIllustration()

```
void TileImprovement::__setUpDispatchIllustration (
    void ) [protected]
```

Helper method to set up and position dispatch assets (drawable).

```
178 {
179     // 1. set up backing
180     this->dispatch_backing.setRadius(16);
181
182     this->dispatch_backing.setOrigin(
183         this->dispatch_backing.getLocalBounds().width / 2,
184         this->dispatch_backing.getLocalBounds().height / 2
185     );
186
187     this->dispatch_backing.setPosition(
188         this->position_x,
189         this->position_y
190     );
191
192     this->dispatch_backing.setFillColor(MONOCROME_SCREEN_BACKGROUND);
193     this->dispatch_backing.setOutlineThickness(2);
194     this->dispatch_backing.setOutlineColor(sf::Color(0, 0, 0, 255));
195
196
197     // 2. set up text
198     this->dispatch_text.setFont(*(assets_manager_ptr->getFont("Glass_TTY_VT220")));
199     this->dispatch_text.setFillColor(MONOCROME_TEXT_GREEN);
200     this->dispatch_text.setCharacterSize(16);
201     this->dispatch_text.setPosition(
202         this->position_x,
203         this->position_y - 4
204     );
205
206     return;
207 } /* __setUpDispatchIllustration() */
```

4.13.3.15 __setUpProductionMenu()

```
void TileImprovement::__setUpProductionMenu (
    void ) [protected]
```

Helper method to set up and position production menu assets (drawable).

```
68 {
69     // 1. set up and place production menu backing and text
70     this->production_menu_backing.setSize(sf::Vector2f(400, 256));
71     this->production_menu_backing.setOrigin(200, 128);
72     this->production_menu_backing.setPosition(400, 400);
73     this->production_menu_backing.setFillColor(MONOCROME_SCREEN_BACKGROUND);
74     this->production_menu_backing.setOutlineColor(MENU_FRAME_GREY);
75     this->production_menu_backing.setOutlineThickness(4);
76
77     this->production_menu_backing_text.setString("**** PRODUCTION MENU ****");
78     this->production_menu_backing_text.setFont(
79         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220"))
80     );
81     this->production_menu_backing_text.setCharacterSize(16);
82     this->production_menu_backing_text.setFillColor(MONOCROME_TEXT_GREEN);
83     this->production_menu_backing_text.setOrigin(
84         this->production_menu_backing_text.getLocalBounds().width / 2, 0
85     );
86     this->production_menu_backing_text.setPosition(400, 400 - 128 + 4);
87
88     return;
89 } /* __setUpProductionMenu() */
```

4.13.3.16 __setUpUpgradeMenu()

```
void TileImprovement::__setUpUpgradeMenu (
    void ) [protected]
```

Helper method to set up and position upgrade menu assets (drawable).

```
104 {
105     // 1. set up and place upgrade menu backing and text
106     this->upgrade_menu_backing.setSize(sf::Vector2f(400, 256));
107     this->upgrade_menu_backing.setOrigin(200, 128);
108     this->upgrade_menu_backing.setPosition(400, 400);
109     this->upgrade_menu_backing.setFillColor(MONOCHROME_SCREEN_BACKGROUND);
110     this->upgrade_menu_backing.setOutlineColor(MENU_FRAME_GREY);
111     this->upgrade_menu_backing.setOutlineThickness(4);
112
113     this->upgrade_menu_backing_text.setString("**** UPGRADE MENU ****");
114     this->upgrade_menu_backing_text.setFont(
115         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220"))
116     );
117     this->upgrade_menu_backing_text.setCharacterSize(16);
118     this->upgrade_menu_backing_text.setFillColor(MONOCHROME_TEXT_GREEN);
119     this->upgrade_menu_backing_text.setOrigin(
120         this->upgrade_menu_backing_text.getLocalBounds().width / 2, 0
121     );
122     this->upgrade_menu_backing_text.setPosition(400, 400 - 128 + 4);
123
124
125     // 2. set up and place storage upgrade sprite (with upgrade plus)
126     this->storage_upgrade_sprite = sf::Sprite(
127         *(this->assets_manager_ptr->getTexture("energy storage system"))
128     );
129
130     this->storage_upgrade_sprite.setOrigin(
131         this->storage_upgrade_sprite.getLocalBounds().width / 2,
132         this->storage_upgrade_sprite.getLocalBounds().height
133     );
134
135     this->storage_upgrade_sprite.setPosition(400 + 100, 400 - 32);
136
137     this->upgrade_plus_sprite = sf::Sprite(
138         *(this->assets_manager_ptr->getTexture("upgrade plus"))
139     );
140
141     this->upgrade_plus_sprite.setOrigin(
142         this->upgrade_plus_sprite.getLocalBounds().width / 2,
143         this->upgrade_plus_sprite.getLocalBounds().height / 2
144     );
145
146     this->upgrade_plus_sprite.setPosition(400 + 130, 400 - 64);
147
148
149     // 3. set up and place upgrade arrow sprite
150     this->upgrade_arrow_sprite = sf::Sprite(
151         *(this->assets_manager_ptr->getTexture("upgrade arrow"))
152     );
153
154     this->upgrade_arrow_sprite.setOrigin(
155         this->upgrade_arrow_sprite.getLocalBounds().width / 2,
156         this->upgrade_arrow_sprite.getLocalBounds().height / 2
157     );
158
159     this->upgrade_arrow_sprite.setPosition(400 - 64, 400 - 64);
160
161     return;
162 } /* __setUpUpgradeMenu() */
```

4.13.3.17 __upgradeStorageCapacity()

```
void TileImprovement::__upgradeStorageCapacity (
    void ) [protected]
```

Helper method to upgrade storage capacity.

```
222 {
223     if (this->credits < ENERGY_STORAGE_SYSTEM_BUILD_COST) {
```

```

224         std::cout << "Cannot add energy storage: insufficient credits (need "
225             << ENERGY_STORAGE_SYSTEM_BUILD_COST << " K)" << std::endl;
226
227         this->__sendInsufficientCreditsMessage();
228         return;
229     }
230
231     if (this->storage_level >= MAX_STORAGE_LEVELS) {
232         return;
233     }
234
235     this->storage_level++;
236     this->storage_kWh += 200;
237
238     this->storage_upgrade_sprite_vec.push_back(
239         sf::Sprite(
240             *(this->assets_manager_ptr->getTexture("storage_level"))
241         )
242     );
243
244     this->storage_upgrade_sprite_vec.back().setOrigin(
245         this->storage_upgrade_sprite_vec.back().getLocalBounds().width / 2,
246         this->storage_upgrade_sprite_vec.back().getLocalBounds().height
247     );
248
249     this->storage_upgrade_sprite_vec.back().setPosition(
250         this->position_x + 18,
251         this->position_y + 25 - 7 * this->storage_upgrade_sprite_vec.size()
252     );
253
254     this->just_upgraded = true;
255
256     this->assets_manager_ptr->getSound("upgrade")->play();
257
258     this->__sendCreditsSpentMessage(ENERGY_STORAGE_SYSTEM_BUILD_COST);
259     this->__sendTileStateRequest();
260
261     return;
262 } /* __upgradeStorageCapacity() */

```

4.13.3.18 advanceTurn()

```

virtual void TileImprovement::advanceTurn (
    void ) [inline], [virtual]

```

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), and [DieselGenerator](#).

```
191 {return;}
```

4.13.3.19 draw()

```

void TileImprovement::draw (
    void ) [virtual]

```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```

915 {
916     if (this->tile_improvement_sprite_static.getTexture() != NULL) {
917         int alpha = this->tile_improvement_sprite_static.getColor().a;
918
919         alpha += 0.08 * FRAMES_PER_SECOND;
920
921         this->tile_improvement_sprite_static.setColor(
922             sf::Color(255, 255, 255, alpha)
923         );
924
925         this->tile_improvement_sprite_static.move(0, 50 * SECONDS_PER_FRAME);

```

```

926
927     if (
928         (alpha >= 255) or
929         (this->tile_improvement_sprite_static.getPosition().y >= this->position_y + 12)
930     ) {
931         this->tile_improvement_sprite_static.setColor(
932             sf::Color(255, 255, 255, 255)
933         );
934
935         this->tile_improvement_sprite_static.setPosition(
936             this->position_x,
937             this->position_y + 12
938         );
939
940         this->just_built = false;
941         this->assets_manager_ptr->getSound("place improvement")->play();
942     }
943
944     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
945 }
946
947
948 else {
949     int alpha = 0;
950
951     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
952         alpha = this->tile_improvement_sprite_animated[i].getColor().a;
953
954         alpha += 0.08 * FRAMES_PER_SECOND;
955
956         this->tile_improvement_sprite_animated[i].setColor(
957             sf::Color(255, 255, 255, alpha)
958         );
959
960         this->tile_improvement_sprite_animated[i].move(0, 50 * SECONDS_PER_FRAME);
961
962         if (
963             (alpha >= 255) or
964             (this->tile_improvement_sprite_animated[i].getPosition().y >= this->position_y + 12)
965         ) {
966             this->tile_improvement_sprite_animated[i].setColor(
967                 sf::Color(255, 255, 255, 255)
968             );
969
970             this->tile_improvement_sprite_animated[i].setPosition(
971                 this->position_x,
972                 this->position_y + 12
973             );
974         }
975
976         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
977     }
978
979     if (
980         (alpha >= 255) or
981         (this->tile_improvement_sprite_animated[0].getPosition().y >= this->position_y + 12)
982     ) {
983         this->just_built = false;
984         this->assets_manager_ptr->getSound("place improvement")->play();
985
986         switch (this->tile_improvement_type) {
987             case (TileImprovementType :: WIND_TURBINE): {
988                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
989                     this->tile_improvement_sprite_animated[i].setOrigin(32, 32);
990                     this->tile_improvement_sprite_animated[i].move(0, -32);
991                 }
992
993                 break;
994             }
995
996             case (TileImprovementType :: TIDAL_TURBINE): {
997                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
998                     this->tile_improvement_sprite_animated[i].setOrigin(32, 45);
999                     this->tile_improvement_sprite_animated[i].move(0, -19);
1000                 }
1001
1002                 break;
1003             }
1004
1005             case (TileImprovementType :: WAVE_ENERGY_CONVERTER): {
1006                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1007                     this->tile_improvement_sprite_animated[i].setOrigin(32, 32);
1008                     this->tile_improvement_sprite_animated[i].move(0, -32);
1009                 }
1010
1011             }
1012

```

```

1013             break;
1014         }
1015
1016         default: {
1017             // do nothing!
1018             break;
1019         }
1020     }
1021 }
1022 }
1023 }
1024 }
1025
1026
1027     this->frame++;
1028     return;
1029 } /* draw() */

```

4.13.3.20 getTileOptionsSubstring()

```

virtual std::string TileImprovement::getTileOptionsSubstring (
    void ) [inline], [virtual]

```

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```

195 {return "";}

```

4.13.3.21 processEvent()

```

void TileImprovement::processEvent (
    void ) [virtual]

```

Method to process [TileImprovement](#). To be called once per event.

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```

855 {
856     if (this->event_ptr->type == sf::Event::KeyPressed) {
857         this->__handleKeyPressEvents();
858     }
859
860     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
861         this->__handleMouseButtonEvents();
862     }
863
864     return;
865 } /* processEvent() */

```

4.13.3.22 processMessage()

```
void TileImprovement::processMessage (
    void ) [virtual]
```

Method to process [TileImprovement](#). To be called once per message.

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```
880 {
881     if (not this->message_hub_ptr->isEmpty(GAME_STATE_CHANNEL)) {
882         Message game_state_message = this->message_hub_ptr->receiveMessage(
883             GAME_STATE_CHANNEL
884         );
885
886         if (game_state_message.subject == "turn advance") {
887             this->credits = game_state_message.int_payload["credits"];
888             this->month = game_state_message.int_payload["month"];
889             this->demand_MWh = game_state_message.int_payload["demand_MWh"];
890
891             this->advanceTurn();
892
893             this->message_hub_ptr->incrementMessageRead(GAME_STATE_CHANNEL);
894             std::cout << "Turn advance message read and passed by " << this << std::endl;
895         }
896     }
897     return;
898 }
899 } /* processMessage() */
```

4.13.3.23 setIsSelected()

```
void TileImprovement::setIsSelected (
    bool is_selected ) [virtual]
```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```
828 {
829     this->is_selected = is_selected;
830
831     if ((not is_selected) and this->production_menu_open) {
832         this->__closeProductionMenu();
833     }
834
835     if ((not is_selected) and this->upgrade_menu_open) {
836         this->__closeUpgradeMenu();
837     }
838     return;
839 }
840 } /* setIsSelected() */
```

4.13.3.24 update()

```
virtual void TileImprovement::update (
    void ) [inline], [virtual]
```

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), and [SolarPV](#).
193 `{return;}`

4.13.4 Member Data Documentation

4.13.4.1 assets_manager_ptr

`AssetsManager* TileImprovement::assets_manager_ptr` [protected]

A pointer to the assets manager.

4.13.4.2 credits

`int TileImprovement::credits`

The current balance of credits.

4.13.4.3 demand_MWh

`int TileImprovement::demand_MWh`

The current demand [MWh].

4.13.4.4 demand_vec_MWh

`std::vector<double> TileImprovement::demand_vec_MWh`

A vector of daily demands [MWh] for the current month.

4.13.4.5 dispatch_backing

`sf::CircleShape TileImprovement::dispatch_backing`

A backing circle for dispatch text illustration.

4.13.4.6 dispatch_text

```
sf::Text TileImprovement::dispatch_text
```

Text for illustrating dispatch.

4.13.4.7 event_ptr

```
sf::Event* TileImprovement::event_ptr [protected]
```

A pointer to the event class.

4.13.4.8 frame

```
unsigned long long int TileImprovement::frame
```

The current frame of this object.

4.13.4.9 game_phase

```
std::string TileImprovement::game_phase
```

The current phase of the game.

4.13.4.10 health

```
int TileImprovement::health
```

The health of the improvement.

4.13.4.11 is_broken

```
bool TileImprovement::is_broken
```

A boolean which indicated whether or not improvement is broken.

4.13.4.12 is_running

```
bool TileImprovement::is_running
```

A boolean which indicates whether or not the improvement is running.

4.13.4.13 is_selected

```
bool TileImprovement::is_selected
```

A boolean which indicates whether or not the tile is selected.

4.13.4.14 just_built

```
bool TileImprovement::just_built
```

A boolean which indicates that the improvement was just built.

4.13.4.15 just_upgraded

```
bool TileImprovement::just_upgraded
```

A boolean which indicates that the improvement was just upgraded.

4.13.4.16 message_hub_ptr

```
MessageHub* TileImprovement::message_hub_ptr [protected]
```

A pointer to the message hub.

4.13.4.17 month

```
int TileImprovement::month
```

The current month of play.

4.13.4.18 operation_maintenance_cost

```
int TileImprovement::operation_maintenance_cost
```

The operation and maintenance costs for this turn.

4.13.4.19 position_x

```
double TileImprovement::position_x
```

The x position of the tile improvement.

4.13.4.20 position_y

```
double TileImprovement::position_y
```

The y position of the tile improvement.

4.13.4.21 production_menu_backing

```
sf::RectangleShape TileImprovement::production_menu_backing
```

A backing for the production menu.

4.13.4.22 production_menu_backing_text

```
sf::Text TileImprovement::production_menu_backing_text
```

Text for the production menu backing.

4.13.4.23 production_menu_open

```
bool TileImprovement::production_menu_open
```

A boolean which indicates whether or not the production menu is open.

4.13.4.24 render_window_ptr

```
sf::RenderWindow* TileImprovement::render_window_ptr [protected]
```

A pointer to the render window.

4.13.4.25 storage_kWh

```
int TileImprovement::storage_kWh
```

The rated energy capacity [kWh] of the storage.

4.13.4.26 storage_level

```
int TileImprovement::storage_level
```

The level of storage installed alongside the tile improvement.

4.13.4.27 storage_upgrade_sprite

```
sf::Sprite TileImprovement::storage_upgrade_sprite
```

A sprite for illustrating storage (in upgrade menu).

4.13.4.28 storage_upgrade_sprite_vec

```
std::vector<sf::Sprite> TileImprovement::storage_upgrade_sprite_vec
```

A vector of sprites for illustrating the storage upgrade level (on tile).

4.13.4.29 tile_improvement_sprite_animated

```
std::vector<sf::Sprite> TileImprovement::tile_improvement_sprite_animated
```

An animated sprite, for the [ContextMenu](#) visual screen.

4.13.4.30 tile_improvement_sprite_static

```
sf::Sprite TileImprovement::tile_improvement_sprite_static
```

A static sprite, for decorating the tile.

4.13.4.31 tile_improvement_string

```
std::string TileImprovement::tile_improvement_string
```

A string representation of the tile improvement type.

4.13.4.32 tile_improvement_type

```
TileImprovementType TileImprovement::tile_improvement_type
```

The type of the tile improvement.

4.13.4.33 tile_resource

```
int TileImprovement::tile_resource
```

The renewable resource quality of the tile.

4.13.4.34 tile_resource_scalar

```
double TileImprovement::tile_resource_scalar
```

A scalar associated with the renewable resource quality.

4.13.4.35 upgrade_arrow_sprite

```
sf::Sprite TileImprovement::upgrade_arrow_sprite
```

An upgrade arrow sprite.

4.13.4.36 upgrade_frame

```
int TileImprovement::upgrade_frame
```

The frame of the upgrade animation.

4.13.4.37 upgrade_level

```
int TileImprovement::upgrade_level
```

The upgrade level of the improvement.

4.13.4.38 upgrade_menu_backing

```
sf::RectangleShape TileImprovement::upgrade_menu_backing
```

A backing for the upgrade menu.

4.13.4.39 upgrade_menu_backing_text

```
sf::Text TileImprovement::upgrade_menu_backing_text
```

Text for the upgrade menu backing.

4.13.4.40 upgrade_menu_open

```
bool TileImprovement::upgrade_menu_open
```

A boolean which indicates whether or not the build menu is open.

4.13.4.41 upgrade_plus_sprite

```
sf::Sprite TileImprovement::upgrade_plus_sprite
```

An upgrade plus sprite.

The documentation for this class was generated from the following files:

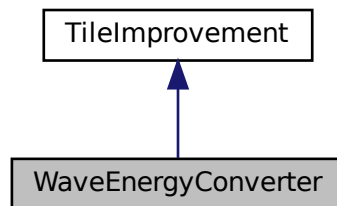
- header/[TileImprovement.h](#)
- source/[TileImprovement.cpp](#)

4.14 WaveEnergyConverter Class Reference

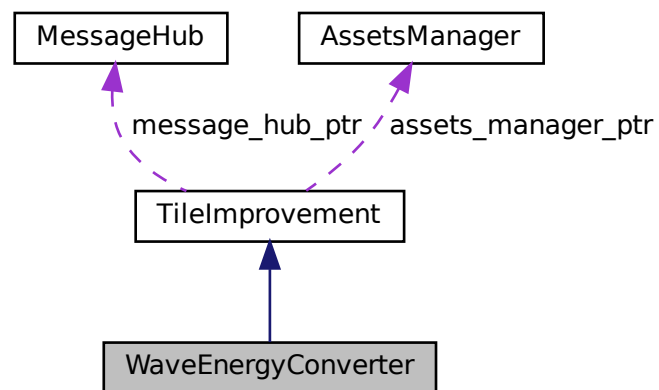
A settlement class (child class of [TileImprovement](#)).

```
#include <WaveEnergyConverter.h>
```

Inheritance diagram for WaveEnergyConverter:



Collaboration diagram for WaveEnergyConverter:



Public Member Functions

- [WaveEnergyConverter](#) (double, double, int, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [WaveEnergyConverter](#) class.
- std::string [getTileOptionsSubstring](#) (void)
Helper method to assemble and return tile options substring.
- void [setIsSelected](#) (bool)
Method to set the is selected attribute.

- void [advanceTurn](#) (void)
Method to handle turn advance.
- void [update](#) (void)
Method to trigger production and dispatchable updates.
- void [processEvent](#) (void)
Method to process [WaveEnergyConverter](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [WaveEnergyConverter](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual [~WaveEnergyConverter](#) (void)
Destructor for the [WaveEnergyConverter](#) class.

Public Attributes

- int [capacity_kW](#)
The rated production capacity [kW] of the solar PV array.
- int [production_MWh](#)
The current production [MWh] of the solar PV array.
- int [dispatch_MWh](#)
The current dispatch [MWh] of the solar PV array.
- int [dispatchable_MWh](#)
The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).
- double [max_daily_production_MWh](#)
The maximum daily production [MWh] of the solar PV array.
- double [bobbing_y](#)
The bobbing extent of the wave energy converter.
- std::vector< double > [capacity_factor_vec](#)
A vector of daily capacity factors for the current month.
- std::vector< double > [production_vec_MWh](#)
A vector of daily production [MWh] for the current month.
- std::vector< double > [dispatch_vec_MWh](#)
A vector of daily dispatch [MWh] for the current month.

Private Member Functions

- void [__setUpTileImprovementSpriteAnimated](#) (void)
Helper method to set up tile improvement sprite (static).
- void [__drawProductionMenu](#) (void)
Helper method to draw production menu assets.
- void [__upgradePowerCapacity](#) (void)
Helper method to upgrade power capacity.
- void [__computeProductionCosts](#) (void)
Helper method to compute production costs (O&M) based on current production level.
- void [__breakdown](#) (void)
Helper method to trigger an equipment breakdown.
- void [__repair](#) (void)
Helper method to repair the wave energy converter.
- void [__computeCapacityFactors](#) (void)

- Helper method to compute capacity factors.*
- void [__computeProduction](#) (void)
- Helper method to compute production values.*
- void [__computeDispatch](#) (void)
- Helper method to compute dispatch values.*
- void [__handleKeyPressEvents](#) (void)
- Helper method to handle key press events.*
- void [__handleMouseButtonEvents](#) (void)
- Helper method to handle mouse button events.*
- void [__drawUpgradeOptions](#) (void)
- Helper method to set up and draw upgrade options.*
- void [__sendImprovementStateMessage](#) (void)
- Helper method to format and sent improvement state message.*

Additional Inherited Members

4.14.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

4.14.2 Constructor & Destructor Documentation

4.14.2.1 WaveEnergyConverter()

```
WaveEnergyConverter::WaveEnergyConverter (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [WaveEnergyConverter](#) class.

Ref: [Wikipedia](#) [2023]

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>tile_resource</i>	The renewable resource quality of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.


```

777 :
778 TileImprovement (
779     position_x,
780     position_y,
781     tile_resource,
782     event_ptr,
783     render_window_ptr,
784     assets_manager_ptr,
785     message_hub_ptr
786 )
787 {
788     // 1. set attributes
789
790     // 1.1. private
791     //...
792
793     // 1.2. public
794     this->tile_improvement_type = TileImprovementType :: WAVE_ENERGY_CONVERTER;
795
796     this->is_running = false;
797
798     this->health = 100;
799
800     this->capacity_kW = 100;
801     this->upgrade_level = 1;
802
803     this->storage_kWh = 0;
804     this->storage_level = 0;
805
806     this->production_MWh = 0;
807     this->dispatch_MWh = 0;
808     this->dispatchable_MWh = 0;
809
810     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
811
812     this->bobbing_y = 4;
813
814     this->capacity_factor_vec.resize(30, 0);
815     this->production_vec_MWh.resize(30, 0);
816     this->dispatch_vec_MWh.resize(30, 0);
817
818     this->tile_improvement_string = "WAVE ENERGY";
819
820     this->__setUpTileImprovementSpriteAnimated();
821     this->__computeCapacityFactors();
822     this->update();
823
824     std::cout << "WaveEnergyConverter constructed at " << this << std::endl;
825
826     return;
827 } /* WaveEnergyConverter() */

```

4.14.2.2 ~WaveEnergyConverter()

```

WaveEnergyConverter::~WaveEnergyConverter (
    void ) [virtual]

```

Destructor for the [WaveEnergyConverter](#) class.

```

1204 {
1205     std::cout << "WaveEnergyConverter at " << this << " destroyed" << std::endl;
1206
1207     return;
1208 } /* ~WaveEnergyConverter() */

```

4.14.3 Member Function Documentation

4.14.3.1 __breakdown()

```
void WaveEnergyConverter::__breakdown (
    void ) [private]
```

Helper method to trigger an equipment breakdown.

```
250 {
251     TileImprovement :: __breakdown();
252
253     this->production_MWh = 0;
254     this->dispatch_MWh = 0;
255     this->dispatchable_MWh = 0;
256     this->operation_maintenance_cost = 0;
257
258     return;
259 } /* __breakdown() */
```

4.14.3.2 __computeCapacityFactors()

```
void WaveEnergyConverter::__computeCapacityFactors (
    void ) [private]
```

Helper method to compute capacity factors.

```
307 {
308     if (this->is_broken) {
309         return;
310     }
311
312     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
313     std::default_random_engine generator(seed);
314
315     double mean =
316         this->tile_resource_scalar * MEAN_DAILY_WAVE_CAPACITY_FACTORS[this->month - 1];
317
318     double stdev = STDEV_DAILY_WAVE_CAPACITY_FACTORS[this->month - 1];
319
320     if (this->tile_resource_scalar > 1) {
321         stdev /= this->tile_resource_scalar;
322     }
323
324     std::normal_distribution<double> normal_dist(mean, stdev);
325
326     double capacity_factor = 0;
327
328     for (int i = 0; i < 30; i++) {
329         capacity_factor = normal_dist(generator);
330
331         if (capacity_factor < 0) {
332             capacity_factor = 0;
333         }
334
335         this->capacity_factor_vec[i] = capacity_factor;
336     }
337
338     return;
339 } /* __computeCapacityFactors() */
```

4.14.3.3 __computeDispatch()

```
void WaveEnergyConverter::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
387 {
388     if (this->is_broken) {
389         this->dispatchable_MWh = 0;
```

```

390         return;
391     }
392
393     double stored_energy_MWh = 0;
394     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
395
396     double demand_MWh = 0;
397     double production_MWh = 0;
398     double dispatchable_MWh = 0;
399     double difference_MWh = 0;
400
401     double room_MWh = 0;
402
403     for (int i = 0; i < 30; i++) {
404         demand_MWh = this->demand_vec_MWh[i];
405         production_MWh = this->production_vec_MWh[i];
406
407         if (production_MWh <= demand_MWh) {
408             this->dispatch_vec_MWh[i] = production_MWh;
409             dispatchable_MWh += this->dispatch_vec_MWh[i];
410
411             difference_MWh = demand_MWh - production_MWh;
412
413             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
414                 if (difference_MWh > stored_energy_MWh) {
415                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
416                     dispatchable_MWh += stored_energy_MWh;
417                     stored_energy_MWh = 0;
418                 }
419
420                 else {
421                     this->dispatch_vec_MWh[i] += difference_MWh;
422                     dispatchable_MWh += difference_MWh;
423                     stored_energy_MWh -= difference_MWh;
424                 }
425             }
426         }
427
428         else {
429             this->dispatch_vec_MWh[i] = demand_MWh;
430             dispatchable_MWh += this->dispatch_vec_MWh[i];
431
432             difference_MWh = production_MWh - demand_MWh;
433
434             if (
435                 (storage_capacity_MWh > 0) and
436                 (stored_energy_MWh < storage_capacity_MWh)
437             ) {
438                 room_MWh = storage_capacity_MWh - stored_energy_MWh;
439
440                 if (difference_MWh > room_MWh) {
441                     stored_energy_MWh += room_MWh;
442                 }
443
444                 else {
445                     stored_energy_MWh += difference_MWh;
446                 }
447             }
448         }
449     }
450
451     this->dispatchable_MWh = round(dispatchable_MWh);
452
453     if (this->dispatch_MWh != this->dispatchable_MWh) {
454         this->dispatch_MWh = this->dispatchable_MWh;
455     }
456
457     return;
458 } /* __computeDispatch() */

```

4.14.3.4 __computeProduction()

```

void WaveEnergyConverter::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

354 {
355     if (this->is_broken) {

```

```

356         this->production_MWh = 0;
357         return;
358     }
359
360     double production_MWh = 0;
361
362     for (int i = 0; i < 30; i++) {
363         this->production_vec_MWh[i] =
364             this->max_daily_production_MWh * this->capacity_factor_vec[i];
365
366         production_MWh += this->production_vec_MWh[i];
367     }
368
369     this->production_MWh = round(production_MWh);
370
371     return;
372 } /* __computeProduction() */

```

4.14.3.5 __computeProductionCosts()

```

void WaveEnergyConverter::__computeProductionCosts (
    void ) [private]

```

Helper method to compute production costs (O&M) based on current production level.

```

229 {
230     double operation_maintenance_cost =
231         (this->production_MWh * WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
232     this->operation_maintenance_cost = round(operation_maintenance_cost);
233
234     return;
235 } /* __computeProductionCosts() */

```

4.14.3.6 __drawProductionMenu()

```

void WaveEnergyConverter::__drawProductionMenu (
    void ) [private]

```

Helper method to draw production menu assets.

```

114 {
115     // 1. draw static sprite
116     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
117         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
118         this->tile_improvement_sprite_animated[i].setPosition(400 - 138, 400 + 16);
119
120         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
121         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
122
123         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
124         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
125
126         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
127         this->tile_improvement_sprite_animated[i].setRotation(0);
128
129         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
130
131         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
132         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
133         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
134         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
135     }
136
137     // 2. draw production text
138     std::string production_string = "[W]: INCREASE DISPATCH\n";
139     production_string += "[S]: DECREASE DISPATCH\n";
140     production_string += "\n";
141
142     production_string += "DISPATCH: ";
143     production_string += std::to_string(this->dispatch_MWh);
144     production_string += " MWh (MAX ";

```

```

145     production_string      += std::to_string(this->dispatchable_MWh);
146     production_string      += "\n";
147
148     production_string      += "O&M COST:  ";
149     production_string      += std::to_string(this->operation_maintenance_cost);
150     production_string      += " K\n";
151
152     sf::Text production_text(
153         production_string,
154         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
155         16
156     );
157
158     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
159     production_text.setFill_color(MONOCHROME_TEXT_GREEN);
160
161     production_text.setPosition(400 + 30, 400 - 45);
162
163     this->render_window_ptr->draw(production_text);
164
165     return;
166 } /* __drawProductionMenu() */

```

4.14.3.7 __drawUpgradeOptions()

```

void WaveEnergyConverter::__drawUpgradeOptions (
    void ) [private]

```

Helper method to set up and draw upgrade options.

```

598 {
599     // 1. draw power capacity upgrade sprite
600     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
601         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
602         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 32 - 20);
603
604         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
605         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
606
607         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
608         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
609
610         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
611
612         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
613         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
614         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
615     }
616
617     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
618
619     // 2. draw power capacity upgrade text
620     // 16 char line = "
621     std::string power_upgrade_string = "POWER CAPACITY \n";
622     power_upgrade_string += " \n";
623
624     power_upgrade_string      += "CAPACITY:  ";
625     power_upgrade_string      += std::to_string(this->capacity_kW);
626     power_upgrade_string      += " kW\n";
627
628     power_upgrade_string      += "LEVEL:      ";
629     power_upgrade_string      += std::to_string(this->upgrade_level);
630     power_upgrade_string      += "\n\n";
631
632     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
633         power_upgrade_string      += "[W]: + 100 kW (";
634         power_upgrade_string      += std::to_string(WAVE_ENERGY_CONVERTER_BUILD_COST);
635         power_upgrade_string      += " K)\n";
636     }
637
638     else {
639         power_upgrade_string      += " * MAX LEVEL * \n";
640     }
641
642     sf::Text power_upgrade_text = sf::Text(
643         power_upgrade_string,
644         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
645         16

```

```

647     );
648
649     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
650     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
651     power_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
652
653     this->render_window_ptr->draw(power_upgrade_text);
654
655
656     // 3. draw energy capacity (storage) upgrade sprite
657     this->render_window_ptr->draw(this->storage_upgrade_sprite);
658     this->render_window_ptr->draw(this->upgrade_plus_sprite);
659
660
661     // 4. draw energy capacity (storage) upgrade text
662     //      16 char line = "                \n"
663     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
664     energy_upgrade_string             += "                \n";
665
666     energy_upgrade_string             += "CAPACITY: ";
667     energy_upgrade_string             += std::to_string(this->storage_level * 200);
668     energy_upgrade_string             += " kWh\n";
669
670     energy_upgrade_string             += "LEVEL: ";
671     energy_upgrade_string             += std::to_string(this->storage_level);
672     energy_upgrade_string             += "\n\n";
673
674     if (this->storage_level < MAX_STORAGE_LEVELS) {
675         energy_upgrade_string         += "[D]: + 200 kWh ";
676         energy_upgrade_string         += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
677         energy_upgrade_string         += " K)\n";
678     }
679
680     else {
681         energy_upgrade_string += " * MAX LEVEL * \n";
682     }
683
684     sf::Text energy_upgrade_text = sf::Text(
685         energy_upgrade_string,
686         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
687         16
688     );
689
690     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
691     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
692     energy_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
693
694     this->render_window_ptr->draw(energy_upgrade_text);
695
696     return;
697 } /* __drawUpgradeOptions() */

```

4.14.3.8 __handleKeyPressEvents()

```

void WaveEnergyConverter::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

473 {
474     if (this->just_built) {
475         return;
476     }
477
478     switch (this->event_ptr->key.code) {
479         case (sf::Keyboard::U): {
480             this->__openUpgradeMenu();
481
482             break;
483         }
484
485
486         case (sf::Keyboard::W): {
487             if (this->production_menu_open) {
488                 this->dispatch_MWh++;
489
490                 if (this->dispatch_MWh > this->dispatchable_MWh) {
491                     this->dispatch_MWh = 0;
492                 }

```

```

493         this->__computeProductionCosts();
494         this->assets_manager_ptr->getSound("interface click")->play();
495     }
496
497     else if (this->upgrade_menu_open) {
498         this->__upgradePowerCapacity();
499     }
500 }
501
502 break;
503 }
504
505
506 case (sf::Keyboard::S): {
507     if (this->production_menu_open) {
508         this->dispatch_MWh--;
509
510         if (this->dispatch_MWh < 0) {
511             this->dispatch_MWh = this->dispatchable_MWh;
512         }
513
514         this->__computeProductionCosts();
515         this->assets_manager_ptr->getSound("interface click")->play();
516     }
517
518     break;
519 }
520
521
522 case (sf::Keyboard::D): {
523     if (this->upgrade_menu_open) {
524         this->__upgradeStorageCapacity();
525         this->__computeProduction();
526         this->__computeDispatch();
527     }
528
529     break;
530 }
531
532
533 default: {
534     // do nothing!
535
536     break;
537 }
538 }
539
540 return;
541 } /* __handleKeyPressEvents() */

```

4.14.3.9 __handleMouseButtonEvents()

```

void WaveEnergyConverter::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

556 {
557     if (this->just_built) {
558         return;
559     }
560     switch (this->event_ptr->mouseButton.button) {
561         case (sf::Mouse::Left): {
562             //...
563
564             break;
565         }
566
567         case (sf::Mouse::Right): {
568             //...
569
570             break;
571         }
572     }
573
574     default: {
575         // do nothing!
576     }
577 }

```

```

578         break;
579     }
580 }
581
582 return;
583 } /* __handleMouseButtonEvents() */

```

4.14.3.10 __repair()

```

void WaveEnergyConverter::__repair (
    void ) [private], [virtual]

```

Helper method to repair the wave energy converter.

Reimplemented from [TileImprovement](#).

```

274 {
275     if (this->credits < WAVE_ENERGY_CONVERTER_BUILD_COST) {
276         std::cout << "Cannot repair wave energy converter: insufficient credits (need "
277             << WAVE_ENERGY_CONVERTER_BUILD_COST << " K)" << std::endl;
278
279         this->__sendInsufficientCreditsMessage();
280         return;
281     }
282
283     TileImprovement :: __repair();
284
285     this->just_upgraded = true;
286
287     this->__sendCreditsSpentMessage(WAVE_ENERGY_CONVERTER_BUILD_COST);
288     this->__sendTileStateRequest();
289     this->__sendGameStateRequest();
290
291     return;
292 } /* __repair() */

```

4.14.3.11 __sendImprovementStateMessage()

```

void WaveEnergyConverter::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

712 {
713     Message improvement_state_message;
714
715     improvement_state_message.channel = GAME_CHANNEL;
716     improvement_state_message.subject = "improvement state";
717
718     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
719     improvement_state_message.int_payload["operation_maintenance_cost"] =
720         this->operation_maintenance_cost;
721
722     this->message_hub_ptr->sendMessage(improvement_state_message);
723
724     std::cout << "Improvement state message sent by " << this << std::endl;
725
726     return;
727 } /* __sendImprovementStateMessage() */

```


4.14.3.12 __setUpTileImprovementSpriteAnimated()

```
void WaveEnergyConverter::__setUpTileImprovementSpriteAnimated (
    void ) [private]
```

Helper method to set up tile improvement sprite (static).

```
68 {
69     sf::Sprite diesel_generator_sheet (
70         *(this->assets_manager_ptr->getTexture("wave energy converter"))
71     );
72
73     int n_elements = diesel_generator_sheet.getLocalBounds().height / 64;
74
75     for (int i = 0; i < n_elements; i++) {
76         this->tile_improvement_sprite_animated.push_back(
77             sf::Sprite(
78                 *(this->assets_manager_ptr->getTexture("wave energy converter")),
79                 sf::IntRect(0, i * 64, 64, 64)
80             )
81         );
82
83         this->tile_improvement_sprite_animated.back().setOrigin(
84             this->tile_improvement_sprite_animated.back().getLocalBounds().width / 2,
85             this->tile_improvement_sprite_animated.back().getLocalBounds().height
86         );
87
88         this->tile_improvement_sprite_animated.back().setPosition(
89             this->position_x,
90             this->position_y - 32
91         );
92
93         this->tile_improvement_sprite_animated.back().setColor(
94             sf::Color(255, 255, 255, 0)
95         );
96     }
97
98     return;
99 } /* __setUpTileImprovementSpriteAnimated() */
```

4.14.3.13 __upgradePowerCapacity()

```
void WaveEnergyConverter::__upgradePowerCapacity (
    void ) [private]
```

Helper method to upgrade power capacity.

```
181 {
182     if (this->credits < WAVE_ENERGY_CONVERTER_BUILD_COST) {
183         std::cout << "Cannot upgrade wave energy converter: insufficient credits (need "
184             << WAVE_ENERGY_CONVERTER_BUILD_COST << " K)" << std::endl;
185
186         this->__sendInsufficientCreditsMessage();
187         return;
188     }
189
190     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
191         return;
192     }
193
194     TileImprovement :: __repair();
195
196     this->capacity_kW += 100;
197     this->upgrade_level++;
198
199     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
200
201     this->__computeProduction();
202     this->__computeDispatch();
203
204     this->just_upgraded = true;
205
206     this->assets_manager_ptr->getSound("upgrade")->play();
207
208     this->__sendCreditsSpentMessage(WAVE_ENERGY_CONVERTER_BUILD_COST);
209     this->__sendTileStateRequest();
210     this->__sendGameStateRequest();
211
212     return;
213 } /* __upgradePowerCapacity() */
```

4.14.3.14 advanceTurn()

```
void WaveEnergyConverter::advanceTurn (
    void ) [virtual]
```

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```
932 {
933     // 1. send improvement state message
934     this->__sendImprovementStateMessage();
935
936     // 2. update
937     this->__computeCapacityFactors();
938     this->update();
939
940     // 3. handle start/stop
941     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
942         this->is_running = true;
943     }
944
945     else if (this->is_running and (this->dispatch_MWh <= 0)) {
946         this->is_running = false;
947     }
948
949     // 4. handle equipment health and breakdowns
950     if (this->is_running) {
951         this->health--;
952
953         if (this->health <= 50) {
954             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
955
956             if ((double)rand() / RAND_MAX <= breakdown_prob) {
957                 this->health = 0;
958             }
959         }
960
961         if (this->health <= 0) {
962             this->__breakdown();
963         }
964     }
965
966     // 5. send tile state request (if selected)
967     if (this->is_selected) {
968         this->__sendTileStateRequest();
969     }
970
971     return;
972 } /* advanceTurn() */
```

4.14.3.15 draw()

```
void WaveEnergyConverter::draw (
    void ) [virtual]
```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```
1061 {
1062     // 1. if just built, call base method and return
1063     if (this->just_built) {
1064         TileImprovement :: draw();
1065
1066         return;
1067     }
1068
1069
1070     // 2. handle upgrade effects
1071     if (this->just_upgraded) {
1072         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1073             this->tile_improvement_sprite_animated[i].setColor(
1074                 sf::Color(
1075                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
```

```

1076         255,
1077         255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1078         255
1079     )
1080 };
1081
1082     this->tile_improvement_sprite_animated[i].setScale(
1083         sf::Vector2f(
1084             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1085             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1086         )
1087     );
1088 }
1089
1090     this->upgrade_frame++;
1091 }
1092
1093     if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1094         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1095             this->tile_improvement_sprite_animated[i].setColor(
1096                 sf::Color(255,255,255,255)
1097             );
1098
1099             this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1100         }
1101
1102         this->just_upgraded = false;
1103         this->upgrade_frame = 0;
1104     }
1105
1106
1107     // 3. draw first element of animated sprite
1108     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1109
1110
1111     // 4. draw second element of animated sprite
1112     if (this->is_running) {
1113         this->tile_improvement_sprite_animated[0].setPosition(
1114             this->position_x,
1115             this->position_y + this->bobbing_y * cos(
1116                 (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1117             )
1118         );
1119
1120         this->tile_improvement_sprite_animated[1].setPosition(
1121             this->position_x,
1122             this->position_y + 1.25 * this->bobbing_y * sin(
1123                 (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1124             )
1125         );
1126     }
1127
1128     else {
1129         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1130             this->tile_improvement_sprite_animated[i].setPosition(
1131                 this->position_x,
1132                 this->position_y + this->bobbing_y * cos(
1133                     (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1134                 )
1135             );
1136         }
1137     }
1138
1139     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1140
1141
1142     // 5. draw storage upgrades
1143     for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1144         this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1145     }
1146
1147
1148     // 6. handle dispatch illustration
1149     if (this->dispatch_MWh > 0) {
1150         this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1151         this->__drawDispatch();
1152     }
1153
1154
1155     // 7. draw production menu
1156     if (this->production_menu_open) {
1157         this->render_window_ptr->draw(this->production_menu_backing);
1158         this->render_window_ptr->draw(this->production_menu_backing_text);
1159
1160         this->__drawProductionMenu();
1161     }
1162

```

```

1163
1164 // 8. draw upgrade menu
1165 if (this->upgrade_menu_open) {
1166     this->render_window_ptr->draw(this->upgrade_menu_backing);
1167     this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1168
1169     this->__drawUpgradeOptions();
1170 }
1171
1172
1173 // 9. handle broken effects
1174 if (this->is_broken) {
1175     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1176         this->tile_improvement_sprite_animated[i].setColor(
1177             sf::Color(
1178                 255,
1179                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1180                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1181                 255
1182             )
1183         );
1184     }
1185 }
1186
1187 this->frame++;
1188 return;
1189 } /* draw() */

```

4.14.3.16 getTileOptionsSubstring()

```

std::string WaveEnergyConverter::getTileOptionsSubstring (
    void ) [virtual]

```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

844 {
845     // 32 char x 17 line console "-----\n";
846     std::string options_substring = "CAPACITY: ";
847     options_substring += std::to_string(this->capacity_kW);
848     options_substring += " kW (level ";
849     options_substring += std::to_string(this->upgrade_level);
850     options_substring += ")\n";
851
852     options_substring += "PRODUCTION: ";
853     options_substring += std::to_string(this->production_MWh);
854     options_substring += " MWh\n";
855
856     options_substring += "DISPATCHABLE: ";
857     options_substring += std::to_string(this->dispatchable_MWh);
858     options_substring += " MWh\n";
859
860     options_substring += "HEALTH: ";
861     options_substring += std::to_string(this->health);
862     options_substring += "/100";
863
864     if (this->health <= 0) {
865         options_substring += " ** BROKEN! **\n";
866     }
867
868     else {
869         options_substring += "\n";
870     }
871
872     options_substring += "
873     options_substring += " **** WAVE ENERGY OPTIONS **** \n";
874     options_substring += "
875
876     if (this->is_broken) {
877         options_substring += " [R]: REPAIR (";

```

```

878         options_substring          += std::to_string(WAVE_ENERGY_CONVERTER_BUILD_COST);
879         options_substring          += " K)\n";
880     }
881
882     else {
883         options_substring          += "      [E]:  OPEN PRODUCTION MENU \n";
884     }
885
886     options_substring          += "      [U]:  OPEN UPGRADE MENU      \n";
887     options_substring          += "HOLD [P]:  SCRAP (";
888     options_substring          += std::to_string(SCRAP_COST);
889     options_substring          += " K)";
890
891     return options_substring;
892 } /* getTileOptionsSubstring() */

```

4.14.3.17 processEvent()

```

void WaveEnergyConverter::processEvent (
    void ) [virtual]

```

Method to process [WaveEnergyConverter](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```

1012 {
1013     TileImprovement :: processEvent();
1014
1015     if (this->event_ptr->type == sf::Event::KeyPressed) {
1016         this->__handleKeyPressEvents();
1017     }
1018
1019     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1020         this->__handleMouseButtonEvents();
1021     }
1022
1023     return;
1024 } /* processEvent() */

```

4.14.3.18 processMessage()

```

void WaveEnergyConverter::processMessage (
    void ) [virtual]

```

Method to process [WaveEnergyConverter](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```

1039 {
1040     TileImprovement :: processMessage();
1041
1042     //...
1043
1044     return;
1045 } /* processMessage() */

```

4.14.3.19 setIsSelected()

```

void WaveEnergyConverter::setIsSelected (
    bool is_selected ) [virtual]

```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```

909 {
910     TileImprovement :: setIsSelected(is_selected);
911
912     if (this->is_running and this->is_selected) {
913         this->assets_manager_ptr->getSound("ocean waves")->play();
914     }
915
916     return;
917 } /* setIsSelected() */

```

4.14.3.20 update()

```

void WaveEnergyConverter::update (
    void ) [virtual]

```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```

987 {
988     this->__computeProduction();
989     this->__computeProductionCosts();
990     this->__computeDispatch();
991
992     if (this->is_selected) {
993         this->__sendTileStateRequest();
994     }
995
996     return;
997 } /* update() */

```

4.14.4 Member Data Documentation

4.14.4.1 bobbing_y

```
double WaveEnergyConverter::bobbing_y
```

The bobbing extent of the wave energy converter.

4.14.4.2 capacity_factor_vec

```
std::vector<double> WaveEnergyConverter::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

4.14.4.3 capacity_kW

```
int WaveEnergyConverter::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

4.14.4.4 dispatch_MWh

```
int WaveEnergyConverter::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

4.14.4.5 dispatch_vec_MWh

```
std::vector<double> WaveEnergyConverter::dispatch_vec_MWh
```

A vector of daily dispatch [MWh] for the current month.

4.14.4.6 dispatchable_MWh

```
int WaveEnergyConverter::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

4.14.4.7 max_daily_production_MWh

```
double WaveEnergyConverter::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

4.14.4.8 production_MWh

```
int WaveEnergyConverter::production_MWh
```

The current production [MWh] of the solar PV array.

4.14.4.9 production_vec_MWh

```
std::vector<double> WaveEnergyConverter::production_vec_MWh
```

A vector of daily production [MWh] for the current month.

The documentation for this class was generated from the following files:

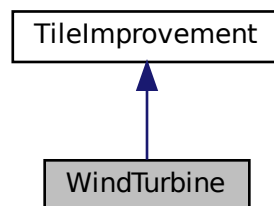
- header/[WaveEnergyConverter.h](#)
- source/[WaveEnergyConverter.cpp](#)

4.15 WindTurbine Class Reference

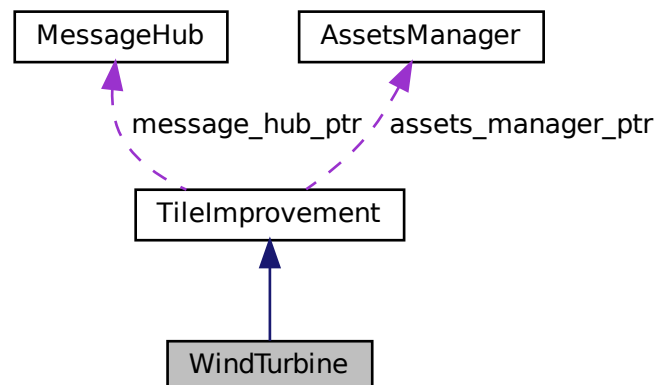
A settlement class (child class of [TileImprovement](#)).

```
#include <WindTurbine.h>
```

Inheritance diagram for WindTurbine:



Collaboration diagram for WindTurbine:



Public Member Functions

- [WindTurbine](#) (double, double, int, sf::Event *, sf::RenderWindow *, [AssetsManager](#) *, [MessageHub](#) *)
Constructor for the [WindTurbine](#) class.
- std::string [getTileOptionsSubstring](#) (void)
Helper method to assemble and return tile options substring.
- void [setIsSelected](#) (bool)
Method to set the is selected attribute.
- void [advanceTurn](#) (void)
Method to handle turn advance.
- void [update](#) (void)
Method to trigger production and dispatchable updates.
- void [processEvent](#) (void)
Method to process [WindTurbine](#). To be called once per event.
- void [processMessage](#) (void)
Method to process [WindTurbine](#). To be called once per message.
- void [draw](#) (void)
Method to draw the hex tile to the render window. To be called once per frame.
- virtual [~WindTurbine](#) (void)
Destructor for the [WindTurbine](#) class.

Public Attributes

- int [capacity_kW](#)
The rated production capacity [kW] of the solar PV array.
- int [production_MWh](#)
The current production [MWh] of the solar PV array.
- int [dispatch_MWh](#)
The current dispatch [MWh] of the solar PV array.
- int [dispatchable_MWh](#)
The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).
- double [max_daily_production_MWh](#)
The maximum daily production [MWh] of the solar PV array.
- double [rotor_drotation](#)
The rotation rate of the rotor.
- std::vector< double > [capacity_factor_vec](#)
A vector of daily capacity factors for the current month.
- std::vector< double > [production_vec_MWh](#)
A vector of daily production [MWh] for the current month.
- std::vector< double > [dispatch_vec_MWh](#)
A vector of daily dispatch [MWh] for the current month.

Private Member Functions

- void [__setUpTileImprovementSpriteAnimated](#) (void)
Helper method to set up tile improvement sprite (static).
- void [__drawProductionMenu](#) (void)
Helper method to draw production menu assets.
- void [__upgradePowerCapacity](#) (void)
Helper method to upgrade the power capacity.
- void [__computeProductionCosts](#) (void)
Helper method to compute production costs (O&M) based on current production level.
- void [__breakdown](#) (void)
Helper method to trigger an equipment breakdown.
- void [__repair](#) (void)
Helper method to repair the wind turbine.
- void [__computeCapacityFactors](#) (void)
Helper method to compute capacity factors.
- void [__computeProduction](#) (void)
Helper method to compute production values.
- void [__computeDispatch](#) (void)
Helper method to compute dispatch values.
- void [__handleKeyPressEvents](#) (void)
Helper method to handle key press events.
- void [__handleMouseButtonEvents](#) (void)
Helper method to handle mouse button events.
- void [__drawUpgradeOptions](#) (void)
Helper method to set up and draw upgrade options.
- void [__sendImprovementStateMessage](#) (void)
Helper method to format and sent improvement state message.

Additional Inherited Members

4.15.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

4.15.2 Constructor & Destructor Documentation

4.15.2.1 WindTurbine()

```
WindTurbine::WindTurbine (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [WindTurbine](#) class.

Ref: [Wikipedia \[2023\]](#)

Parameters

<i>position_x</i>	The x position of the tile.
<i>position_y</i>	The y position of the tile.
<i>tile_resource</i>	The renewable resource quality of the tile.
<i>event_ptr</i>	Pointer to the event class.
<i>render_window_ptr</i>	Pointer to the render window.
<i>assets_manager_ptr</i>	Pointer to the assets manager.
<i>message_hub_ptr</i>	Pointer to the message hub.

```

782 :
783 TileImprovement (
784     position_x,
785     position_y,
786     tile_resource,
787     event_ptr,
788     render_window_ptr,
789     assets_manager_ptr,
790     message_hub_ptr
791 )
792 {
793     // 1. set attributes
794
795     // 1.1. private
796     ///...
797
798     // 1.2. public
799     this->tile_improvement_type = TileImprovementType :: WIND_TURBINE;
800
801     this->is_running = false;
802
803     this->health = 100;
804
805     this->capacity_kW = 100;
806     this->upgrade_level = 1;
807
808     this->storage_kWh = 0;
809     this->storage_level = 0;
810
811     this->production_MWh = 0;
812     this->dispatch_MWh = 0;
813     this->dispatchable_MWh = 0;
814
815     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
816
817     this->rotor_drotation = 256 * SECONDS_PER_FRAME;
818
819     this->capacity_factor_vec.resize(30, 0);
820     this->production_vec_MWh.resize(30, 0);
821     this->dispatch_vec_MWh.resize(30, 0);
822
823     this->tile_improvement_string = "WIND TURBINE";
824
825     this->__setUpTileImprovementSpriteAnimated();
826     this->__computeCapacityFactors();
827     this->update();
828
829     std::cout << "WindTurbine constructed at " << this << std::endl;
830
831     return;
832 } /* WindTurbine() */

```

4.15.2.2 ~WindTurbine()

```

WindTurbine::~WindTurbine (
    void ) [virtual]

```

Destructor for the [WindTurbine](#) class.

```

1188 {
1189     std::cout << "WindTurbine at " << this << " destroyed" << std::endl;
1190
1191     return;
1192 } /* ~WindTurbine() */

```

4.15.3 Member Function Documentation

4.15.3.1 `__breakdown()`

```
void WindTurbine::__breakdown (
    void ) [private]
```

Helper method to trigger an equipment breakdown.

```
250 {
251     TileImprovement :: __breakdown();
252
253     this->production_MWh = 0;
254     this->dispatch_MWh = 0;
255     this->dispatchable_MWh = 0;
256     this->operation_maintenance_cost = 0;
257
258     return;
259 } /* __breakdown() */
```

4.15.3.2 `__computeCapacityFactors()`

```
void WindTurbine::__computeCapacityFactors (
    void ) [private]
```

Helper method to compute capacity factors.

```
307 {
308     if (this->is_broken) {
309         return;
310     }
311
312     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
313     std::default_random_engine generator(seed);
314
315     double mean =
316         this->tile_resource_scalar * MEAN_DAILY_WIND_CAPACITY_FACTORS[this->month - 1];
317
318     double stdev = STDEV_DAILY_WIND_CAPACITY_FACTORS[this->month - 1];
319
320     if (this->tile_resource_scalar > 1) {
321         stdev /= this->tile_resource_scalar;
322     }
323
324     std::normal_distribution<double> normal_dist(mean, stdev);
325
326     double capacity_factor = 0;
327
328     for (int i = 0; i < 30; i++) {
329         capacity_factor = normal_dist(generator);
330
331         if (capacity_factor < 0) {
332             capacity_factor = 0;
333         }
334
335         this->capacity_factor_vec[i] = capacity_factor;
336     }
337
338     return;
339 } /* __computeCapacityFactors() */
```

4.15.3.3 __computeDispatch()

```
void WindTurbine::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
387 {
388     if (this->is_broken) {
389         this->dispatchable_MWh = 0;
390         return;
391     }
392
393     double stored_energy_MWh = 0;
394     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
395
396     double demand_MWh = 0;
397     double production_MWh = 0;
398     double dispatchable_MWh = 0;
399     double difference_MWh = 0;
400
401     double room_MWh = 0;
402
403     for (int i = 0; i < 30; i++) {
404         demand_MWh = this->demand_vec_MWh[i];
405         production_MWh = this->production_vec_MWh[i];
406
407         if (production_MWh <= demand_MWh) {
408             this->dispatch_vec_MWh[i] = production_MWh;
409             dispatchable_MWh += this->dispatch_vec_MWh[i];
410
411             difference_MWh = demand_MWh - production_MWh;
412
413             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
414                 if (difference_MWh > stored_energy_MWh) {
415                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
416                     dispatchable_MWh += stored_energy_MWh;
417                     stored_energy_MWh = 0;
418                 }
419
420                 else {
421                     this->dispatch_vec_MWh[i] += difference_MWh;
422                     dispatchable_MWh += difference_MWh;
423                     stored_energy_MWh -= difference_MWh;
424                 }
425             }
426         }
427
428         else {
429             this->dispatch_vec_MWh[i] = demand_MWh;
430             dispatchable_MWh += this->dispatch_vec_MWh[i];
431
432             difference_MWh = production_MWh - demand_MWh;
433
434             if (
435                 (storage_capacity_MWh > 0) and
436                 (stored_energy_MWh < storage_capacity_MWh)
437             ) {
438                 room_MWh = storage_capacity_MWh - stored_energy_MWh;
439
440                 if (difference_MWh > room_MWh) {
441                     stored_energy_MWh += room_MWh;
442                 }
443
444                 else {
445                     stored_energy_MWh += difference_MWh;
446                 }
447             }
448         }
449     }
450
451     this->dispatchable_MWh = round(dispatchable_MWh);
452
453     if (this->dispatch_MWh != this->dispatchable_MWh) {
454         this->dispatch_MWh = this->dispatchable_MWh;
455     }
456
457     return;
458 } /* __computeDispatch() */
```

4.15.3.4 __computeProduction()

```
void WindTurbine::__computeProduction (
    void ) [private]
```

Helper method to compute production values.

```
354 {
355     if (this->is_broken) {
356         this->production_MWh = 0;
357         return;
358     }
359
360     double production_MWh = 0;
361
362     for (int i = 0; i < 30; i++) {
363         this->production_vec_MWh[i] =
364             this->max_daily_production_MWh * this->capacity_factor_vec[i];
365
366         production_MWh += this->production_vec_MWh[i];
367     }
368
369     this->production_MWh = round(production_MWh);
370
371     return;
372 } /* __computeProduction() */
```

4.15.3.5 __computeProductionCosts()

```
void WindTurbine::__computeProductionCosts (
    void ) [private]
```

Helper method to compute production costs (O&M) based on current production level.

```
229 {
230     double operation_maintenance_cost =
231         (this->production_MWh * WIND_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
232     this->operation_maintenance_cost = round(operation_maintenance_cost);
233
234     return;
235 } /* __computeProductionCosts() */
```

4.15.3.6 __drawProductionMenu()

```
void WindTurbine::__drawProductionMenu (
    void ) [private]
```

Helper method to draw production menu assets.

```
114 {
115     // 1. draw static sprite
116     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
117         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
118         this->tile_improvement_sprite_animated[i].setPosition(400 - 138, 400 + 16);
119
120         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
121         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
122
123         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
124         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
125
126         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
127         this->tile_improvement_sprite_animated[i].setRotation(0);
128
129         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
130
131         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
132         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
133         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
134     }
```

```

134         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
135     }
136
137     // 2. draw production text
138     std::string production_string = "[W]: INCREASE DISPATCH\n";
139     production_string += "[S]: DECREASE DISPATCH\n";
140     production_string += "\n";
141
142     production_string += "DISPATCH: ";
143     production_string += std::to_string(this->dispatch_MWh);
144     production_string += " MWh (MAX ";
145     production_string += std::to_string(this->dispatchable_MWh);
146     production_string += ")\n";
147
148     production_string += "O&M COST: ";
149     production_string += std::to_string(this->operation_maintenance_cost);
150     production_string += " K\n";
151
152     sf::Text production_text(
153         production_string,
154         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
155         16
156     );
157
158     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
159     production_text.setFillColor(MONOCHROME_TEXT_GREEN);
160
161     production_text.setPosition(400 + 30, 400 - 45);
162
163     this->render_window_ptr->draw(production_text);
164
165     return;
166 } /* __drawProductionMenu() */

```

4.15.3.7 __drawUpgradeOptions()

```

void WindTurbine::__drawUpgradeOptions (
    void ) [private]

```

Helper method to set up and draw upgrade options.

```

599 {
600     // 1. draw power capacity upgrade sprite
601     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
602         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
603         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 56);
604
605         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
606         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
607
608         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
609         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
610
611         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
612         this->tile_improvement_sprite_animated[i].setRotation(0);
613
614         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
615
616         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
617         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
618         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
619         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
620     }
621
622     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
623
624     // 2. draw power capacity upgrade text
625     // 16 char line = "
626     std::string power_upgrade_string = "POWER CAPACITY\n";
627     power_upgrade_string += "\n";
628     power_upgrade_string += "\n";
629
630     power_upgrade_string += "CAPACITY: ";
631     power_upgrade_string += std::to_string(this->capacity_kW);
632     power_upgrade_string += " kW\n";
633
634     power_upgrade_string += "LEVEL: ";
635     power_upgrade_string += std::to_string(this->upgrade_level);
636     power_upgrade_string += "\n\n";

```

```

637
638     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
639         power_upgrade_string += "[W]: + 100 kW (";
640         power_upgrade_string += std::to_string(WIND_TURBINE_BUILD_COST);
641         power_upgrade_string += " K)\n";
642     }
643
644     else {
645         power_upgrade_string += " * MAX LEVEL * \n";
646     }
647
648     sf::Text power_upgrade_text = sf::Text(
649         power_upgrade_string,
650         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
651         16
652     );
653
654     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
655     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
656     power_upgrade_text.setFillColor(MONOCHROME_TEXT_GREEN);
657
658     this->render_window_ptr->draw(power_upgrade_text);
659
660
661     // 3. draw energy capacity (storage) upgrade sprite
662     this->render_window_ptr->draw(this->storage_upgrade_sprite);
663     this->render_window_ptr->draw(this->upgrade_plus_sprite);
664
665
666     // 4. draw energy capacity (storage) upgrade text
667     //      16 char line = "          \n"
668     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
669     energy_upgrade_string += "          \n";
670
671     energy_upgrade_string += "CAPACITY: ";
672     energy_upgrade_string += std::to_string(this->storage_level * 200);
673     energy_upgrade_string += " kWh\n";
674
675     energy_upgrade_string += "LEVEL: ";
676     energy_upgrade_string += std::to_string(this->storage_level);
677     energy_upgrade_string += "\n\n";
678
679     if (this->storage_level < MAX_STORAGE_LEVELS) {
680         energy_upgrade_string += "[D]: + 200 kWh (";
681         energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
682         energy_upgrade_string += " K)\n";
683     }
684
685     else {
686         energy_upgrade_string += " * MAX LEVEL * \n";
687     }
688
689     sf::Text energy_upgrade_text = sf::Text(
690         energy_upgrade_string,
691         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
692         16
693     );
694
695     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
696     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
697     energy_upgrade_text.setFillColor(MONOCHROME_TEXT_GREEN);
698
699     this->render_window_ptr->draw(energy_upgrade_text);
700
701     return;
702 } /* __drawUpgradeOptions() */

```

4.15.3.8 __handleKeyPressEvents()

```

void WindTurbine::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

473 {
474     if (this->just_built) {
475         return;
476     }
477

```



```

478     switch (this->event_ptr->key.code) {
479         case (sf::Keyboard::U): {
480             this->__openUpgradeMenu();
481
482             break;
483         }
484
485
486         case (sf::Keyboard::W): {
487             if (this->production_menu_open) {
488                 this->dispatch_MWh++;
489
490                 if (this->dispatch_MWh > this->dispatchable_MWh) {
491                     this->dispatch_MWh = 0;
492                 }
493
494                 this->__computeProductionCosts();
495                 this->assets_manager_ptr->getSound("interface click")->play();
496             }
497
498             else if (this->upgrade_menu_open) {
499                 this->__upgradePowerCapacity();
500             }
501
502             break;
503         }
504
505
506         case (sf::Keyboard::S): {
507             if (this->production_menu_open) {
508                 this->dispatch_MWh--;
509
510                 if (this->dispatch_MWh < 0) {
511                     this->dispatch_MWh = this->dispatchable_MWh;
512                 }
513
514                 this->__computeProductionCosts();
515                 this->assets_manager_ptr->getSound("interface click")->play();
516             }
517
518             break;
519         }
520
521
522         case (sf::Keyboard::D): {
523             if (this->upgrade_menu_open) {
524                 this->__upgradeStorageCapacity();
525                 this->__computeProduction();
526                 this->__computeDispatch();
527             }
528
529             break;
530         }
531
532
533         default: {
534             // do nothing!
535
536             break;
537         }
538     }
539
540     return;
541 } /* __handleKeyPressEvents() */

```

4.15.3.9 __handleMouseButtonEvents()

```

void WindTurbine::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

556 {
557     if (this->just_built) {
558         return;
559     }
560
561     switch (this->event_ptr->mouseButton.button) {
562         case (sf::Mouse::Left): {

```

```

563         //...
564
565         break;
566     }
567
568
569     case (sf::Mouse::Right): {
570         //...
571
572         break;
573     }
574
575
576     default: {
577         // do nothing!
578
579         break;
580     }
581 }
582
583 return;
584 } /* __handleMouseButtonEvents() */

```

4.15.3.10 __repair()

```

void WindTurbine::__repair (
    void ) [private], [virtual]

```

Helper method to repair the wind turbine.

Reimplemented from [TileImprovement](#).

```

274 {
275     if (this->credits < WIND_TURBINE_BUILD_COST) {
276         std::cout << "Cannot repair wind turbine: insufficient credits (need "
277             << WIND_TURBINE_BUILD_COST << " K)" << std::endl;
278
279         this->__sendInsufficientCreditsMessage();
280         return;
281     }
282
283     TileImprovement :: __repair();
284
285     this->just_upgraded = true;
286
287     this->__sendCreditsSpentMessage(WIND_TURBINE_BUILD_COST);
288     this->__sendTileStateRequest();
289     this->__sendGameStateRequest();
290
291     return;
292 } /* __repair() */

```

4.15.3.11 __sendImprovementStateMessage()

```

void WindTurbine::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

717 {
718     Message improvement_state_message;
719
720     improvement_state_message.channel = GAME_CHANNEL;
721     improvement_state_message.subject = "improvement state";
722
723     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
724     improvement_state_message.int_payload["operation_maintenance_cost"] =
725         this->operation_maintenance_cost;
726
727     this->message_hub_ptr->sendMessage(improvement_state_message);
728
729     std::cout << "Improvement state message sent by " << this << std::endl;
730
731     return;
732 } /* __sendImprovementStateMessage() */

```

4.15.3.12 __setUpTileImprovementSpriteAnimated()

```
void WindTurbine::__setUpTileImprovementSpriteAnimated (
    void ) [private]
```

Helper method to set up tile improvement sprite (static).

```
68 {
69     sf::Sprite diesel_generator_sheet (
70         *(this->assets_manager_ptr->getTexture("wind turbine"))
71     );
72
73     int n_elements = diesel_generator_sheet.getLocalBounds().height / 64;
74
75     for (int i = 0; i < n_elements; i++) {
76         this->tile_improvement_sprite_animated.push_back(
77             sf::Sprite(
78                 *(this->assets_manager_ptr->getTexture("wind turbine")),
79                 sf::IntRect(0, i * 64, 64, 64)
80             )
81         );
82
83         this->tile_improvement_sprite_animated.back().setOrigin(
84             this->tile_improvement_sprite_animated.back().getLocalBounds().width / 2,
85             this->tile_improvement_sprite_animated.back().getLocalBounds().height
86         );
87
88         this->tile_improvement_sprite_animated.back().setPosition(
89             this->position_x,
90             this->position_y - 32
91         );
92
93         this->tile_improvement_sprite_animated.back().setColor(
94             sf::Color(255, 255, 255, 0)
95         );
96     }
97
98     return;
99 } /* __setUpTileImprovementSpriteAnimated() */
```

4.15.3.13 __upgradePowerCapacity()

```
void WindTurbine::__upgradePowerCapacity (
    void ) [private]
```

Helper method to upgrade the power capacity.

```
181 {
182     if (this->credits < WIND_TURBINE_BUILD_COST) {
183         std::cout << "Cannot upgrade wind turbine: insufficient credits (need "
184             << WIND_TURBINE_BUILD_COST << " K)" << std::endl;
185
186         this->__sendInsufficientCreditsMessage();
187         return;
188     }
189
190     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
191         return;
192     }
193
194     TileImprovement :: __repair();
195
196     this->capacity_kW += 100;
197     this->upgrade_level++;
198
199     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
200
201     this->__computeProduction();
202     this->__computeDispatch();
203
204     this->just_upgraded = true;
205
206     this->assets_manager_ptr->getSound("upgrade")->play();
207
208     this->__sendCreditsSpentMessage(WIND_TURBINE_BUILD_COST);
209     this->__sendTileStateRequest();
210     this->__sendGameStateRequest();
211
212     return;
213 } /* __upgradePowerCapacity() */
```

4.15.3.14 advanceTurn()

```
void WindTurbine::advanceTurn (
    void ) [virtual]
```

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```
937 {
938     // 1. send improvement state message
939     this->__sendImprovementStateMessage();
940
941     // 2. update
942     this->__computeCapacityFactors();
943     this->update();
944
945     // 3. handle start/stop
946     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
947         this->is_running = true;
948     }
949
950     else if (this->is_running and (this->dispatch_MWh <= 0)) {
951         this->is_running = false;
952     }
953
954     // 4. handle equipment health and breakdowns
955     if (this->is_running) {
956         this->health--;
957
958         if (this->health <= 50) {
959             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
960
961             if ((double)rand() / RAND_MAX <= breakdown_prob) {
962                 this->health = 0;
963             }
964         }
965
966         if (this->health <= 0) {
967             this->__breakdown();
968         }
969     }
970
971     // 5. send tile state request (if selected)
972     if (this->is_selected) {
973         this->__sendTileStateRequest();
974     }
975
976     return;
977 } /* advanceTurn() */
```

4.15.3.15 draw()

```
void WindTurbine::draw (
    void ) [virtual]
```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```
1068 {
1069     // 1. if just built, call base method and return
1070     if (this->just_built) {
1071         TileImprovement :: draw();
1072
1073         return;
1074     }
1075
1076
1077     // 2. handle upgrade effects
1078     if (this->just_upgraded) {
1079         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1080             this->tile_improvement_sprite_animated[i].setColor(
1081                 sf::Color(
1082                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
```

```

1083         255,
1084         255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1085         255
1086     )
1087 };
1088
1089     this->tile_improvement_sprite_animated[i].setScale(
1090         sf::Vector2f(
1091             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1092             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1093         )
1094     );
1095 }
1096
1097     this->upgrade_frame++;
1098 }
1099
1100     if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1101         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1102             this->tile_improvement_sprite_animated[i].setColor(
1103                 sf::Color(255,255,255,255)
1104             );
1105
1106             this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1107         }
1108
1109         this->just_upgraded = false;
1110         this->upgrade_frame = 0;
1111     }
1112
1113     // 3. draw first element of animated sprite
1114     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1115
1116     // 4. draw second element of animated sprite
1117     if (this->is_running) {
1118         this->tile_improvement_sprite_animated[1].rotate(this->rotor_drotation);
1119     }
1120
1121     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1122
1123     // 5. draw storage upgrades
1124     for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1125         this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1126     }
1127
1128     // 6. handle dispatch illustration
1129     if (this->dispatch_MWh > 0) {
1130         this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1131         this->__drawDispatch();
1132     }
1133
1134     // 7. draw production menu
1135     if (this->production_menu_open) {
1136         this->render_window_ptr->draw(this->production_menu_backing);
1137         this->render_window_ptr->draw(this->production_menu_backing_text);
1138
1139         this->__drawProductionMenu();
1140     }
1141
1142     // 8. draw upgrade menu
1143     if (this->upgrade_menu_open) {
1144         this->render_window_ptr->draw(this->upgrade_menu_backing);
1145         this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1146
1147         this->__drawUpgradeOptions();
1148     }
1149
1150     // 9. handle broken effects
1151     if (this->is_broken) {
1152         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1153             this->tile_improvement_sprite_animated[i].setColor(
1154                 sf::Color(
1155                     255,
1156                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1157                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1158                     255
1159                 )
1160             );
1161         }
1162     }
1163 }
1164
1165     }
1166 }
1167
1168     }
1169 }

```

```

1170
1171     this->frame++;
1172     return;
1173 }    /* draw() */

```

4.15.3.16 getTileOptionsSubstring()

```

std::string WindTurbine::getTileOptionsSubstring (
    void ) [virtual]

```

Helper method to assemble and return tile options substring.

Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

849 {
850     //          32 char x 17 line console "-----\n";
851     std::string options_substring = "CAPACITY: ";
852     options_substring += std::to_string(this->capacity_kW);
853     options_substring += " kW (level ";
854     options_substring += std::to_string(this->upgrade_level);
855     options_substring += ")\n";
856
857     options_substring += "PRODUCTION: ";
858     options_substring += std::to_string(this->production_MWh);
859     options_substring += " MWh\n";
860
861     options_substring += "DISPATCHABLE: ";
862     options_substring += std::to_string(this->dispatchable_MWh);
863     options_substring += " MWh\n";
864
865     options_substring += "HEALTH: ";
866     options_substring += std::to_string(this->health);
867     options_substring += "/100";
868
869     if (this->health <= 0) {
870         options_substring += " ** BROKEN! **\n";
871     }
872
873     else {
874         options_substring += "\n";
875     }
876
877     options_substring += "
878     options_substring += " **** WIND TURBINE OPTIONS ****
879     options_substring += "
880
881     if (this->is_broken) {
882         options_substring += " [R]: REPAIR (";
883         options_substring += std::to_string(WIND_TURBINE_BUILD_COST);
884         options_substring += " K)\n";
885     }
886
887     else {
888         options_substring += " [E]: OPEN PRODUCTION MENU \n";
889     }
890
891     options_substring += " [U]: OPEN UPGRADE MENU \n";
892     options_substring += "HOLD [P]: SCRAP (";
893     options_substring += std::to_string(SCRAP_COST);
894     options_substring += " K)";
895
896     return options_substring;
897 }    /* getTileOptionsSubstring() */

```

4.15.3.17 processEvent()

```
void WindTurbine::processEvent (
    void ) [virtual]
```

Method to process [WindTurbine](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```
1019 {
1020     TileImprovement :: processEvent();
1021
1022     if (this->event_ptr->type == sf::Event::KeyPressed) {
1023         this->__handleKeyPressEvents();
1024     }
1025
1026     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1027         this->__handleMouseButtonEvents();
1028     }
1029
1030     return;
1031 } /* processEvent() */
```

4.15.3.18 processMessage()

```
void WindTurbine::processMessage (
    void ) [virtual]
```

Method to process [WindTurbine](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```
1046 {
1047     TileImprovement :: processMessage();
1048
1049     //...
1050
1051     return;
1052 } /* processMessage() */
```

4.15.3.19 setIsSelected()

```
void WindTurbine::setIsSelected (
    bool is_selected ) [virtual]
```

Method to set the is selected attribute.

Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```
914 {
915     TileImprovement :: setIsSelected(is_selected);
916
917     if (this->is_running and this->is_selected) {
918         this->assets_manager_ptr->getSound("wind turbine running")->play();
919     }
920 }
```

```

921     return;
922 } /* setIsSelected() */

```

4.15.3.20 update()

```

void WindTurbine::update (
    void ) [virtual]

```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```

992 {
993     std::cout << "WindTurbine :: update()" << std::endl;
994
995     this->__computeProduction();
996     this->__computeProductionCosts();
997     this->__computeDispatch();
998
999     if (this->is_selected) {
1000         this->__sendTileStateRequest();
1001     }
1002
1003     return;
1004 } /* update() */

```

4.15.4 Member Data Documentation

4.15.4.1 capacity_factor_vec

```
std::vector<double> WindTurbine::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

4.15.4.2 capacity_kW

```
int WindTurbine::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

4.15.4.3 dispatch_MWh

```
int WindTurbine::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

4.15.4.4 dispatch_vec_MWh

```
std::vector<double> WindTurbine::dispatch_vec_MWh
```

A vector of daily dispatch [MWh] for the current month.

4.15.4.5 dispatchable_MWh

```
int WindTurbine::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

4.15.4.6 max_daily_production_MWh

```
double WindTurbine::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

4.15.4.7 production_MWh

```
int WindTurbine::production_MWh
```

The current production [MWh] of the solar PV array.

4.15.4.8 production_vec_MWh

```
std::vector<double> WindTurbine::production_vec_MWh
```

A vector of daily production [MWh] for the current month.

4.15.4.9 rotor_drotation

```
double WindTurbine::rotor_drotation
```

The rotation rate of the rotor.

The documentation for this class was generated from the following files:

- header/[WindTurbine.h](#)
- source/[WindTurbine.cpp](#)

Chapter 5

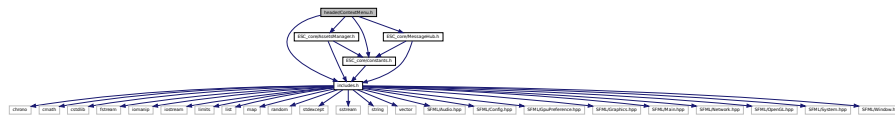
File Documentation

5.1 header/ContextMenu.h File Reference

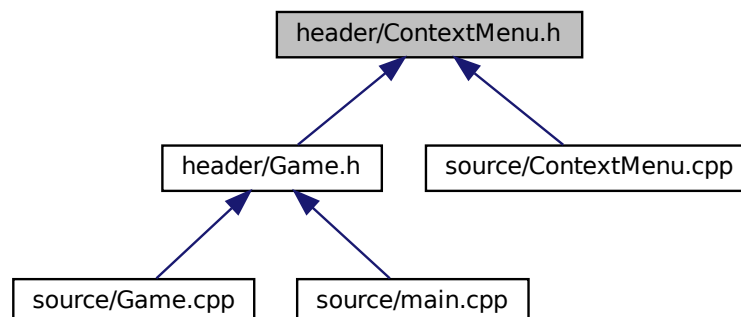
Header file for the [ContextMenu](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
```

Include dependency graph for ContextMenu.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [ContextMenu](#)

A class which defines a context menu for the game.

Enumerations

- enum [ConsoleState](#) {
[NONE_STATE](#) , [READY](#) , [MENU](#) , [TILE](#) ,
[N_CONSOLE_STATES](#) }

An enumeration of the different console screen states.

5.1.1 Detailed Description

Header file for the [ContextMenu](#) class.

5.1.2 Enumeration Type Documentation

5.1.2.1 ConsoleState

enum [ConsoleState](#)

An enumeration of the different console screen states.

Enumerator

NONE_STATE	None state (for initialization)
READY	Ready (default) state.
MENU	Game menu state.
TILE	Tile context state.
N_CONSOLE_STATES	A simple hack to get the number of console screen states.

```

68         {
69     NONE\_STATE,
70     READY,
71     MENU,
72     TILE,
73     N\_CONSOLE\_STATES
74 };

```

5.2 header/DieselGenerator.h File Reference

Header file for the [DieselGenerator](#) class.

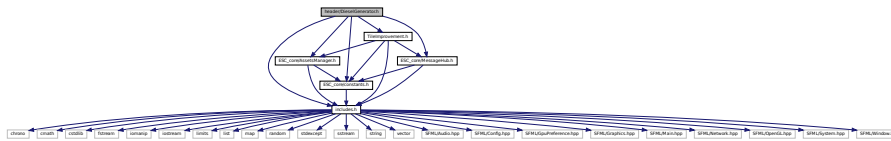
```

#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"

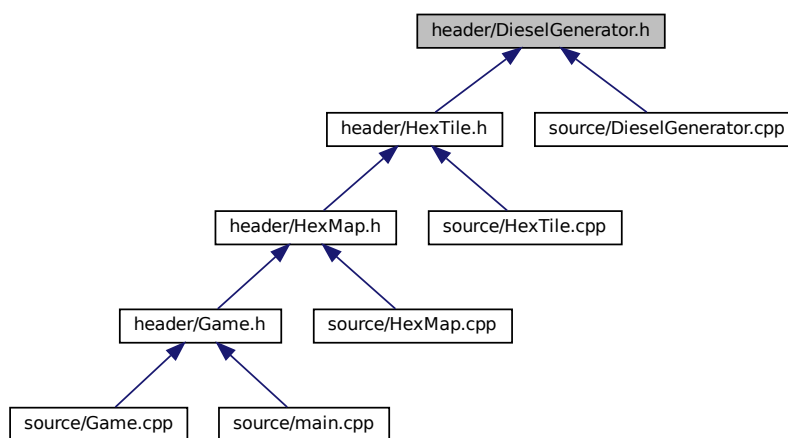
```

```
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"
```

Include dependency graph for DieselGenerator.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [DieselGenerator](#)
A settlement class (child class of [TileImprovement](#)).

5.2.1 Detailed Description

Header file for the [DieselGenerator](#) class.

5.3 header/EnergyStorageSystem.h File Reference

Header file for the [EnergyStorageSystem](#) class. DEPRECATED / NOT USED.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
```


[illegible]

- class `AssetsManager`
A class which manages visual and sound assets.

Header file for the `AssetsManager` class.

Header file for various constants.

[illegible][illegible]

Functions

- const sf::Color [FOREST_GREEN](#) (34, 139, 34)
The base colour of a forest tile.
- const sf::Color [LAKE_BLUE](#) (0, 102, 204)
The base colour of a lake (water) tile.
- const sf::Color [MOUNTAINS_GREY](#) (97, 110, 113)
The base colour of a mountains tile.
- const sf::Color [OCEAN_BLUE](#) (0, 51, 102)
The base colour of an ocean (water) tile.
- const sf::Color [PLAINS_YELLOW](#) (245, 222, 133)
The base colour of a plains tile.
- const sf::Color [RESOURCE_CHIP_GREY](#) (175, 175, 175, 250)
The base colour of the resource chip (backing).
- const sf::Color [MENU_FRAME_GREY](#) (185, 187, 182)
The base colour of the context menu frame.
- const sf::Color [MONOCHROME_SCREEN_BACKGROUND](#) (40, 40, 40)
The base colour of old monochrome screens.
- const sf::Color [VISUAL_SCREEN_FRAME_GREY](#) (151, 151, 143)
The base colour of the framing of the visual screen.
- const sf::Color [MONOCHROME_TEXT_GREEN](#) (0, 255, 102)
The base colour of old monochrome text (green).
- const sf::Color [MONOCHROME_TEXT_AMBER](#) (255, 176, 0)
The base colour of old monochrome text (amber).
- const sf::Color [MONOCHROME_TEXT_RED](#) (255, 44, 0)
The base colour of old monochrome text (red).

Variables

- const double [FLOAT_TOLERANCE](#) = 1e-6
Tolerance for floating point equality tests.
- const unsigned long long int [SECONDS_PER_YEAR](#) = 31537970
- const unsigned long long int [SECONDS_PER_MONTH](#) = 2628164
- const int [FRAMES_PER_SECOND](#) = 60
Target frames per second.
- const double [SECONDS_PER_FRAME](#) = 1.0 / 60
Target seconds per frame (just reciprocal of target frames per second).
- const int [GAME_WIDTH](#) = 1200
Width of the game space.
- const int [GAME_HEIGHT](#) = 800
Height of the game space.
- const std::vector< double > [TILE_TYPE_CUMULATIVE_PROBABILITIES](#)
Cumulative probabilities for each tile type (to support procedural generation).
- const std::vector< double > [TILE_RESOURCE_CUMULATIVE_PROBABILITIES](#)
Cumulative probabilities for each tile resource (to support procedural generation).
- const std::string [TILE_SELECTED_CHANNEL](#) = "TILE SELECTED CHANNEL"
A message channel for tile selection messages.
- const std::string [NO_TILE_SELECTED_CHANNEL](#) = "NO TILE SELECTED CHANNEL"
A message channel for no tile selected messages.
- const std::string [TILE_STATE_CHANNEL](#) = "TILE STATE CHANNEL"

- A message channel for tile state messages.*
- const std::string `HEX_MAP_CHANNEL` = "HEX MAP CHANNEL"
- A message channel for hex map messages.*
- const std::string `SETTLEMENT_CHANNEL` = "SETTLEMENT CHANNEL"
- A message channel for the settlement.*
- const int `CLEAR_FOREST_COST` = 160
- The cost of clearing a forest tile.*
- const int `CLEAR_MOUNTAINS_COST` = 500
- The cost of clearing a mountains tile.*
- const int `CLEAR_PLAINS_COST` = 80
- The cost of clearing a plains tile.*
- const int `DIESEL_GENERATOR_BUILD_COST` = 200
- The cost of building (or upgrading) a diesel generator in 200 kW increments.*
- const int `WIND_TURBINE_BUILD_COST` = 450
- The cost of building (or upgrading) a wind turbine in 100 kW increments.*
- const double `WIND_TURBINE_WATER_BUILD_MULTIPLIER` = 1.222222
- The additional cost of building on water.*
- const int `SOLAR_PV_BUILD_COST` = 350
- The cost of building (or upgrading) a solar PV array in 100 kW increments.*
- const double `SOLAR_PV_WATER_BUILD_MULTIPLIER` = 1.285714
- The additional cost of building on water.*
- const int `TIDAL_TURBINE_BUILD_COST` = 550
- The cost of building (or upgrading) a tidal turbine in 100 kW increments.*
- const int `WAVE_ENERGY_CONVERTER_BUILD_COST` = 850
- The cost of building (or upgrading) a wave energy converter in 100 kW increments.*
- const int `ENERGY_STORAGE_SYSTEM_BUILD_COST` = 160
- The cost of adding energy storage in 200 kWh increments.*
- const double `BREAKDOWN_PROBABILITY_INCREMENT` = 0.01
- The amount by which equipment breakdown probability is incremented for each point of health below 50.*
- const int `SCRAP_COST` = 50
- The cost of scrapping a tile improvement (other than settlement).*
- const int `MAX_UPGRADE_LEVELS` = 5
- The maximum upgrade level of any tile improvement.*
- const int `MAX_STORAGE_LEVELS` = 5
- The maximum storage level of any tile improvement.*
- const int `STARTING_CREDITS` = 800
- The starting balance of credits.*
- const double `CREDITS_PER_MWH_SERVED` = 1.125
- The number of credits (x1000) earned.*
- const int `EMISSIONS_LIFETIME_LIMIT_TONNES` = 2000
- The lifetime limit on CO2-equivalent emissions (1 tonne CO2e ~ = 667 L diesel).*
- const int `RESOURCE_ASSESSMENT_COST` = 20
- The cost of doing a resource assessment.*
- const int `BUILD_SETTLEMENT_COST` = 250
- The cost of building a settlement.*
- const int `STARTING_POPULATION` = 100
- The starting population of a settlement.*
- const double `MEAN_POPULATION_GROWTH_RATE` = 0.020
- The mean monthly population growth rate.*
- const double `STDEV_POPULATION_GROWTH_RATE` = 0.005
- The standard deviation in monthly population growth rate.*

- const double `LITRES_DIESEL_PER_MWH_PRODUCTION` = 375
The litres of diesel consumed in producing 1 MWh (assumes higher heating value and constant thermal efficiency of ~0.25).
- const double `COST_PER_LITRE_DIESEL` = 1.75
The cost of a litre of diesel.
- const double `KG_CO2E_PER_LITRE_DIESEL` = 3.16
The CO2-equivalent mass of emissions that result from burning one litre of diesel fuel.
- const double `DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION` = 50
The operation and maintenance cost of running a diesel generator (assumed 0.05 credits per kWh produced).
- const double `SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION` = 10
The operation and maintenance cost of running a solar PV array (assumed 0.01 credits per kWh produced).
- const double `TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION` = 50
The operation and maintenance cost of running a tidal turbine (assumed 0.05 credits per kWh produced).
- const double `WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION` = 50
The operation and maintenance cost of running a wave energy converter (assumed 0.05 credits per kWh produced).
- const double `WIND_OP_MAINT_COST_PER_MWH_PRODUCTION` = 50
The operation and maintenance cost of running a wind turbine (assumed 0.05 credits per kWh produced).
- const std::vector< double > `MEAN_DAILY_DEMAND_RATIOS`
The mean daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply (24)(max load [kW]) / 1000.
- const std::vector< double > `STDEV_DAILY_DEMAND_RATIOS`
The standard deviation in daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply (24)(max load [kW]) / 1000.
- const double `MAXIMUM_DAILY_DEMAND_PER_CAPITA` = 0.05
The maximum daily demand [MWh] (at any point in the year) per capita.
- const std::vector< double > `MEAN_DAILY_SOLAR_CAPACITY_FACTORS`
The mean daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.
- const std::vector< double > `STDEV_DAILY_SOLAR_CAPACITY_FACTORS`
The standard deviation in daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.
- const double `DAILY_TIDAL_CAPACITY_FACTOR` = 0.225
The daily tidal capacity factor, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000. The tides are not a random process (usually semi-diurnal, mostly driven by orbits of moon and sun).
- const std::vector< double > `MEAN_DAILY_WAVE_CAPACITY_FACTORS`
The mean daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.
- const std::vector< double > `STDEV_DAILY_WAVE_CAPACITY_FACTORS`
The standard deviation in daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.
- const std::vector< double > `MEAN_DAILY_WIND_CAPACITY_FACTORS`
The mean daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.
- const std::vector< double > `STDEV_DAILY_WIND_CAPACITY_FACTORS`
The standard deviation in daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.
- const std::string `GAME_CHANNEL` = "GAME CHANNEL"
A message channel for game messages.
- const std::string `GAME_STATE_CHANNEL` = "GAME STATE CHANNEL"
A message channel for game state messages.
- const std::vector< std::string > `TUTORIAL_PAGES`

5.5.1 Detailed Description

Header file for various constants.

5.5.2 Function Documentation

5.5.2.1 FOREST_GREEN()

```
const sf::Color FOREST_GREEN (
    34 ,
    139 ,
    34 )
```

The base colour of a forest tile.

5.5.2.2 LAKE_BLUE()

```
const sf::Color LAKE_BLUE (
    0 ,
    102 ,
    204 )
```

The base colour of a lake (water) tile.

5.5.2.3 MENU_FRAME_GREY()

```
const sf::Color MENU_FRAME_GREY (
    185 ,
    187 ,
    182 )
```

The base colour of the context menu frame.

5.5.2.4 MONOCHROME_SCREEN_BACKGROUND()

```
const sf::Color MONOCHROME_SCREEN_BACKGROUND (
    40 ,
    40 ,
    40 )
```

The base colour of old monochrome screens.

5.5.2.5 MONOCHROME_TEXT_AMBER()

```
const sf::Color MONOCHROME_TEXT_AMBER (
    255 ,
    176 ,
    0 )
```

The base colour of old monochrome text (amber).

5.5.2.6 MONOCHROME_TEXT_GREEN()

```
const sf::Color MONOCHROME_TEXT_GREEN (
    0 ,
    255 ,
    102 )
```

The base colour of old monochrome text (green).

5.5.2.7 MONOCHROME_TEXT_RED()

```
const sf::Color MONOCHROME_TEXT_RED (
    255 ,
    44 ,
    0 )
```

The base colour of old monochrome text (red).

5.5.2.8 MOUNTAINS_GREY()

```
const sf::Color MOUNTAINS_GREY (
    97 ,
    110 ,
    113 )
```

The base colour of a mountains tile.

5.5.2.9 OCEAN_BLUE()

```
const sf::Color OCEAN_BLUE (
    0 ,
    51 ,
    102 )
```

The base colour of an ocean (water) tile.

5.5.2.10 PLAINS_YELLOW()

```
const sf::Color PLAINS_YELLOW (
    245 ,
    222 ,
    133 )
```

The base colour of a plains tile.

5.5.2.11 RESOURCE_CHIP_GREY()

```
const sf::Color RESOURCE_CHIP_GREY (
    175 ,
    175 ,
    175 ,
    250 )
```

The base colour of the resource chip (backing).

5.5.2.12 VISUAL_SCREEN_FRAME_GREY()

```
const sf::Color VISUAL_SCREEN_FRAME_GREY (
    151 ,
    151 ,
    143 )
```

The base colour of the framing of the visual screen.

5.5.3 Variable Documentation

5.5.3.1 BREAKDOWN_PROBABILITY_INCREMENT

```
const double BREAKDOWN_PROBABILITY_INCREMENT = 0.01
```

The amount by which equipment breakdown probability is incremented for each point of health below 50.

5.5.3.2 BUILD_SETTLEMENT_COST

```
const int BUILD_SETTLEMENT_COST = 250
```

The cost of building a settlement.

5.5.3.3 CLEAR_FOREST_COST

```
const int CLEAR_FOREST_COST = 160
```

The cost of clearing a forest tile.

5.5.3.4 CLEAR_MOUNTAINS_COST

```
const int CLEAR_MOUNTAINS_COST = 500
```

The cost of clearing a mountains tile.

5.5.3.5 CLEAR_PLAINS_COST

```
const int CLEAR_PLAINS_COST = 80
```

The cost of clearing a plains tile.

5.5.3.6 COST_PER_LITRE_DIESEL

```
const double COST_PER_LITRE_DIESEL = 1.75
```

The cost of a litre of diesel.

5.5.3.7 CREDITS_PER_MWH_SERVED

```
const double CREDITS_PER_MWH_SERVED = 1.125
```

The number of credits (x1000) earned.

5.5.3.8 DAILY_TIDAL_CAPACITY_FACTOR

```
const double DAILY_TIDAL_CAPACITY_FACTOR = 0.225
```

The daily tidal capacity factor, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000. The tides are not a random process (usually semi-diurnal, mostly driven by orbits of moon and sun).

5.5.3.9 DIESEL_GENERATOR_BUILD_COST

```
const int DIESEL_GENERATOR_BUILD_COST = 200
```

The cost of building (or upgrading) a diesel generator in 200 kW increments.

5.5.3.10 DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION

```
const double DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenance cost of running a diesel generator (assumed 0.05 credits per kWh produced).

5.5.3.11 EMISSIONS_LIFETIME_LIMIT_TONNES

```
const int EMISSIONS_LIFETIME_LIMIT_TONNES = 2000
```

The lifetime limit on CO₂-equivalent emissions (1 tonne CO₂e \approx 667 L diesel).

5.5.3.12 ENERGY_STORAGE_SYSTEM_BUILD_COST

```
const int ENERGY_STORAGE_SYSTEM_BUILD_COST = 160
```

The cost of adding energy storage in 200 kWh increments.

5.5.3.13 FLOAT_TOLERANCE

```
const double FLOAT_TOLERANCE = 1e-6
```

Tolerance for floating point equality tests.

5.5.3.14 FRAMES_PER_SECOND

```
const int FRAMES_PER_SECOND = 60
```

Target frames per second.

5.5.3.15 GAME_CHANNEL

```
const std::string GAME_CHANNEL = "GAME CHANNEL"
```

A message channel for game messages.

5.5.3.16 GAME_HEIGHT

```
const int GAME_HEIGHT = 800
```

Height of the game space.

5.5.3.17 GAME_STATE_CHANNEL

```
const std::string GAME_STATE_CHANNEL = "GAME STATE CHANNEL"
```

A message channel for game state messages.

5.5.3.18 GAME_WIDTH

```
const int GAME_WIDTH = 1200
```

Width of the game space.

5.5.3.19 HEX_MAP_CHANNEL

```
const std::string HEX_MAP_CHANNEL = "HEX MAP CHANNEL"
```

A message channel for hex map messages.

5.5.3.20 KG_CO2E_PER_LITRE_DIESEL

```
const double KG_CO2E_PER_LITRE_DIESEL = 3.16
```

The CO2-equivalent mass of emissions that result from burning one litre of diesel fuel.

5.5.3.21 LITRES_DIESEL_PER_MWH_PRODUCTION

```
const double LITRES_DIESEL_PER_MWH_PRODUCTION = 375
```

The litres of diesel consumed in producing 1 MWh (assumes higher heating value and constant thermal efficiency of ~ 0.25).

5.5.3.22 MAX_STORAGE_LEVELS

```
const int MAX_STORAGE_LEVELS = 5
```

The maximum storage level of any tile improvement.

5.5.3.23 MAX_UPGRADE_LEVELS

```
const int MAX_UPGRADE_LEVELS = 5
```

The maximum upgrade level of any tile improvement.

5.5.3.24 MAXIMUM_DAILY_DEMAND_PER_CAPITA

```
const double MAXIMUM_DAILY_DEMAND_PER_CAPITA = 0.05
```

The maximum daily demand [MWh] (at any point in the year) per capita.

5.5.3.25 MEAN_DAILY_DEMAND_RATIOS

```
const std::vector<double> MEAN_DAILY_DEMAND_RATIOS
```

Initial value:

```
= {  
    0.702, 0.704, 0.652,  
    0.546, 0.445, 0.362,  
    0.261, 0.261, 0.379,  
    0.518, 0.622, 0.716  
}
```

The mean daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply $(24)(\text{max load [kW]}) / 1000$.

5.5.3.26 MEAN_DAILY_SOLAR_CAPACITY_FACTORS

```
const std::vector<double> MEAN_DAILY_SOLAR_CAPACITY_FACTORS
```

Initial value:

```
= {  
    0.029, 0.061, 0.117,  
    0.183, 0.228, 0.233,  
    0.219, 0.185, 0.139,  
    0.081, 0.040, 0.021  
}
```

The mean daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

5.5.3.27 MEAN_DAILY_WAVE_CAPACITY_FACTORS

```
const std::vector<double> MEAN_DAILY_WAVE_CAPACITY_FACTORS
```

Initial value:

```
= {  
    0.742, 0.694, 0.618,  
    0.467, 0.366, 0.292,  
    0.280, 0.293, 0.374,  
    0.424, 0.662, 0.600  
}
```

The mean daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

5.5.3.28 MEAN_DAILY_WIND_CAPACITY_FACTORS

```
const std::vector<double> MEAN_DAILY_WIND_CAPACITY_FACTORS
```

Initial value:

```
= {  
    0.591, 0.594, 0.627,  
    0.629, 0.579, 0.537,  
    0.442, 0.507, 0.587,  
    0.618, 0.611, 0.580  
}
```

The mean daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

5.5.3.29 MEAN_POPULATION_GROWTH_RATE

```
const double MEAN_POPULATION_GROWTH_RATE = 0.020
```

The mean monthly population growth rate.

5.5.3.30 NO_TILE_SELECTED_CHANNEL

```
const std::string NO_TILE_SELECTED_CHANNEL = "NO TILE SELECTED CHANNEL"
```

A message channel for no tile selected messages.

5.5.3.31 RESOURCE_ASSESSMENT_COST

```
const int RESOURCE_ASSESSMENT_COST = 20
```

The cost of doing a resource assessment.

5.5.3.32 SCRAP_COST

```
const int SCRAP_COST = 50
```

The cost of scrapping a tile improvement (other than settlement).

5.5.3.33 SECONDS_PER_FRAME

```
const double SECONDS_PER_FRAME = 1.0 / 60
```

Target seconds per frame (just reciprocal of target frames per second).

5.5.3.34 SECONDS_PER_MONTH

```
const unsigned long long int SECONDS_PER_MONTH = 2628164
```

5.5.3.35 SECONDS_PER_YEAR

```
const unsigned long long int SECONDS_PER_YEAR = 31537970
```

5.5.3.36 SETTLEMENT_CHANNEL

```
const std::string SETTLEMENT_CHANNEL = "SETTLEMENT CHANNEL"
```

A message channel for the settlement.

5.5.3.37 SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION

```
const double SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION = 10
```

The operation and maintenance cost of running a solar PV array (assumed 0.01 credits per kWh produced).

5.5.3.38 SOLAR_PV_BUILD_COST

```
const int SOLAR_PV_BUILD_COST = 350
```

The cost of building (or upgrading) a solar PV array in 100 kW increments.

5.5.3.39 SOLAR_PV_WATER_BUILD_MULTIPLIER

```
const double SOLAR_PV_WATER_BUILD_MULTIPLIER = 1.285714
```

The additional cost of building on water.

5.5.3.40 STARTING_CREDITS

```
const int STARTING_CREDITS = 800
```

The starting balance of credits.

5.5.3.41 STARTING_POPULATION

```
const int STARTING_POPULATION = 100
```

The starting population of a settlement.

5.5.3.42 STDEV_DAILY_DEMAND_RATIOS

```
const std::vector<double> STDEV_DAILY_DEMAND_RATIOS
```

Initial value:

```
= {  
    0.069, 0.074, 0.072,  
    0.072, 0.063, 0.060,  
    0.012, 0.031, 0.040,  
    0.049, 0.063, 0.053  
}
```

The standard deviation in daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply (24)(max load [kW]) / 1000.

5.5.3.43 STDEV_DAILY_SOLAR_CAPACITY_FACTORS

```
const std::vector<double> STDEV_DAILY_SOLAR_CAPACITY_FACTORS
```

Initial value:

```
= {  
    0.013, 0.024, 0.043,  
    0.049, 0.072, 0.072,  
    0.076, 0.065, 0.048,  
    0.026, 0.018, 0.009  
}
```

The standard deviation in daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

5.5.3.44 STDEV_DAILY_WAVE_CAPACITY_FACTORS

```
const std::vector<double> STDEV_DAILY_WAVE_CAPACITY_FACTORS
```

Initial value:

```
= {  
    0.146, 0.135, 0.163,  
    0.145, 0.158, 0.106,  
    0.086, 0.058, 0.145,  
    0.171, 0.184, 0.309  
}
```

The standard deviation in daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

5.5.3.45 STDEV_DAILY_WIND_CAPACITY_FACTORS

```
const std::vector<double> STDEV_DAILY_WIND_CAPACITY_FACTORS
```

Initial value:

```
= {  
    0.147, 0.142, 0.198,  
    0.154, 0.162, 0.202,  
    0.180, 0.217, 0.198,  
    0.168, 0.141, 0.168  
}
```

The standard deviation in daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

5.5.3.46 STDEV_POPULATION_GROWTH_RATE

```
const double STDEV_POPULATION_GROWTH_RATE = 0.005
```

The standard deviation in monthly population growth rate.

5.5.3.47 TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION

```
const double TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenance cost of running a tidal turbine (assumed 0.05 credits per kWh produced).

5.5.3.48 TIDAL_TURBINE_BUILD_COST

```
const int TIDAL_TURBINE_BUILD_COST = 550
```

The cost of building (or upgrading) a tidal turbine in 100 kW increments.

5.5.3.49 TILE_RESOURCE_CUMULATIVE_PROBABILITIES

```
const std::vector<double> TILE_RESOURCE_CUMULATIVE_PROBABILITIES
```

Initial value:

```
= {  
    0.10,  
    0.30,  
    0.70,  
    0.90,  
    1.00  
}
```

Cumulative probabilities for each tile resource (to support procedural generation).

5.5.3.50 TILE_SELECTED_CHANNEL

```
const std::string TILE_SELECTED_CHANNEL = "TILE SELECTED CHANNEL"
```

A message channel for tile selection messages.

5.5.3.51 TILE_STATE_CHANNEL

```
const std::string TILE_STATE_CHANNEL = "TILE STATE CHANNEL"
```

A message channel for tile state messages.

5.5.3.52 TILE_TYPE_CUMULATIVE_PROBABILITIES

```
const std::vector<double> TILE_TYPE_CUMULATIVE_PROBABILITIES
```

Initial value:

```
= {  
    0.25,  
    0.50,  
    0.75,  
    1.00  
}
```

Cumulative probabilities for each tile type (to support procedural generation).

5.5.3.53 TUTORIAL_PAGES

```
const std::vector<std::string> TUTORIAL_PAGES
```

5.5.3.54 WAVE_ENERGY_CONVERTER_BUILD_COST

```
const int WAVE_ENERGY_CONVERTER_BUILD_COST = 850
```

The cost of building (or upgrading) a wave energy converter in 100 kW increments.

5.5.3.55 WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION

```
const double WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenance cost of running a wave energy converter (assumed 0.05 credits per kWh produced).

5.5.3.56 WIND_OP_MAINT_COST_PER_MWH_PRODUCTION

```
const double WIND_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenance cost of running a wind turbine (assumed 0.05 credits per kWh produced).

5.5.3.57 WIND_TURBINE_BUILD_COST

```
const int WIND_TURBINE_BUILD_COST = 450
```

The cost of building (or upgrading) a wind turbine in 100 kW increments.

5.5.3.58 WIND_TURBINE_WATER_BUILD_MULTIPLIER

```
const double WIND_TURBINE_WATER_BUILD_MULTIPLIER = 1.222222
```

The additional cost of building on water.

5.6 header/ESC_core/doxygen_cite.h File Reference

Header file which simply cites the doxygen tool.

5.6.1 Detailed Description

Header file which simply cites the doxygen tool.

Ref: [van Heesch. \[2023\]](#)

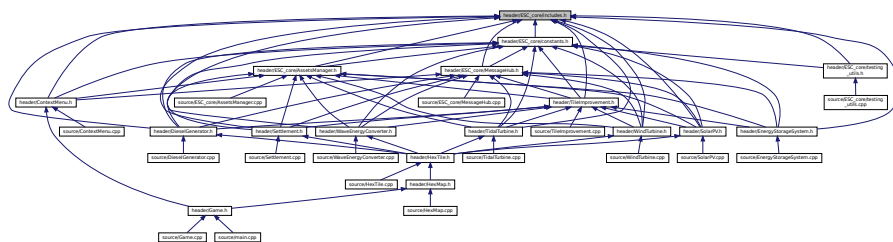
5.7 header/ESC_core/includes.h File Reference

Header file for various includes.

```
#include <chrono>
#include <cmath>
#include <cstdlib>
#include <fstream>
#include <iomanip>
#include <iostream>
#include <limits>
#include <list>
#include <map>
#include <random>
#include <stdexcept>
#include <sstream>
#include <string>
#include <vector>
#include <SFML/Audio.hpp>
#include <SFML/Config.hpp>
#include <SFML/GpuPreference.hpp>
#include <SFML/Graphics.hpp>
#include <SFML/Main.hpp>
#include <SFML/Network.hpp>
#include <SFML/OpenGL.hpp>
#include <SFML/System.hpp>
#include <SFML/Window.hpp>
Include dependency graph for includes.h:
```



This graph shows which files directly or indirectly include this file:

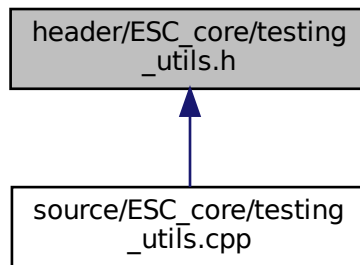


5.7.1 Detailed Description

Header file for various includes.

Ref: [Gomila \[2023\]](#)

This graph shows which files directly or indirectly include this file:



Functions

- void [printGreen](#) (std::string)
A function that sends green text to std::cout.
- void [printGold](#) (std::string)
A function that sends gold text to std::cout.
- void [printRed](#) (std::string)
A function that sends red text to std::cout.
- void [testFloatEquals](#) (double, double, std::string, int)
Tests for the equality of two floating point numbers x and y (to within `FLOAT_TOLERANCE`).
- void [testGreaterThan](#) (double, double, std::string, int)
Tests if $x > y$.
- void [testGreaterThanOrEqualTo](#) (double, double, std::string, int)
Tests if $x \geq y$.
- void [testLessThan](#) (double, double, std::string, int)
Tests if $x < y$.
- void [testLessThanOrEqualTo](#) (double, double, std::string, int)
Tests if $x \leq y$.
- void [testTruth](#) (bool, std::string, int)
Tests if the given statement is true.
- void [expectedErrorNotDetected](#) (std::string, int)
A utility function to print out a meaningful error message whenever an expected error fails to be thrown/caught/detected.

5.9.1 Detailed Description

Header file for various testing utilities.

This is a library of utility functions used throughout the various test suites.

5.9.2 Function Documentation

5.9.2.1 expectedErrorNotDetected()

```
void expectedErrorNotDetected (
    std::string file,
    int line )
```

A utility function to print out a meaningful error message whenever an expected error fails to be thrown/caught/detected.

Parameters

<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```
434 {
435     std::string error_str = "\n ERROR   failed to throw expected error prior to line ";
436     error_str += std::to_string(line);
437     error_str += " of ";
438     error_str += file;
439
440     #ifdef _WIN32
441         std::cout << error_str << std::endl;
442     #endif
443
444     throw std::runtime_error(error_str);
445     return;
446 } /* expectedErrorNotDetected() */
```

5.9.2.2 printGold()

```
void printGold (
    std::string input_str )
```

A function that sends gold text to std::cout.

Parameters

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```
86 {
87     std::cout << "\x1B[33m" << input_str << "\033[0m";
88     return;
89 } /* printGold() */
```

5.9.2.3 printGreen()

```
void printGreen (
    std::string input_str )
```

A function that sends green text to std::cout.

Parameters

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```

66 {
67     std::cout << "\x1B[32m" << input_str << "\033[0m";
68     return;
69 } /* printGreen() */

```

5.9.2.4 printRed()

```

void printRed (
    std::string input_str )

```

A function that sends red text to std::cout.

Parameters

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```

106 {
107     std::cout << "\x1B[31m" << input_str << "\033[0m";
108     return;
109 } /* printRed() */

```

5.9.2.5 testFloatEquals()

```

void testFloatEquals (
    double x,
    double y,
    std::string file,
    int line )

```

Tests for the equality of two floating point numbers *x* and *y* (to within FLOAT_TOLERANCE).

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

140 {
141     if (fabs(x - y) <= FLOAT_TOLERANCE) {
142         return;
143     }
144
145     std::string error_str = "ERROR: testFloatEquals():\t in ";
146     error_str += file;
147     error_str += "\tline ";
148     error_str += std::to_string(line);
149     error_str += ":\t\n";
150     error_str += std::to_string(x);
151     error_str += " and ";
152     error_str += std::to_string(y);
153     error_str += " are not equal to within +/- ";
154     error_str += std::to_string(FLOAT_TOLERANCE);
155     error_str += "\n";
156
157     #ifdef _WIN32
158         std::cout << error_str << std::endl;
159     #endif

```

```

160
161     throw std::runtime_error(error_str);
162     return;
163 } /* testFloatEquals() */

```

5.9.2.6 testGreaterThan()

```

void testGreaterThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if $x > y$.

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

193 {
194     if (x > y) {
195         return;
196     }
197
198     std::string error_str = "ERROR: testGreaterThan():\t in ";
199     error_str += file;
200     error_str += "\tline ";
201     error_str += std::to_string(line);
202     error_str += ":\t\n";
203     error_str += std::to_string(x);
204     error_str += " is not greater than ";
205     error_str += std::to_string(y);
206     error_str += "\n";
207
208     #ifdef _WIN32
209         std::cout << error_str << std::endl;
210     #endif
211
212     throw std::runtime_error(error_str);
213     return;
214 } /* testGreaterThan() */

```

5.9.2.7 testGreaterThanOrEqualTo()

```

void testGreaterThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if $x \geq y$.

Parameters

<i>x</i>	The first of two numbers to test.
----------	-----------------------------------

Parameters

<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

244 {
245     if (x >= y) {
246         return;
247     }
248
249     std::string error_str = "ERROR: testGreaterThanOrEqualTo():\t in ";
250     error_str += file;
251     error_str += "\tline ";
252     error_str += std::to_string(line);
253     error_str += ":\t\n";
254     error_str += std::to_string(x);
255     error_str += " is not greater than or equal to ";
256     error_str += std::to_string(y);
257     error_str += "\n";
258
259     #ifdef _WIN32
260         std::cout << error_str << std::endl;
261     #endif
262
263     throw std::runtime_error(error_str);
264     return;
265 } /* testGreaterThanOrEqualTo() */

```

5.9.2.8 testLessThan()

```

void testLessThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if $x < y$.

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

295 {
296     if (x < y) {
297         return;
298     }
299
300     std::string error_str = "ERROR: testLessThan():\t in ";
301     error_str += file;
302     error_str += "\tline ";
303     error_str += std::to_string(line);
304     error_str += ":\t\n";
305     error_str += std::to_string(x);
306     error_str += " is not less than ";
307     error_str += std::to_string(y);
308     error_str += "\n";
309
310     #ifdef _WIN32
311         std::cout << error_str << std::endl;
312     #endif
313
314     throw std::runtime_error(error_str);
315     return;

```

```
316 }    /* testLessThan() */
```

5.9.2.9 testLessThanOrEqualTo()

```
void testLessThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )
```

Tests if $x \leq y$.

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```
346 {
347     if (x <= y) {
348         return;
349     }
350
351     std::string error_str = "ERROR: testLessThanOrEqualTo():\t in ";
352     error_str += file;
353     error_str += "\tline ";
354     error_str += std::to_string(line);
355     error_str += ":\t\n";
356     error_str += std::to_string(x);
357     error_str += " is not less than or equal to ";
358     error_str += std::to_string(y);
359     error_str += "\n";
360
361     #ifdef _WIN32
362         std::cout << error_str << std::endl;
363     #endif
364
365     throw std::runtime_error(error_str);
366     return;
367 }    /* testLessThanOrEqualTo() */
```

5.9.2.10 testTruth()

```
void testTruth (
    bool statement,
    std::string file,
    int line )
```

Tests if the given statement is true.

Parameters

<i>statement</i>	The statement whose truth is to be tested ("1 == 0", for example).
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").


```

394 {
395     if (statement) {
396         return;
397     }
398
399     std::string error_str = "ERROR: testTruth():\t in ";
400     error_str += file;
401     error_str += "\tline ";
402     error_str += std::to_string(line);
403     error_str += ":\t\n";
404     error_str += "Given statement is not true";
405
406     #ifdef _WIN32
407         std::cout << error_str << std::endl;
408     #endif
409
410     throw std::runtime_error(error_str);
411     return;
412 } /* testTruth() */

```

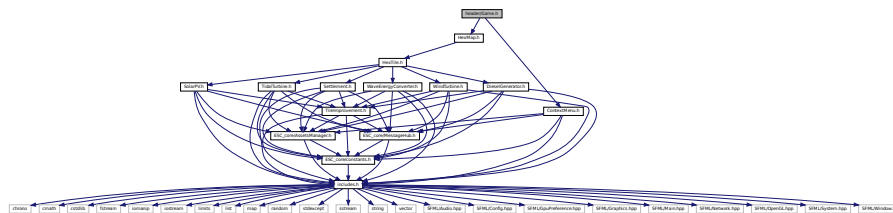
5.10 header/Game.h File Reference

```

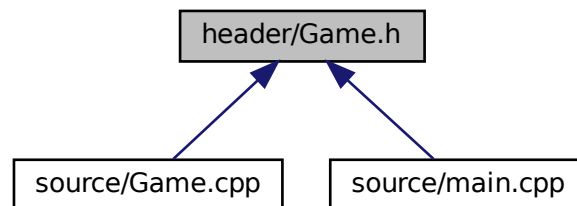
#include "HexMap.h"
#include "ContextMenu.h"

```

Include dependency graph for Game.h:



This graph shows which files directly or indirectly include this file:

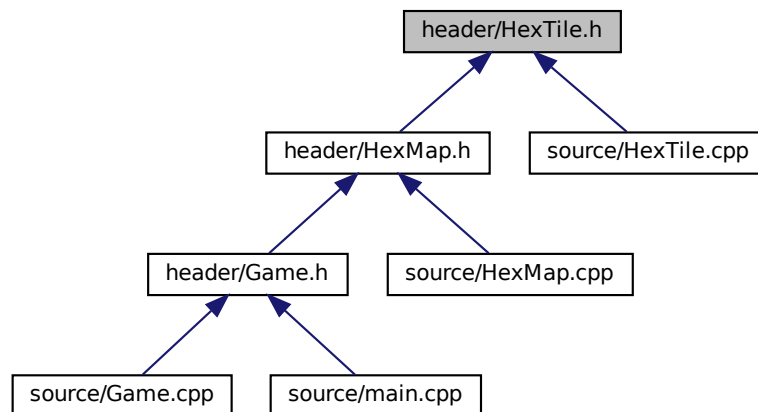


Classes

- class [Game](#)

A class which acts as the central class for the game, by containing all other classes and implementing the game loop.

This graph shows which files directly or indirectly include this file:



Classes

- class [HexTile](#)
A class which defines a hex tile of the hex map.

Enumerations

- enum [TileType](#) {
NONE_TYPE , FOREST , LAKE , MOUNTAINS ,
OCEAN , PLAINS , N_TILE_TYPES }
An enumeration of the different tile types.
- enum [TileResource](#) {
POOR , BELOW_AVERAGE , AVERAGE , ABOVE_AVERAGE ,
GOOD , N_TILE_RESOURCES }
An enumeration of the different tile resource values.

5.12.1 Detailed Description

Header file for the [Game](#) class.

Header file for the [HexTile](#) class.

5.12.2 Enumeration Type Documentation

5.12.2.1 TileResource

enum [TileResource](#)

An enumeration of the different tile resource values.

Enumerator

POOR	A poor resource value.
BELOW_AVERAGE	A below average resource value.
AVERAGE	An average resource value.
ABOVE_AVERAGE	An above average resource value.
GOOD	A good resource value.
N_TILE_RESOURCES	A simple hack to get the number of elements in TileResource.

```

88         {
89     POOR,
90     BELOW_AVERAGE,
91     AVERAGE,
92     ABOVE_AVERAGE,
93     GOOD,
94     N_TILE_RESOURCES
95 }; /* TileResource */

```

5.12.2.2 TileType

```
enum TileType
```

An enumeration of the different tile types.

Enumerator

NONE_TYPE	A dummy tile (for initialization).
FOREST	A forest tile.
LAKE	A lake tile.
MOUNTAINS	A mountains tile.
OCEAN	An ocean tile.
PLAINS	A plains tile.
N_TILE_TYPES	A simple hack to get the number of elements in TileType.

```

71         {
72     NONE_TYPE,
73     FOREST,
74     LAKE,
75     MOUNTAINS,
76     OCEAN,
77     PLAINS,
78     N_TILE_TYPES
79 }; /* TileType */

```

5.13 header/Settlement.h File Reference

Header file for the [Settlement](#) class.

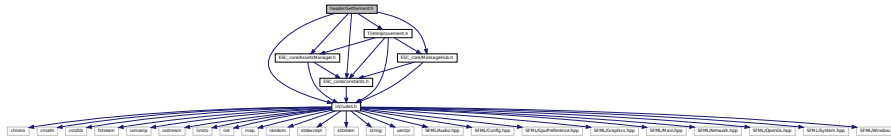
```

#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"

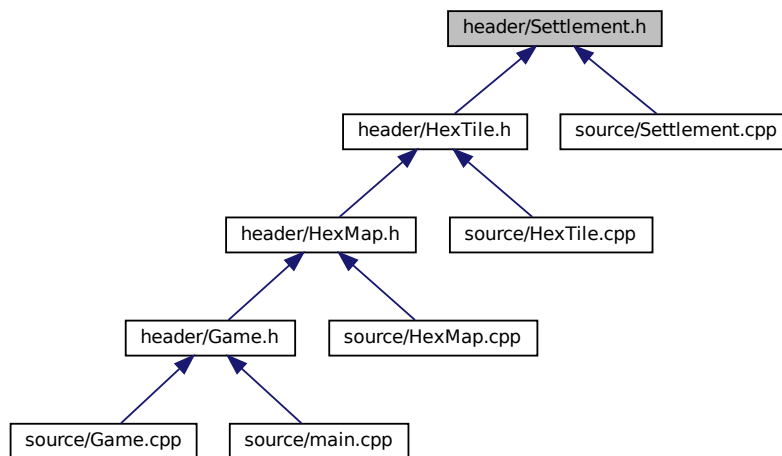
```

```
#include "TileImprovement.h"
```

Include dependency graph for Settlement.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [Settlement](#)
A settlement class (child class of [TileImprovement](#)).

5.13.1 Detailed Description

Header file for the [Settlement](#) class.

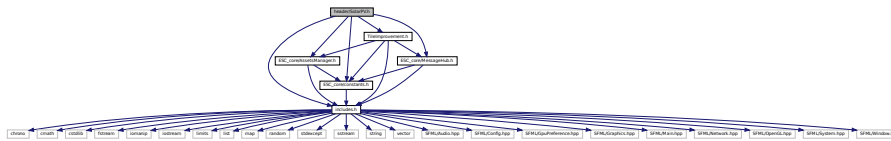
5.14 header/SolarPV.h File Reference

Header file for the [SolarPV](#) class.

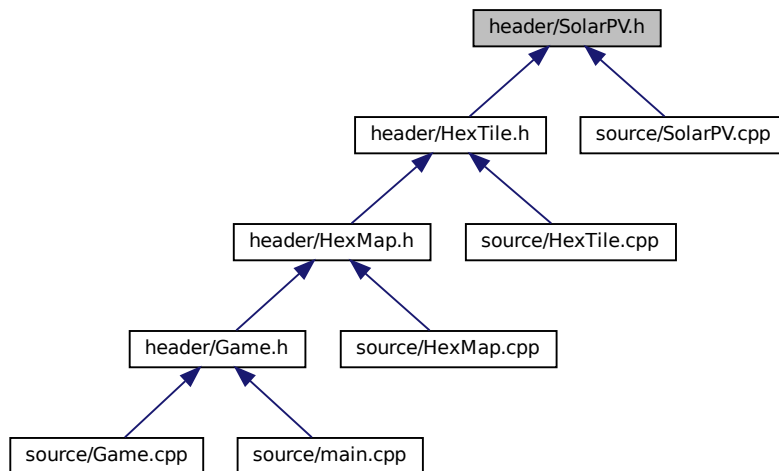
```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
```

```
#include "TileImprovement.h"
```

Include dependency graph for SolarPV.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [SolarPV](#)
A settlement class (child class of [TileImprovement](#)).

5.14.1 Detailed Description

Header file for the [SolarPV](#) class.

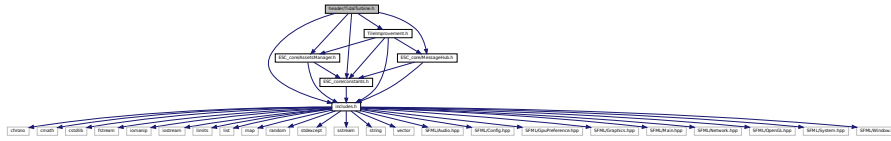
5.15 header/TidalTurbine.h File Reference

Header file for the [TidalTurbine](#) class.

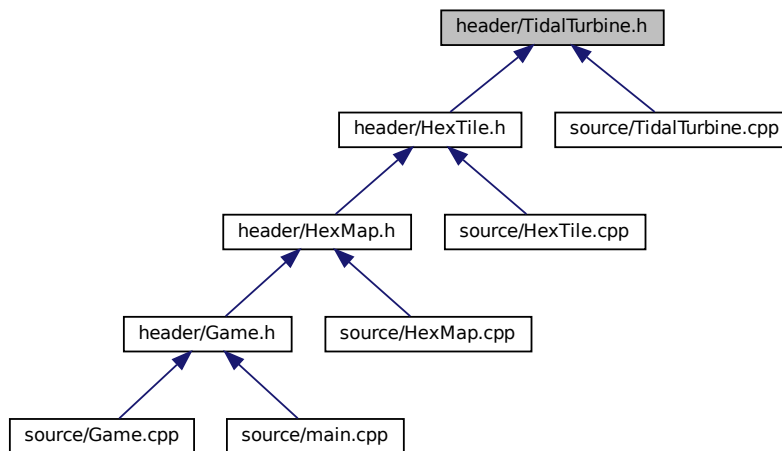
```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
```

```
#include "TileImprovement.h"
```

Include dependency graph for TidalTurbine.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [TidalTurbine](#)

A settlement class (child class of [TileImprovement](#)).

5.15.1 Detailed Description

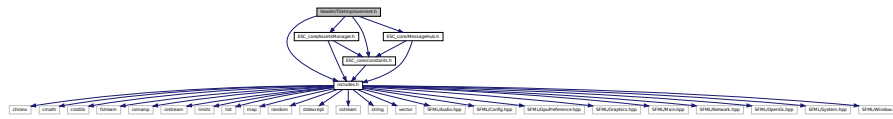
Header file for the [TidalTurbine](#) class.

5.16 header/TileImprovement.h File Reference

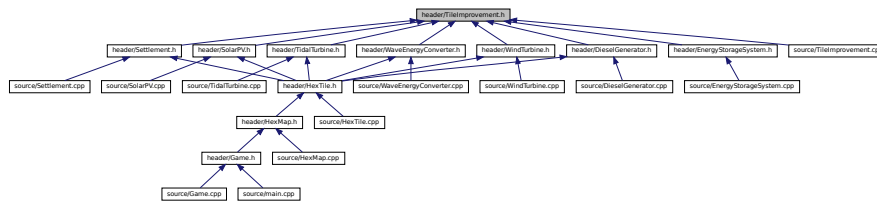
Header file for the [TileImprovement](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
```


Include dependency graph for TileImprovement.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `TileImprovement`
A base class for the tile improvement hierarchy.

Enumerations

- enum `TileImprovementType` {
`SETTLEMENT`, `DIESEL_GENERATOR`, `SOLAR_PV`, `WIND_TURBINE`,
`TIDAL_TURBINE`, `WAVE_ENERGY_CONVERTER`, `N_TILE_IMPROVEMENT_TYPES` }
An enumeration of the different tile improvement types.

5.16.1 Detailed Description

Header file for the `TileImprovement` class.

5.16.2 Enumeration Type Documentation

5.16.2.1 TileImprovementType

```
enum TileImprovementType
```

An enumeration of the different tile improvement types.

Enumerator

SETTLEMENT	A settlement.
DIESEL_GENERATOR	A diesel generator.
SOLAR_PV	A solar PV array.
WIND_TURBINE	A wind turbine.
TIDAL_TURBINE	A tidal turbine.
WAVE_ENERGY_CONVERTER	A wave energy converter.
N_TILE_IMPROVEMENT_TYPES	A simple hack to get the number of elements in TileImprovementType.

```

68         {
69             SETTLEMENT,
70             DIESEL_GENERATOR,
71             SOLAR_PV,
72             WIND_TURBINE,
73             TIDAL_TURBINE,
74             WAVE_ENERGY_CONVERTER,
75             N_TILE_IMPROVEMENT_TYPES
76 }; /* TileImprovementType */

```

5.17 header/WaveEnergyConverter.h File Reference

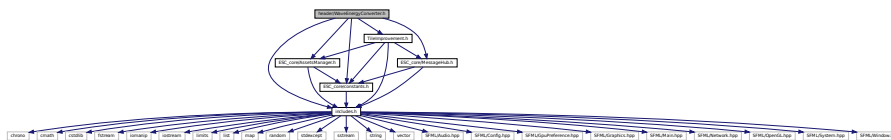
Header file for the [WaveEnergyConverter](#) class.

```

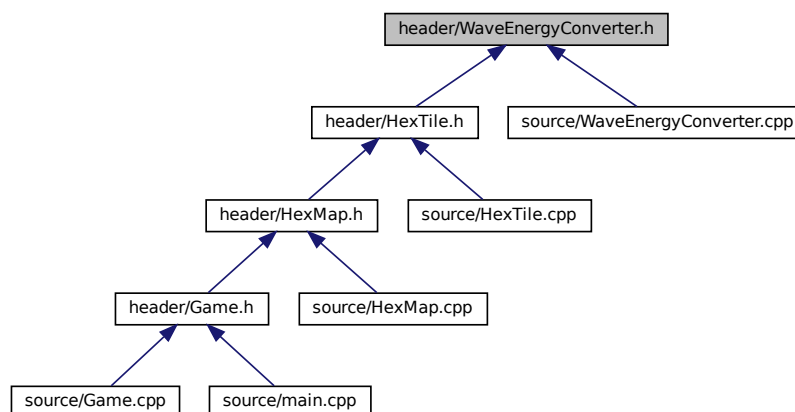
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"

```

Include dependency graph for WaveEnergyConverter.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [WaveEnergyConverter](#)
A settlement class (child class of [TileImprovement](#)).

5.17.1 Detailed Description

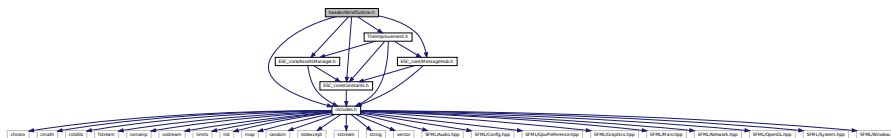
Header file for the [WaveEnergyConverter](#) class.

5.18 header/WindTurbine.h File Reference

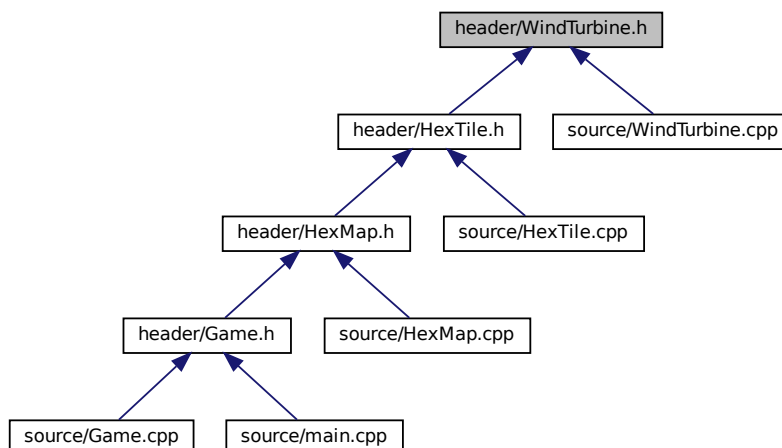
Header file for the [WindTurbine](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"
```

Include dependency graph for WindTurbine.h:



This graph shows which files directly or indirectly include this file:



Classes

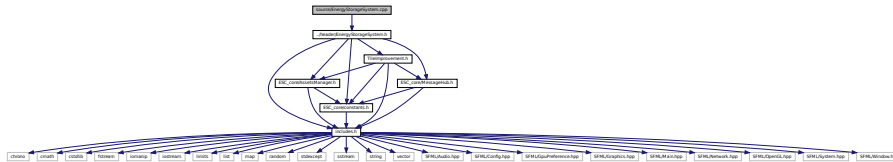
- class [WindTurbine](#)
A settlement class (child class of [TileImprovement](#)).

5.21 source/EnergyStorageSystem.cpp File Reference

Implementation file for the [EnergyStorageSystem](#) class. DEPRECATED / NOT USED.

```
#include "../header/EnergyStorageSystem.h"
```

Include dependency graph for EnergyStorageSystem.cpp:



5.21.1 Detailed Description

Implementation file for the [EnergyStorageSystem](#) class. DEPRECATED / NOT USED.

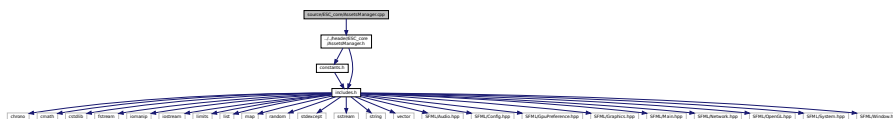
A base class for the tile improvement hierarchy.

5.22 source/ESC_core/AssetsManager.cpp File Reference

Implementation file for the `AssetsManager` class.

```
#include "../..header/ESC_core/AssetsManager.h"
```

Include dependency graph for AssetsManager.cpp:



5.22.1 Detailed Description

Implementation file for the `AssetsManager` class.

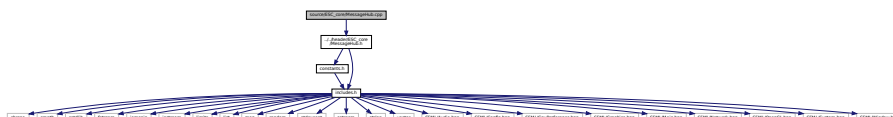
A class which manages visual and sound assets.

5.23 source/ESC_core/MessageHub.cpp File Reference

Implementation file for the `MessageHub` class.

```
#include "../..header/ESC_core/MessageHub.h"
```

Include dependency graph for MessageHub.cpp:



5.24.2 Function Documentation

5.24.2.1 expectedErrorNotDetected()

```
void expectedErrorNotDetected (
    std::string file,
    int line )
```

A utility function to print out a meaningful error message whenever an expected error fails to be thrown/caught/detected.

Parameters

<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```
434 {
435     std::string error_str = "\n ERROR   failed to throw expected error prior to line ";
436     error_str += std::to_string(line);
437     error_str += " of ";
438     error_str += file;
439
440     #ifdef _WIN32
441         std::cout << error_str << std::endl;
442     #endif
443
444     throw std::runtime_error(error_str);
445     return;
446 } /* expectedErrorNotDetected() */
```

5.24.2.2 printGold()

```
void printGold (
    std::string input_str )
```

A function that sends gold text to std::cout.

Parameters

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```
86 {
87     std::cout << "\x1B[33m" << input_str << "\033[0m";
88     return;
89 } /* printGold() */
```

5.24.2.3 printGreen()

```
void printGreen (
    std::string input_str )
```

A function that sends green text to std::cout.

Parameters

<i>input_str</i>	The text of the string to be sent to <code>std::cout</code> .
------------------	---

```

66 {
67     std::cout << "\xB{32m" << input_str << "\033[0m";
68     return;
69 } /* printGreen() */

```

5.24.2.4 printRed()

```

void printRed (
    std::string input_str )

```

A function that sends red text to `std::cout`.

Parameters

<i>input_str</i>	The text of the string to be sent to <code>std::cout</code> .
------------------	---

```

106 {
107     std::cout << "\xB{31m" << input_str << "\033[0m";
108     return;
109 } /* printRed() */

```

5.24.2.5 testFloatEquals()

```

void testFloatEquals (
    double x,
    double y,
    std::string file,
    int line )

```

Tests for the equality of two floating point numbers *x* and *y* (to within `FLOAT_TOLERANCE`).

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in " <code>__FILE__</code> ").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in " <code>__LINE__</code> ").

```

140 {
141     if (fabs(x - y) <= FLOAT_TOLERANCE) {
142         return;
143     }
144
145     std::string error_str = "ERROR: testFloatEquals():\t in ";
146     error_str += file;
147     error_str += "\tline ";
148     error_str += std::to_string(line);
149     error_str += ":\t\n";
150     error_str += std::to_string(x);
151     error_str += " and ";
152     error_str += std::to_string(y);
153     error_str += " are not equal to within +/- ";

```



```

154     error_str += std::to_string(FLOAT_TOLERANCE);
155     error_str += "\n";
156
157     #ifdef _WIN32
158         std::cout << error_str << std::endl;
159     #endif
160
161     throw std::runtime_error(error_str);
162     return;
163 } /* testFloatEquals() */

```

5.24.2.6 testGreaterThan()

```

void testGreaterThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if $x > y$.

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

193 {
194     if (x > y) {
195         return;
196     }
197
198     std::string error_str = "ERROR: testGreaterThan():\t in ";
199     error_str += file;
200     error_str += "\tline ";
201     error_str += std::to_string(line);
202     error_str += ":\t\n";
203     error_str += std::to_string(x);
204     error_str += " is not greater than ";
205     error_str += std::to_string(y);
206     error_str += "\n";
207
208     #ifdef _WIN32
209         std::cout << error_str << std::endl;
210     #endif
211
212     throw std::runtime_error(error_str);
213     return;
214 } /* testGreaterThan() */

```

5.24.2.7 testGreaterThanOrEqualTo()

```

void testGreaterThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if $x \geq y$.

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

244 {
245     if (x >= y) {
246         return;
247     }
248
249     std::string error_str = "ERROR: testGreaterThanOrEqualTo():\t in ";
250     error_str += file;
251     error_str += "\tline ";
252     error_str += std::to_string(line);
253     error_str += ":\t\n";
254     error_str += std::to_string(x);
255     error_str += " is not greater than or equal to ";
256     error_str += std::to_string(y);
257     error_str += "\n";
258
259     #ifdef _WIN32
260         std::cout << error_str << std::endl;
261     #endif
262
263     throw std::runtime_error(error_str);
264     return;
265 } /* testGreaterThanOrEqualTo() */

```

5.24.2.8 testLessThan()

```

void testLessThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if $x < y$.

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

295 {
296     if (x < y) {
297         return;
298     }
299
300     std::string error_str = "ERROR: testLessThan():\t in ";
301     error_str += file;
302     error_str += "\tline ";
303     error_str += std::to_string(line);
304     error_str += ":\t\n";
305     error_str += std::to_string(x);
306     error_str += " is not less than ";
307     error_str += std::to_string(y);
308     error_str += "\n";
309
310     #ifdef _WIN32
311         std::cout << error_str << std::endl;
312     #endif
313
314     throw std::runtime_error(error_str);

```

```

315     return;
316 } /* testLessThan() */

```

5.24.2.9 testLessThanOrEqualTo()

```

void testLessThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if $x \leq y$.

Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

346 {
347     if (x <= y) {
348         return;
349     }
350
351     std::string error_str = "ERROR: testLessThanOrEqualTo():\t in ";
352     error_str += file;
353     error_str += "\tline ";
354     error_str += std::to_string(line);
355     error_str += ":\t\n";
356     error_str += std::to_string(x);
357     error_str += " is not less than or equal to ";
358     error_str += std::to_string(y);
359     error_str += "\n";
360
361     #ifdef _WIN32
362         std::cout << error_str << std::endl;
363     #endif
364
365     throw std::runtime_error(error_str);
366     return;
367 } /* testLessThanOrEqualTo() */

```

5.24.2.10 testTruth()

```

void testTruth (
    bool statement,
    std::string file,
    int line )

```

Tests if the given statement is true.

Parameters

<i>statement</i>	The statement whose truth is to be tested ("1 == 0", for example).
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

Functions

- void [loadAssets](#) ([AssetsManager](#) *assets_manager_ptr)
Helper function to load game assets.
- sf::RenderWindow * [constructRenderWindow](#) (void)
Helper function to construct render window.
- void [playBrandAnimation](#) (sf::RenderWindow *render_window_ptr)
- void [showTitleScreen](#) (sf::RenderWindow *render_window_ptr, [AssetsManager](#) *assets_manager_ptr)
Helper function.
- int [main](#) (int argc, char **argv)

5.28.1 Detailed Description

Implementation file for [main\(\)](#) for Road To Zero.

5.28.2 Function Documentation

5.28.2.1 [constructRenderWindow\(\)](#)

```
sf::RenderWindow * constructRenderWindow (
    void )
```

Helper function to construct render window.

Returns

Pointer to the render window.

```
345 {
346     // 1. get desktop resolution
347     sf::VideoMode video_mode = sf::VideoMode::getDesktopMode();
348     int desktop_width = video_mode.width;
349     int desktop_height = video_mode.height;
350
351     // 2. adjust render window dimensions as necessary (maintain 3:2 aspect ratio)
352     int window_width = GAME_WIDTH;
353     int window_height = GAME_HEIGHT;
354
355     if (
356         (window_width > desktop_width) or
357         (window_height > desktop_height)
358     ) {
359         int width_diff = window_width - desktop_width;
360         int height_diff = window_height - desktop_height;
361
362         if (width_diff > height_diff) {
363             window_width = desktop_width;
364             window_height = (2.0 / 3.0) * desktop_width;
365         }
366         else {
367             window_height = desktop_height;
368             window_width = (3.0 / 2.0) * desktop_height;
369         }
370     }
371 }
372
373 // 3. construct render window
374 sf::RenderWindow* render_window_ptr = new sf::RenderWindow(
375     sf::VideoMode(window_width, window_height),
376     "Road To Zero"
377 );
```

```

378
379 // 4. reset render window view as necessary
380 if (
381     (window_width != GAME_WIDTH) or
382     (window_height != GAME_HEIGHT)
383 ) {
384     sf::View view;
385     view.reset(sf::FloatRect(0, 0, GAME_WIDTH, GAME_HEIGHT));
386     render_window_ptr->setView(view);
387 }
388
389 return render_window_ptr;
390 } /* constructRenderWindow() */

```

5.28.2.2 loadAssets()

```

void loadAssets (
    AssetsManager * assets_manager_ptr )

```

Helper function to load game assets.

Parameters

<code>assets_manager_ptr</code>	Pointer to the assets manager.
---------------------------------	--------------------------------

```

66 {
67     // 1. load font assets
68     assets_manager_ptr->loadFont("assets/fonts/DroidSansMono.ttf", "DroidSansMono");
69     assets_manager_ptr->loadFont("assets/fonts/Glass_TTY_VT220.ttf", "Glass_TTY_VT220");
70
71
72     // 2. load tile sheets
73     assets_manager_ptr->loadTexture(
74         "assets/tile_sheets/pine_tree_64x64_1_CC-BY.png",
75         "pine_tree_64x64_1"
76     );
77
78     assets_manager_ptr->loadTexture(
79         "assets/tile_sheets/wheat_64x64_1_CC-BY.png",
80         "wheat_64x64_1"
81     );
82
83     assets_manager_ptr->loadTexture(
84         "assets/tile_sheets/mountain_64x64_1_CC-BY.png",
85         "mountain_64x64_1"
86     );
87
88     assets_manager_ptr->loadTexture(
89         "assets/tile_sheets/water_waves_64x64_1_CC-BY.png",
90         "water_waves_64x64_1"
91     );
92
93     assets_manager_ptr->loadTexture(
94         "assets/tile_sheets/water_shimmer_64x64_1_CC-BY.png",
95         "water_shimmer_64x64_1"
96     );
97
98     assets_manager_ptr->loadTexture(
99         "assets/tile_sheets/brick_house_64x64_1_CC-BY.png",
100         "brick_house_64x64_1"
101     );
102
103     assets_manager_ptr->loadTexture(
104         "assets/tile_sheets/magnifying_glass_64x64_1_CC-BY.png",
105         "magnifying_glass_64x64_1"
106     );
107
108     assets_manager_ptr->loadTexture(
109         "assets/tile_sheets/exp2_0_CC0.png",
110         "tile clear explosion"
111     );
112
113     assets_manager_ptr->loadTexture(
114         "assets/tile_sheets/emissions_8x8_1_CC-BY.png",
115         "emissions"

```

```
116     );
117
118     assets_manager_ptr->loadTexture(
119         "assets/tile_sheets/diesel_generator_64x64_2_CC-BY.png",
120         "diesel generator"
121     );
122
123     assets_manager_ptr->loadTexture(
124         "assets/tile_sheets/solar_PV_64x64_1_CC-BY.png",
125         "solar PV array"
126     );
127
128     assets_manager_ptr->loadTexture(
129         "assets/tile_sheets/wind_turbine_64x64_2_CC-BY.png",
130         "wind turbine"
131     );
132
133     assets_manager_ptr->loadTexture(
134         "assets/tile_sheets/energy_storage_system_64x64_1_CC-BY.png",
135         "energy storage system"
136     );
137
138     assets_manager_ptr->loadTexture(
139         "assets/tile_sheets/tidal_turbine_64x64_2_CC-BY.png",
140         "tidal turbine"
141     );
142
143     assets_manager_ptr->loadTexture(
144         "assets/tile_sheets/wave_energy_converter_64x64_2_CC-BY.png",
145         "wave energy converter"
146     );
147
148     assets_manager_ptr->loadTexture(
149         "assets/tile_sheets/upgrade_arrow_16x16_1_CC-BY.png",
150         "upgrade arrow"
151     );
152
153     assets_manager_ptr->loadTexture(
154         "assets/tile_sheets/upgrade_plus_16x16_1_CC-BY.png",
155         "upgrade plus"
156     );
157
158     assets_manager_ptr->loadTexture(
159         "assets/tile_sheets/energy_storage_16x16_1_CC-BY.png",
160         "storage level"
161     );
162
163     assets_manager_ptr->loadTexture(
164         "assets/tile_sheets/coin_16x16_1_CC-BY.png",
165         "coin"
166     );
167
168
169     // 3. load sounds
170     assets_manager_ptr->loadSound(
171         "assets/audio/samples/mixkit-magical-coin-win-1936_MixkitFree.ogg",
172         "coin ring"
173     );
174
175     assets_manager_ptr->loadSound(
176         "assets/audio/samples/mixkit-positive-notification-951_MixkitFree.ogg",
177         "positive notification"
178     );
179
180     assets_manager_ptr->loadSound(
181         "assets/audio/samples/mixkit-sci-fi-click-900_MixkitFree.ogg",
182         "sci-fi click"
183     );
184
185     assets_manager_ptr->loadSound(
186         "assets/audio/samples/mixkit-apartment-buzzer-bell-press-932_MixkitFree.ogg",
187         "insufficient credits"
188     );
189
190     assets_manager_ptr->loadSound(
191         "assets/audio/samples/mixkit-data-scanner-2487_MixkitFree.ogg",
192         "resource assessment"
193     );
194
195     assets_manager_ptr->loadSound(
196         "assets/audio/samples/mixkit-interface-click-1126_MixkitFree.ogg",
197         "console string print"
198     );
199
200     assets_manager_ptr->loadSound(
201         "assets/audio/samples/mixkit-video-game-retro-click-237_MixkitFree.ogg",
202         "resource overlay toggle on"
```



```
203     );
204
205     assets_manager_ptr->loadSound(
206         "assets/audio/samples/mixkit-video-game-retro-click-237_REVERSED_MixkitFree.ogg",
207         "resource overlay toggle off"
208     );
209
210     assets_manager_ptr->loadSound(
211         "assets/audio/samples/mixkit-explosion-with-rocks-debris-1703_MixkitFree.ogg",
212         "clear mountains tile"
213     );
214
215     assets_manager_ptr->loadSound(
216         "assets/audio/samples/mixkit-arcade-game-explosion-2759_MixkitFree.ogg",
217         "clear non-mountains tile"
218     );
219
220     assets_manager_ptr->loadSound(
221         "assets/audio/samples/mixkit-electronic-retro-block-hit-2185_MixkitFree.ogg",
222         "place improvement"
223     );
224
225     assets_manager_ptr->loadSound(
226         "assets/audio/samples/mixkit-video-game-lock-2851_REVERSED_MixkitFree.ogg",
227         "build menu open"
228     );
229
230     assets_manager_ptr->loadSound(
231         "assets/audio/samples/mixkit-video-game-lock-2851_MixkitFree.ogg",
232         "build menu close"
233     );
234
235     assets_manager_ptr->loadSound(
236         "assets/audio/samples/mixkit-jump-into-the-water-1180_MixkitFree.ogg",
237         "splash"
238     );
239
240     assets_manager_ptr->loadSound(
241         "assets/audio/samples/505316__nuncaconoci__diesel_CC0.ogg",
242         "diesel running"
243     );
244
245     assets_manager_ptr->loadSound(
246         "assets/audio/samples/33460__pempi__320d_2_CC-BY.ogg",
247         "diesel start"
248     );
249
250     assets_manager_ptr->loadSound(
251         "assets/audio/samples/132724__andy_gardner__wind-turbine-blades_CC-BY.ogg",
252         "wind turbine running"
253     );
254
255     assets_manager_ptr->loadSound(
256         "assets/audio/samples/58416__darren1979__oceanwaves_CC-SAMPLING.ogg",
257         "ocean waves"
258     );
259
260     assets_manager_ptr->loadSound(
261         "assets/audio/samples/369927__mephisto_egmont__water-flowing-in-tubes_CC-BY.ogg",
262         "water flow"
263     );
264
265     assets_manager_ptr->loadSound(
266         "assets/audio/samples/647663__jotraing__electric-train-motor-idle-loop-new-generation-rollingstock_CC0.ogg",
267         "solar hum"
268     );
269
270     assets_manager_ptr->loadSound(
271         "assets/audio/samples/mixkit-epic-futuristic-movie-accent-2913_MixkitFree.ogg",
272         "game title screen"
273     );
274
275     assets_manager_ptr->loadSound(
276         "assets/audio/samples/mixkit-calm-park-with-people-and-children_MixkitFree.ogg",
277         "people and children"
278     );
279
280     assets_manager_ptr->loadSound(
281         "assets/audio/samples/mixkit-magical-coin-win-1936_MixkitFree.ogg",
282         "upgrade"
283     );
284
285     assets_manager_ptr->loadSound(
286         "assets/audio/samples/mixkit-cool-interface-click-tone-2568_MixkitFree.ogg",
287         "interface click"
288     );
```

```

289
290     assets_manager_ptr->loadSound(
291         "assets/audio/samples/mixkit-factory-metal-hard-hit-2980_MixkitFree.ogg",
292         "breakdown"
293     );
294
295     assets_manager_ptr->loadSound(
296         "assets/audio/samples/mixkit-fantasy-game-success-notification-270_MixkitFree.ogg",
297         "victory"
298     );
299
300     assets_manager_ptr->loadSound(
301         "assets/audio/samples/mixkit-player-losing-or-failing-2042_MixkitFree.ogg",
302         "loss"
303     );
304
305     assets_manager_ptr->loadSound(
306         "assets/audio/samples/mixkit-poker-card-flick-2002_MixkitFree.ogg",
307         "card flick"
308     );
309
310
311     // 4. load tracks
312     assets_manager_ptr->loadTrack(
313         "assets/audio/tracks/TreeStarMoon_Dobranoc_CC0.ogg",
314         "Tree Star Moon - Dobranoc"
315     );
316
317     assets_manager_ptr->loadTrack(
318         "assets/audio/tracks/TreeStarMoon_Lighthouse_CC0.ogg",
319         "Tree Star Moon - Lighthouse"
320     );
321
322     assets_manager_ptr->loadTrack(
323         "assets/audio/tracks/TreeStarMoon_SkyFarm_CC0.ogg",
324         "Tree Star Moon - Sky Farm"
325     );
326
327     return;
328 } /* loadAssets() */

```

5.28.2.3 main()

```

int main (
    int argc,
    char ** argv )
{
    // 1. load assets
    AssetsManager assets_manager;
    loadAssets(&assets_manager);

    // 2. construct render window
    sf::RenderWindow* render_window_ptr = constructRenderWindow();

    // 3. show brand animation and splash screen
    playBrandAnimation(render_window_ptr);

    // 4. show title screen
    if (render_window_ptr->isOpen()) {
        showTitleScreen(render_window_ptr, &assets_manager);
    }

    // 5. start game loop
    bool quit_game = false;
    bool transition_from_title = true;

    if (render_window_ptr->isOpen()) {
        assets_manager.playTrack();
    }

    else {
        quit_game = true;
    }

    while (not quit_game) {
        Game game(render_window_ptr, &assets_manager, transition_from_title);
        quit_game = game.run();

        if (transition_from_title and (not quit_game)) {

```

```

1023         transition_from_title = false;
1024     }
1025 }
1026
1027 // 4. clean up
1028 render_window_ptr->close();
1029 delete render_window_ptr;
1030
1031 return 0;
1032 } /* main() */

```

5.28.2.4 playBrandAnimation()

```

void playBrandAnimation (
    sf::RenderWindow * render_window_ptr )
{
    // 1. load assets
    AssetsManager brand_assets_manager;

    brand_assets_manager.loadFont (
        "assets/ESC_brand/OpenSans-Bold.ttf",
        "OpenSansBold"
    );

    brand_assets_manager.loadTexture (
        "assets/ESC_brand/ESC_key_109x90.png",
        "[ESC] large"
    );

    brand_assets_manager.loadTexture (
        "assets/ESC_brand/ESC_key_98x81.png",
        "[ESC] small"
    );

    brand_assets_manager.loadTexture (
        "assets/ESC_brand/SFML_256x128.png",
        "SFML"
    );

    brand_assets_manager.loadSound (
        "assets/ESC_brand/mixkit-single-key-type-2533-MixkitFree.ogg",
        "key press"
    );

    // 2. set up and position assets
    std::string brand_string = "INTERACTIVE";

    sf::Text brand_text (
        brand_string,
        *(brand_assets_manager.getFont("OpenSansBold")),
        64
    );

    brand_text.setOrigin (
        brand_text.getLocalBounds().width / 2,
        brand_text.getLocalBounds().height / 2
    );

    brand_text.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2);

    double key_position_x =
        (GAME_WIDTH / 2) - (brand_text.getLocalBounds().width / 2) - 64;

    double key_position_y =
        (GAME_HEIGHT / 2) - (brand_text.getLocalBounds().height / 2) - 32;

    sf::Sprite ESC_large (
        *(brand_assets_manager.getTexture("[ESC] large"))
    );

    ESC_large.setOrigin (
        ESC_large.getLocalBounds().width / 2,
        ESC_large.getLocalBounds().height / 2
    );

    ESC_large.setPosition(key_position_x, key_position_y);

    ESC_large.setColor(sf::Color(255, 255, 255, 0));
}

```

```

472
473     sf::Sprite ESC_small(
474         *(brand_assets_manager.getTextured("ESC] small"))
475     );
476
477     ESC_small.setOrigin(
478         ESC_small.getLocalBounds().width / 2,
479         ESC_small.getLocalBounds().height / 2
480     );
481
482     ESC_small.setPosition(key_position_x, key_position_y);
483
484     ESC_small.setColor(sf::Color(255, 255, 255, 255));
485
486     sf::Sprite SFML(
487         *(brand_assets_manager.getTextured("SFML"))
488     );
489
490     SFML.setOrigin(
491         SFML.getLocalBounds().width / 2,
492         SFML.getLocalBounds().height / 2
493     );
494
495     SFML.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2);
496
497     SFML.setColor(sf::Color(255, 255, 255, 0));
498
499
500     // 3. draw loop
501     bool sound_played = false;
502
503     int brand_frame = 0;
504     int click_frame = 0;
505     int brand_state = 0;
506
507     size_t substring_idx = 0;
508
509     double alpha = 0;
510     double dalpha = FRAMES_PER_SECOND / 18;
511     double time_since_start_s = 0;
512
513     sf::Clock brand_clock;
514     sf::Event brand_event;
515
516     while (brand_state < 6) {
517         time_since_start_s = brand_clock.getElapsedTime().asSeconds();
518
519         if (time_since_start_s >= (brand_frame + 1) * SECONDS_PER_FRAME) {
520             render_window_ptr->clear();
521
522             while (render_window_ptr->pollEvent(brand_event)) {
523                 if (brand_event.type == sf::Event::Closed) {
524                     render_window_ptr->close();
525                     return;
526                 }
527             }
528
529             // 3.1. brand state switch
530             switch (brand_state) {
531                 case (0): {
532                     // fade in key
533                     render_window_ptr->draw(ESC_large);
534
535                     if (alpha < 255) {
536
537                         alpha += dalpha;
538
539                         if (alpha > 255) {
540                             alpha = 255;
541                         }
542
543                         ESC_large.setColor(sf::Color(255, 255, 255, alpha));
544                     }
545
546                     else {
547                         brand_state++;
548                     }
549
550                     break;
551                 }
552
553                 case (1): {
554                     // key press
555                     render_window_ptr->draw(ESC_small);
556
557                     if (click_frame < FRAMES_PER_SECOND / 8) {

```

```
559             if (not sound_played) {
560                 brand_assets_manager.getSound("key press")->play();
561                 sound_played = true;
562             }
563
564             click_frame++;
565         }
566
567         else {
568             brand_state++;
569         }
570
571         break;
572     }
573
574
575     case (2): {
576         // text wave
577         brand_text.setString(brand_string.substr(0, substring_idx));
578
579         render_window_ptr->draw(brand_text);
580         render_window_ptr->draw(ESC_large);
581
582         if (substring_idx <= brand_string.size()) {
583             if (brand_frame % (FRAMES_PER_SECOND / 20) == 0) {
584                 substring_idx++;
585             }
586         }
587
588         else {
589             brand_state++;
590         }
591
592         break;
593     }
594
595
596     case (3): {
597         // fade out brand
598         render_window_ptr->draw(brand_text);
599         render_window_ptr->draw(ESC_large);
600
601         if (alpha > 0) {
602             alpha -= dalpha;
603
604             if (alpha < 0) {
605                 alpha = 0;
606             }
607
608             brand_text.setFillColor(sf::Color(255, 255, 255, alpha));
609             ESC_large.setColor(sf::Color(255, 255, 255, alpha));
610         }
611
612         else {
613             brand_state++;
614         }
615
616         break;
617     }
618
619
620     case (4): {
621         // fade in SFML
622         render_window_ptr->draw(SFML);
623
624         if (alpha < 255) {
625             alpha += dalpha;
626
627             if (alpha > 255) {
628                 alpha = 255;
629             }
630
631             SFML.setColor(sf::Color(255, 255, 255, alpha));
632         }
633
634         else {
635             brand_state++;
636         }
637
638         break;
639     }
640
641
642     case (5): {
643         // fade out SFML
644         render_window_ptr->draw(SFML);
645     }
```

```

646         if (alpha > 0) {
647             alpha -= dalpha;
648
649             if (alpha < 0) {
650                 alpha = 0;
651             }
652
653             SFML.setColor(sf::Color(255, 255, 255, alpha));
654         }
655
656         else {
657             brand_state++;
658         }
659
660         break;
661     }
662
663     default: {
664         // do nothing!
665
666         break;
667     }
668 }
669
670 render_window_ptr->display();
671 brand_frame++;
672 }
673
674 }
675
676 return;
677 } /* playBrandAnimation() */

```

5.28.2.5 showTitleScreen()

```

void showTitleScreen (
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr )

```

Helper function.

Parameters

<i>render_window_ptr</i>	A pointer to the render window.
<i>assets_manager_ptr</i>	A pointer to the assets manager.

```

702 {
703     // 1. set up and position title assets
704     int outline_thickness = 32;
705
706     sf::RectangleShape title_console(
707         sf::Vector2f(
708             GAME_WIDTH - 2 * outline_thickness,
709             GAME_HEIGHT - 2 * outline_thickness
710         )
711     );
712
713     title_console.setPosition(outline_thickness, outline_thickness);
714
715     sf::Color title_fill_colour = MONOCHROME_SCREEN_BACKGROUND;
716     title_fill_colour.a = 0;
717
718     sf::Color title_outline_colour = MENU_FRAME_GREY;
719     title_outline_colour.a = 0;
720
721     title_console.setFillColor(title_fill_colour);
722     title_console.setOutlineColor(title_outline_colour);
723     title_console.setOutlineThickness(outline_thickness);
724
725     std::string title_string_upper = "ROAD TO ZERO";
726     sf::Text title_text_upper(
727         title_string_upper,
728         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
729         128

```

```

730     );
731
732     title_text_upper.setOrigin(
733         title_text_upper.getLocalBounds().width / 2,
734         title_text_upper.getLocalBounds().height / 2
735     );
736
737     title_text_upper.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2 - 128);
738     title_text_upper.setFillColor(MONOCROME_TEXT_GREEN);
739
740     std::string title_string_lower = "THE MICROGRID MANAGEMENT GAME";
741     sf::Text title_text_lower(
742         title_string_lower,
743         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
744         64
745     );
746
747     title_text_lower.setOrigin(
748         title_text_lower.getLocalBounds().width / 2,
749         title_text_lower.getLocalBounds().height / 2
750     );
751
752     title_text_lower.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2);
753     title_text_lower.setFillColor(MONOCROME_TEXT_GREEN);
754
755     std::string title_string_bottom = "COPYRIGHT 2023 - [ESC] INTERACTIVE";
756     sf::Text title_text_bottom(
757         title_string_bottom,
758         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
759         16
760     );
761
762     title_text_bottom.setOrigin(
763         title_text_bottom.getLocalBounds().width / 2,
764         title_text_bottom.getLocalBounds().height / 2
765     );
766
767     title_text_bottom.setPosition(GAME_WIDTH / 2, GAME_HEIGHT - 64);
768     title_text_bottom.setFillColor(MONOCROME_TEXT_GREEN);
769
770     sf::Text prompt_text(
771         "PRESS ANY KEY TO CONTINUE",
772         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
773         24
774     );
775
776     prompt_text.setOrigin(
777         prompt_text.getLocalBounds().width / 2,
778         prompt_text.getLocalBounds().height / 2
779     );
780
781     prompt_text.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2 + 175);
782     prompt_text.setFillColor(MONOCROME_TEXT_GREEN);
783
784     sf::RectangleShape fade_rectangle(sf::Vector2f(GAME_WIDTH, GAME_HEIGHT));
785     sf::Color fade_rectangle_colour(0, 0, 0, 0);
786     fade_rectangle.setFillColor(fade_rectangle_colour);
787
788
789     // 2. draw loop
790     bool draw_title = true;
791     bool sound_played = false;
792
793     int title_frame = 0;
794     int title_state = 0;
795
796     size_t upper_substring_idx = 0;
797     size_t lower_substring_idx = 0;
798     size_t bottom_substring_idx = 0;
799
800     double alpha = 0;
801     double dalpha = FRAMES_PER_SECOND / 18;
802     double time_since_start_s = 0;
803
804     sf::Clock title_clock;
805     sf::Event title_event;
806
807     while (draw_title) {
808         time_since_start_s = title_clock.getElapsedTime().asSeconds();
809
810         if (time_since_start_s >= (title_frame + 1) * SECONDS_PER_FRAME) {
811             render_window_ptr->clear();
812
813             // 2.1. title state switch
814             switch (title_state) {
815                 case (0): {
816                     while (render_window_ptr->pollEvent(title_event)) {

```

```

817         if (title_event.type == sf::Event::Closed) {
818             render_window_ptr->close();
819             return;
820         }
821     }
822
823     // fade in title console
824     render_window_ptr->draw(title_console);
825
826     if (alpha < 255) {
827         alpha += dalpha;
828
829         if (alpha > 255) {
830             alpha = 255;
831         }
832
833         title_fill_colour.a = alpha;
834         title_outline_colour.a = alpha;
835
836         title_console.setFillColor(title_fill_colour);
837         title_console.setOutlineColor(title_outline_colour);
838     }
839
840     else {
841         title_state++;
842         alpha = 0;
843     }
844
845     break;
846 }
847
848
849 case (1): {
850     while (render_window_ptr->pollEvent(title_event)) {
851         if (title_event.type == sf::Event::Closed) {
852             render_window_ptr->close();
853             return;
854         }
855     }
856
857     // fade in title text
858     if (not sound_played) {
859         assets_manager_ptr->getSound("game title screen")->play();
860         sound_played = true;
861     }
862
863     if (title_string_bottom.substr(0, bottom_substring_idx) != title_string_bottom) {
864         title_text_upper.setString(title_string_upper.substr(0, upper_substring_idx));
865         title_text_lower.setString(title_string_lower.substr(0, lower_substring_idx));
866         title_text_bottom.setString(title_string_bottom.substr(0,
bottom_substring_idx));
867
868         assets_manager_ptr->getSound("console string print")->play();
869
870         upper_substring_idx++;
871         lower_substring_idx++;
872         bottom_substring_idx++;
873
874         if (upper_substring_idx > title_string_upper.size()) {
875             upper_substring_idx = title_string_upper.size();
876         }
877
878         if (lower_substring_idx > title_string_lower.size()) {
879             lower_substring_idx = title_string_lower.size();
880         }
881     }
882
883     else {
884         title_text_upper.setString(title_string_upper.substr(0, upper_substring_idx));
885         title_text_lower.setString(title_string_lower.substr(0, lower_substring_idx));
886         title_text_bottom.setString(title_string_bottom.substr(0,
bottom_substring_idx));
887         title_state++;
888     }
889
890     render_window_ptr->draw(title_console);
891     render_window_ptr->draw(title_text_upper);
892     render_window_ptr->draw(title_text_lower);
893     render_window_ptr->draw(title_text_bottom);
894
895     break;
896 }
897
898
899 case (2): {
900     while (render_window_ptr->pollEvent(title_event)) {
901         if (title_event.type == sf::Event::KeyPressed) {

```



```

902             title_state++;
903         }
904
905         if (title_event.type == sf::Event::Closed) {
906             render_window_ptr->close();
907             return;
908         }
909     }
910
911     // flashing prompt
912     render_window_ptr->draw(title_console);
913     render_window_ptr->draw(title_text_upper);
914     render_window_ptr->draw(title_text_lower);
915     render_window_ptr->draw(title_text_bottom);
916
917     if (
918         (title_frame > 3.5 * FRAMES_PER_SECOND) and
919         ((title_frame % FRAMES_PER_SECOND) > FRAMES_PER_SECOND / 2)
920     ) {
921         render_window_ptr->draw(prompt_text);
922     }
923
924     break;
925 }
926
927
928 case (3): {
929     while (render_window_ptr->pollEvent(title_event)) {
930         if (title_event.type == sf::Event::Closed) {
931             render_window_ptr->close();
932             return;
933         }
934     }
935
936     // fade out
937     render_window_ptr->draw(title_console);
938     render_window_ptr->draw(title_text_upper);
939     render_window_ptr->draw(title_text_lower);
940     render_window_ptr->draw(title_text_bottom);
941
942     if ((title_frame % FRAMES_PER_SECOND) > FRAMES_PER_SECOND / 2) {
943         render_window_ptr->draw(prompt_text);
944     }
945
946     render_window_ptr->draw(fade_rectangle);
947
948     if (alpha < 255) {
949         alpha += dalpha;
950
951         if (alpha > 255) {
952             alpha = 255;
953         }
954
955         fade_rectangle.colour.a = alpha;
956
957         fade_rectangle.setFillColor(fade_rectangle.colour);
958     }
959
960     else {
961         draw_title = false;
962     }
963
964     break;
965 }
966
967
968 default: {
969     // do nothing!
970
971     break;
972 }
973 }
974
975 render_window_ptr->display();
976 title_frame++;
977 }
978 }
979
980 return;
981 } /* showTitleScreen() */

```


Bibliography

L. Gomila. SFML: Simple and Fast Multimedia Library, 2023. URL <https://www.sfml-dev.org/>. 307

D. van Heesch. Doxygen: Generate documentation from source code, 2023. URL <https://www.doxygen.nl>. 306

Wikipedia. Hexagon, 2023. URL <https://en.wikipedia.org/wiki/Hexagon>. 40, 54, 128, 181, 191, 208, 228, 250, 268

Index

- __advanceTurn
 - Game, [66](#)
- __assembleHexMap
 - HexMap, [99](#)
- __assessNeighbours
 - HexMap, [100](#)
- __breakdown
 - DieselGenerator, [41](#)
 - SolarPV, [192](#)
 - TidalTurbine, [210](#)
 - TileImprovement, [230](#)
 - WaveEnergyConverter, [251](#)
 - WindTurbine, [270](#)
- __buildDieselGenerator
 - HexTile, [129](#)
- __buildDrawOrderVector
 - HexMap, [100](#)
- __buildEnergyStorage
 - HexTile, [130](#)
- __buildSettlement
 - HexTile, [130](#)
- __buildSolarPV
 - HexTile, [131](#)
- __buildTidalTurbine
 - HexTile, [132](#)
- __buildWaveEnergyConverter
 - HexTile, [132](#)
- __buildWindTurbine
 - HexTile, [133](#)
- __checkTerminatingConditions
 - Game, [66](#)
- __clearDecoration
 - HexTile, [133](#)
- __closeBuildMenu
 - HexTile, [134](#)
- __closeProductionMenu
 - TileImprovement, [230](#)
- __closeUpgradeMenu
 - TileImprovement, [230](#)
- __computeCapacityFactors
 - SolarPV, [192](#)
 - TidalTurbine, [210](#)
 - WaveEnergyConverter, [252](#)
 - WindTurbine, [270](#)
- __computeCurrentDemand
 - Game, [67](#)
- __computeDispatch
 - SolarPV, [193](#)
 - TidalTurbine, [210](#)
 - WaveEnergyConverter, [252](#)
 - WindTurbine, [270](#)
- __computeProduction
 - SolarPV, [194](#)
 - TidalTurbine, [211](#)
 - WaveEnergyConverter, [253](#)
 - WindTurbine, [271](#)
- __computeProductionCosts
 - DieselGenerator, [41](#)
 - SolarPV, [194](#)
 - TidalTurbine, [212](#)
 - WaveEnergyConverter, [254](#)
 - WindTurbine, [272](#)
- __decrementTutorial
 - Game, [67](#)
- __draw
 - Game, [68](#)
- __drawConsoleScreenFrame
 - ContextMenu, [22](#)
- __drawConsoleText
 - ContextMenu, [23](#)
- __drawDispatch
 - TileImprovement, [230](#)
- __drawFrameClockOverlay
 - Game, [69](#)
- __drawHUD
 - Game, [69](#)
- __drawLossCredits
 - Game, [71](#)
- __drawLossDemand
 - Game, [72](#)
- __drawLossEmissions
 - Game, [72](#)
- __drawProductionMenu
 - DieselGenerator, [41](#)
 - SolarPV, [195](#)
 - TidalTurbine, [212](#)
 - WaveEnergyConverter, [254](#)
 - WindTurbine, [272](#)
- __drawTotalDispatch
 - HexMap, [101](#)
- __drawTurnAdvanceBanner
 - Game, [73](#)
- __drawTurnSummary
 - Game, [74](#)
- __drawTutorial
 - Game, [75](#)
- __drawUpgradeOptions
 - SolarPV, [195](#)

- TidalTurbine, [213](#)
- WaveEnergyConverter, [255](#)
- WindTurbine, [273](#)
- __drawVictory
 - Game, [75](#)
- __drawVisualScreenFrame
 - ContextMenu, [24](#)
- __enforceOceanContinuity
 - HexMap, [103](#)
- __getMajorityTileType
 - HexMap, [103](#)
- __getNeighboursVector
 - HexMap, [104](#)
- __getNoise
 - HexMap, [105](#)
- __getSelectedTile
 - HexMap, [106](#)
- __getTileCoordsSubstring
 - HexTile, [134](#)
- __getTileImprovementSubstring
 - HexTile, [135](#)
- __getTileOptionsSubstring
 - HexTile, [135](#)
- __getTileResourceSubstring
 - HexTile, [136](#)
- __getTileTypeSubstring
 - HexTile, [137](#)
- __getValidMapIndexPositions
 - HexMap, [107](#)
- __handleImprovementStateMessage
 - Game, [76](#)
- __handleInitialDraw
 - HexMap, [108](#)
- __handleKeyPressEvents
 - ContextMenu, [24](#)
 - DieselGenerator, [42](#)
 - EnergyStorageSystem, [55](#)
 - Game, [76](#)
 - HexMap, [108](#)
 - HexTile, [138](#)
 - Settlement, [182](#)
 - SolarPV, [197](#)
 - TidalTurbine, [214](#)
 - TileImprovement, [231](#)
 - WaveEnergyConverter, [256](#)
 - WindTurbine, [274](#)
- __handleKeyReleaseEvents
 - HexTile, [142](#)
- __handleMouseButtonEvents
 - ContextMenu, [25](#)
 - DieselGenerator, [43](#)
 - EnergyStorageSystem, [56](#)
 - Game, [77](#)
 - HexMap, [109](#)
 - HexTile, [143](#)
 - Settlement, [183](#)
 - SolarPV, [198](#)
 - TidalTurbine, [215](#)
- TileImprovement, [232](#)
- WaveEnergyConverter, [257](#)
- WindTurbine, [275](#)
- __incrementTutorial
 - Game, [78](#)
- __insufficientCreditsAlarm
 - Game, [78](#)
- __isClicked
 - HexTile, [143](#)
- __isLakeTouchingOcean
 - HexMap, [109](#)
- __layTiles
 - HexMap, [110](#)
- __loadSoundBuffer
 - AssetsManager, [9](#)
- __logSettlementPosition
 - HexMap, [112](#)
- __openBuildMenu
 - HexTile, [144](#)
- __openProductionMenu
 - TileImprovement, [232](#)
- __openUpgradeMenu
 - TileImprovement, [232](#)
- __procedurallyGenerateTileResources
 - HexMap, [113](#)
- __procedurallyGenerateTileTypes
 - HexMap, [113](#)
- __processEvent
 - Game, [79](#)
- __processMessage
 - Game, [80](#)
- __repair
 - DieselGenerator, [44](#)
 - SolarPV, [198](#)
 - TidalTurbine, [215](#)
 - TileImprovement, [233](#)
 - WaveEnergyConverter, [258](#)
 - WindTurbine, [276](#)
- __scrapImprovement
 - HexTile, [144](#)
- __sendAssessNeighboursMessage
 - HexTile, [145](#)
- __sendCreditsEarnedMessage
 - Game, [81](#)
- __sendCreditsSpentMessage
 - HexTile, [145](#)
 - TileImprovement, [233](#)
- __sendGameStateMessage
 - Game, [81](#)
- __sendGameStateRequest
 - HexTile, [146](#)
 - TileImprovement, [234](#)
- __sendImprovementStateMessage
 - DieselGenerator, [44](#)
 - SolarPV, [199](#)
 - TidalTurbine, [216](#)
 - WaveEnergyConverter, [258](#)
 - WindTurbine, [276](#)

- __sendInsufficientCreditsMessage
 - HexTile, [146](#)
 - TileImprovement, [234](#)
- __sendNoTileSelectedMessage
 - HexMap, [114](#)
- __sendQuitGameMessage
 - ContextMenu, [25](#)
- __sendRestartGameMessage
 - ContextMenu, [25](#)
- __sendTileSelectedMessage
 - HexTile, [146](#)
- __sendTileStateMessage
 - HexTile, [147](#)
- __sendTileStateRequest
 - TileImprovement, [234](#)
- __sendTurnAdvanceMessage
 - Game, [82](#)
- __sendUpdateGamePhaseMessage
 - HexTile, [147](#)
- __setConsoleState
 - ContextMenu, [26](#)
- __setConsoleString
 - ContextMenu, [26](#)
- __setIsSelected
 - HexTile, [148](#)
- __setResourceText
 - HexTile, [148](#)
- __setUpBuildMenu
 - HexTile, [149](#)
- __setUpBuildOption
 - HexTile, [150](#)
- __setUpCoinSprite
 - Settlement, [183](#)
- __setUpConsoleScreen
 - ContextMenu, [27](#)
- __setUpConsoleScreenFrame
 - ContextMenu, [27](#)
- __setUpDieselGeneratorBuildOption
 - HexTile, [151](#)
- __setUpDispatchIllustration
 - TileImprovement, [234](#)
- __setUpEnergyStorageSystemBuildOption
 - HexTile, [152](#)
- __setUpGlassScreen
 - HexMap, [114](#)
- __setUpInitialDraw
 - HexMap, [114](#)
- __setUpMagnifyingGlassSprite
 - HexTile, [152](#)
- __setUpMenuFrame
 - ContextMenu, [29](#)
- __setUpNodeSprite
 - HexTile, [152](#)
- __setUpProductionMenu
 - EnergyStorageSystem, [56](#)
 - TileImprovement, [235](#)
- __setUpResourceChipSprite
 - HexTile, [153](#)
- __setUpSelectOutlineSprite
 - HexTile, [153](#)
- __setUpSolarPVBuildOption
 - HexTile, [153](#)
- __setUpTidalTurbineBuildOption
 - HexTile, [154](#)
- __setUpTileExplosionReel
 - HexTile, [154](#)
- __setUpTileImprovementSpriteAnimated
 - DieselGenerator, [44](#)
 - TidalTurbine, [216](#)
 - WaveEnergyConverter, [258](#)
 - WindTurbine, [276](#)
- __setUpTileImprovementSpriteStatic
 - EnergyStorageSystem, [56](#)
 - Settlement, [183](#)
 - SolarPV, [199](#)
- __setUpTileSprite
 - HexTile, [155](#)
- __setUpUpgradeMenu
 - TileImprovement, [235](#)
- __setUpVisualScreen
 - ContextMenu, [30](#)
- __setUpVisualScreenFrame
 - ContextMenu, [30](#)
- __setUpWaveEnergyConverterBuildOption
 - HexTile, [155](#)
- __setUpWindTurbineBuildOption
 - HexTile, [156](#)
- __smoothTileTypes
 - HexMap, [115](#)
- __summarizeTurn
 - Game, [83](#)
- __toggleFrameClockOverlay
 - Game, [84](#)
- __toggleTutorial
 - Game, [85](#)
- __updatePopulation
 - Game, [85](#)
- __upgrade
 - DieselGenerator, [45](#)
 - EnergyStorageSystem, [57](#)
- __upgradePowerCapacity
 - SolarPV, [199](#)
 - TidalTurbine, [217](#)
 - WaveEnergyConverter, [259](#)
 - WindTurbine, [277](#)
- __upgradeStorageCapacity
 - TileImprovement, [236](#)
- ~AssetsManager
 - AssetsManager, [8](#)
- ~ContextMenu
 - ContextMenu, [22](#)
- ~DieselGenerator
 - DieselGenerator, [41](#)
- ~EnergyStorageSystem
 - EnergyStorageSystem, [55](#)
- ~Game

- Game, 66
- ~HexMap
 - HexMap, 99
- ~HexTile
 - HexTile, 129
- ~MessageHub
 - MessageHub, 173
- ~Settlement
 - Settlement, 182
- ~SolarPV
 - SolarPV, 192
- ~TidalTurbine
 - TidalTurbine, 209
- ~TileImprovement
 - TileImprovement, 229
- ~WaveEnergyConverter
 - WaveEnergyConverter, 251
- ~WindTurbine
 - WindTurbine, 269
- ABOVE_AVERAGE
 - HexTile.h, 319
- addChannel
 - MessageHub, 173
- advanceTurn
 - DieselGenerator, 45
 - SolarPV, 200
 - TidalTurbine, 217
 - TileImprovement, 237
 - WaveEnergyConverter, 259
 - WindTurbine, 277
- assess
 - HexMap, 115
 - HexTile, 156
- assets_manager_ptr
 - ContextMenu, 33
 - Game, 87
 - HexMap, 119
 - HexTile, 163
 - TileImprovement, 241
- AssetsManager, 7
 - __loadSoundBuffer, 9
 - ~AssetsManager, 8
 - AssetsManager, 8
 - clear, 10
 - current_track, 18
 - font_map, 18
 - getCurrentTrackKey, 11
 - getFont, 11
 - getSound, 12
 - getSoundBuffer, 12
 - getTexture, 13
 - getTrackStatus, 13
 - loadFont, 14
 - loadSound, 14
 - loadTexture, 15
 - loadTrack, 16
 - nextTrack, 16
 - pauseTrack, 17
 - playTrack, 17
 - previousTrack, 17
 - sound_map, 18
 - soundbuffer_map, 18
 - stopTrack, 17
 - texture_map, 18
 - track_map, 19
- AVERAGE
 - HexTile.h, 319
- BELOW_AVERAGE
 - HexTile.h, 319
- bobbing_y
 - TidalTurbine, 222
 - WaveEnergyConverter, 264
- bool_payload
 - Message, 170
- border_tiles_vec
 - HexMap, 119
- BREAKDOWN_PROBABILITY_INCREMENT
 - constants.h, 295
- build_menu_backing
 - HexTile, 163
- build_menu_backing_text
 - HexTile, 164
- build_menu_open
 - HexTile, 164
- build_menu_options_text_vec
 - HexTile, 164
- build_menu_options_vec
 - HexTile, 164
- BUILD_SETTLEMENT
 - Game.h, 316
- BUILD_SETTLEMENT_COST
 - constants.h, 295
- capacity_factor_vec
 - SolarPV, 204
 - TidalTurbine, 222
 - WaveEnergyConverter, 264
 - WindTurbine, 282
- capacity_kW
 - DieselGenerator, 50
 - SolarPV, 204
 - TidalTurbine, 222
 - WaveEnergyConverter, 264
 - WindTurbine, 282
- capacity_MWh
 - EnergyStorageSystem, 60
- channel
 - Message, 170
- charge_MWh
 - EnergyStorageSystem, 60
- check_terminating_conditions
 - Game, 87
- clear
 - AssetsManager, 10
 - HexMap, 116
 - MessageHub, 174

- CLEAR_FOREST_COST
 - constants.h, [295](#)
- CLEAR_MOUNTAINS_COST
 - constants.h, [296](#)
- CLEAR_PLAINS_COST
 - constants.h, [296](#)
- clearMessages
 - MessageHub, [174](#)
- clock
 - Game, [87](#)
- coin_sprite
 - Settlement, [187](#)
- consecutive_zero_emissions_months
 - Game, [87](#)
- console_screen
 - ContextMenu, [33](#)
- console_screen_frame_bottom
 - ContextMenu, [33](#)
- console_screen_frame_left
 - ContextMenu, [34](#)
- console_screen_frame_right
 - ContextMenu, [34](#)
- console_screen_frame_top
 - ContextMenu, [34](#)
- console_state
 - ContextMenu, [34](#)
- console_string
 - ContextMenu, [34](#)
- console_string_changed
 - ContextMenu, [34](#)
- console_substring_idx
 - ContextMenu, [35](#)
- ConsoleState
 - ContextMenu.h, [286](#)
- constants.h
 - BREAKDOWN_PROBABILITY_INCREMENT, [295](#)
 - BUILD_SETTLEMENT_COST, [295](#)
 - CLEAR_FOREST_COST, [295](#)
 - CLEAR_MOUNTAINS_COST, [296](#)
 - CLEAR_PLAINS_COST, [296](#)
 - COST_PER_LITRE_DIESEL, [296](#)
 - CREDITS_PER_MWH_SERVED, [296](#)
 - DAILY_TIDAL_CAPACITY_FACTOR, [296](#)
 - DIESEL_GENERATOR_BUILD_COST, [296](#)
 - DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION, [297](#)
 - EMISSIONS_LIFETIME_LIMIT_TONNES, [297](#)
 - ENERGY_STORAGE_SYSTEM_BUILD_COST, [297](#)
 - FLOAT_TOLERANCE, [297](#)
 - FOREST_GREEN, [293](#)
 - FRAMES_PER_SECOND, [297](#)
 - GAME_CHANNEL, [297](#)
 - GAME_HEIGHT, [298](#)
 - GAME_STATE_CHANNEL, [298](#)
 - GAME_WIDTH, [298](#)
 - HEX_MAP_CHANNEL, [298](#)
 - KG_CO2E_PER_LITRE_DIESEL, [298](#)
 - LAKE_BLUE, [293](#)
 - LITRES_DIESEL_PER_MWH_PRODUCTION, [298](#)
 - MAX_STORAGE_LEVELS, [299](#)
 - MAX_UPGRADE_LEVELS, [299](#)
 - MAXIMUM_DAILY_DEMAND_PER_CAPITA, [299](#)
 - MEAN_DAILY_DEMAND_RATIOS, [299](#)
 - MEAN_DAILY_SOLAR_CAPACITY_FACTORS, [299](#)
 - MEAN_DAILY_WAVE_CAPACITY_FACTORS, [300](#)
 - MEAN_DAILY_WIND_CAPACITY_FACTORS, [300](#)
 - MEAN_POPULATION_GROWTH_RATE, [300](#)
 - MENU_FRAME_GREY, [293](#)
 - MONOCHROME_SCREEN_BACKGROUND, [293](#)
 - MONOCHROME_TEXT_AMBER, [293](#)
 - MONOCHROME_TEXT_GREEN, [294](#)
 - MONOCHROME_TEXT_RED, [294](#)
 - MOUNTAINS_GREY, [294](#)
 - NO_TILE_SELECTED_CHANNEL, [300](#)
 - OCEAN_BLUE, [294](#)
 - PLAINS_YELLOW, [294](#)
 - RESOURCE_ASSESSMENT_COST, [301](#)
 - RESOURCE_CHIP_GREY, [295](#)
 - SCRAP_COST, [301](#)
 - SECONDS_PER_FRAME, [301](#)
 - SECONDS_PER_MONTH, [301](#)
 - SECONDS_PER_YEAR, [301](#)
 - SETTLEMENT_CHANNEL, [301](#)
 - SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION, [302](#)
 - SOLAR_PV_BUILD_COST, [302](#)
 - SOLAR_PV_WATER_BUILD_MULTIPLIER, [302](#)
 - STARTING_CREDITS, [302](#)
 - STARTING_POPULATION, [302](#)
 - STDEV_DAILY_DEMAND_RATIOS, [302](#)
 - STDEV_DAILY_SOLAR_CAPACITY_FACTORS, [303](#)
 - STDEV_DAILY_WAVE_CAPACITY_FACTORS, [303](#)
 - STDEV_DAILY_WIND_CAPACITY_FACTORS, [303](#)
 - STDEV_POPULATION_GROWTH_RATE, [304](#)
 - TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION, [304](#)
 - TIDAL_TURBINE_BUILD_COST, [304](#)
 - TILE_RESOURCE_CUMULATIVE_PROBABILITIES, [304](#)
 - TILE_SELECTED_CHANNEL, [304](#)
 - TILE_STATE_CHANNEL, [305](#)
 - TILE_TYPE_CUMULATIVE_PROBABILITIES, [305](#)
 - TUTORIAL_PAGES, [305](#)
 - VISUAL_SCREEN_FRAME_GREY, [295](#)
 - WAVE_ENERGY_CONVERTER_BUILD_COST, [305](#)
 - WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION, [305](#)
 - WIND_OP_MAINT_COST_PER_MWH_PRODUCTION, [305](#)

- WIND_TURBINE_BUILD_COST, 306
- WIND_TURBINE_WATER_BUILD_MULTIPLIER, 306
- constructRenderWindow
 - main.cpp, 336
- context_menu_ptr
 - Game, 87
- ContextMenu, 19
 - __drawConsoleScreenFrame, 22
 - __drawConsoleText, 23
 - __drawVisualScreenFrame, 24
 - __handleKeyPressEvents, 24
 - __handleMouseButtonEvents, 25
 - __sendQuitGameMessage, 25
 - __sendRestartGameMessage, 25
 - __setConsoleState, 26
 - __setConsoleString, 26
 - __setUpConsoleScreen, 27
 - __setUpConsoleScreenFrame, 27
 - __setUpMenuFrame, 29
 - __setUpVisualScreen, 30
 - __setUpVisualScreenFrame, 30
 - ~ContextMenu, 22
 - assets_manager_ptr, 33
 - console_screen, 33
 - console_screen_frame_bottom, 33
 - console_screen_frame_left, 34
 - console_screen_frame_right, 34
 - console_screen_frame_top, 34
 - console_state, 34
 - console_string, 34
 - console_string_changed, 34
 - console_substring_idx, 35
 - ContextMenu, 21
 - draw, 31
 - event_ptr, 35
 - frame, 35
 - game_menu_up, 35
 - menu_frame, 35
 - message_hub_ptr, 35
 - position_x, 36
 - position_y, 36
 - processEvent, 32
 - processMessage, 32
 - render_window_ptr, 36
 - visual_screen, 36
 - visual_screen_frame_bottom, 36
 - visual_screen_frame_left, 36
 - visual_screen_frame_right, 37
 - visual_screen_frame_top, 37
- ContextMenu.h
 - ConsoleState, 286
 - MENU, 286
 - N_CONSOLE_STATES, 286
 - NONE_STATE, 286
 - READY, 286
 - TILE, 286
- COST_PER_LITRE_DIESEL
 - constants.h, 296
- credits
 - Game, 88
 - HexTile, 164
 - TileImprovement, 241
- CREDITS_PER_MWH_SERVED
 - constants.h, 296
- cumulative_emissions_tonnes
 - Game, 88
- current_track
 - AssetsManager, 18
- DAILY_TIDAL_CAPACITY_FACTOR
 - constants.h, 296
- dalpha
 - HexMap, 119
- decorateTile
 - HexTile, 157
- decoration_cleared
 - HexTile, 164
- demand_MWh
 - Game, 88
 - HexMap, 119
 - TileImprovement, 241
- demand_remaining_MWh
 - Game, 88
- demand_served_MWh
 - Game, 88
- demand_vec_MWh
 - Game, 88
 - TileImprovement, 241
- DIESEL_GENERATOR
 - TileImprovement.h, 324
- DIESEL_GENERATOR_BUILD_COST
 - constants.h, 296
- DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION
 - constants.h, 297
- DieselGenerator, 37
 - __breakdown, 41
 - __computeProductionCosts, 41
 - __drawProductionMenu, 41
 - __handleKeyPressEvents, 42
 - __handleMouseButtonEvents, 43
 - __repair, 44
 - __sendImprovementStateMessage, 44
 - __setUpTileImprovementSpriteAnimated, 44
 - __upgrade, 45
 - ~DieselGenerator, 41
 - advanceTurn, 45
 - capacity_kW, 50
 - DieselGenerator, 39
 - draw, 46
 - emissions_tonnes_CO2e, 50
 - fuel_cost, 50
 - getTileOptionsSubstring, 48
 - max_production_MWh, 51
 - processEvent, 49
 - processMessage, 49
 - production_MWh, 51

- setIsSelected, 50
- smoke_da, 51
- smoke_dx, 51
- smoke_dy, 51
- smoke_prob, 51
- smoke_sprite_list, 52
- dispatch_backing
 - TileImprovement, 241
- dispatch_income
 - Game, 89
- dispatch_MWh
 - SolarPV, 205
 - TidalTurbine, 222
 - WaveEnergyConverter, 265
 - WindTurbine, 282
- dispatch_text
 - TileImprovement, 241
- dispatch_vec_MWh
 - SolarPV, 205
 - TidalTurbine, 223
 - WaveEnergyConverter, 265
 - WindTurbine, 282
- dispatchable_MWh
 - SolarPV, 205
 - TidalTurbine, 223
 - WaveEnergyConverter, 265
 - WindTurbine, 283
- double_payload
 - Message, 170
- draw
 - ContextMenu, 31
 - DieselGenerator, 46
 - EnergyStorageSystem, 57
 - HexMap, 116
 - HexTile, 158
 - Settlement, 184
 - SolarPV, 201
 - TidalTurbine, 218
 - TileImprovement, 237
 - WaveEnergyConverter, 260
 - WindTurbine, 278
- draw_coin
 - Settlement, 187
- draw_explosion
 - HexTile, 165
- draw_turn_advance_banner
 - Game, 89
- EMISSIONS_LIFETIME_LIMIT_TONNES
 - constants.h, 297
- emissions_tonnes_CO2e
 - DieselGenerator, 50
- ENERGY_STORAGE_SYSTEM_BUILD_COST
 - constants.h, 297
- EnergyStorageSystem, 52
 - __handleKeyPressEvents, 55
 - __handleMouseButtonEvents, 56
 - __setUpProductionMenu, 56
 - __setUpTileImprovementSpriteStatic, 56
 - __upgrade, 57
 - ~EnergyStorageSystem, 55
 - capacity_MWh, 60
 - charge_MWh, 60
 - draw, 57
 - EnergyStorageSystem, 54
 - getTileOptionsSubstring, 58
 - processEvent, 59
 - processMessage, 59
 - setIsSelected, 59
- event
 - Game, 89
- event_ptr
 - ContextMenu, 35
 - HexMap, 120
 - HexTile, 165
 - TileImprovement, 242
- expectedErrorNotDetected
 - testing_utils.cpp, 329
 - testing_utils.h, 309
- explosion_frame
 - HexTile, 165
- explosion_sprite_reel
 - HexTile, 165
- fade_rectangle
 - Game, 89
- FLOAT_TOLERANCE
 - constants.h, 297
- font_map
 - AssetsManager, 18
- FOREST
 - HexTile.h, 319
- FOREST_GREEN
 - constants.h, 293
- frame
 - ContextMenu, 35
 - Game, 89
 - HexMap, 120
 - HexTile, 165
 - TileImprovement, 242
- FRAMES_PER_SECOND
 - constants.h, 297
- fuel_cost
 - DieselGenerator, 50
- Game, 60
 - __advanceTurn, 66
 - __checkTerminatingConditions, 66
 - __computeCurrentDemand, 67
 - __decrementTutorial, 67
 - __draw, 68
 - __drawFrameClockOverlay, 69
 - __drawHUD, 69
 - __drawLossCredits, 71
 - __drawLossDemand, 72
 - __drawLossEmissions, 72
 - __drawTurnAdvanceBanner, 73
 - __drawTurnSummary, 74

- [__drawTutorial](#), 75
- [__drawVictory](#), 75
- [__handleImprovementStateMessage](#), 76
- [__handleKeyPressEvents](#), 76
- [__handleMouseButtonEvents](#), 77
- [__incrementTutorial](#), 78
- [__insufficientCreditsAlarm](#), 78
- [__processEvent](#), 79
- [__processMessage](#), 80
- [__sendCreditsEarnedMessage](#), 81
- [__sendGameStateMessage](#), 81
- [__sendTurnAdvanceMessage](#), 82
- [__summarizeTurn](#), 83
- [__toggleFrameClockOverlay](#), 84
- [__toggleTutorial](#), 85
- [__updatePopulation](#), 85
- [~Game](#), 66
- [assets_manager_ptr](#), 87
- [check_terminating_conditions](#), 87
- [clock](#), 87
- [consecutive_zero_emissions_months](#), 87
- [context_menu_ptr](#), 87
- [credits](#), 88
- [cumulative_emissions_tonnes](#), 88
- [demand_MWh](#), 88
- [demand_remaining_MWh](#), 88
- [demand_served_MWh](#), 88
- [demand_vec_MWh](#), 88
- [dispatch_income](#), 89
- [draw_turn_advance_banner](#), 89
- [event](#), 89
- [fade_rectangle](#), 89
- [frame](#), 89
- [Game](#), 64
- [game_loop_broken](#), 89
- [game_phase](#), 90
- [hex_map_ptr](#), 90
- [increase_turn_advance_alpha](#), 90
- [message_deadlock](#), 90
- [message_deadlock_frame](#), 90
- [message_hub](#), 90
- [month](#), 91
- [net_credit_flow](#), 91
- [overproduction_MWh](#), 91
- [overproduction_penalty](#), 91
- [past_demand_MWh](#), 91
- [population](#), 91
- [quit_game](#), 92
- [render_window_ptr](#), 92
- [run](#), 85
- [show_frame_clock_overlay](#), 92
- [show_tutorial](#), 92
- [substring_idx](#), 92
- [time_since_start_s](#), 92
- [transition_from_title](#), 93
- [turn](#), 93
- [turn_advance_alpha](#), 93
- [turn_emissions_tonnes](#), 93
- [turn_end](#), 93
- [turn_fuel_cost](#), 93
- [turn_operation_maintenance_cost](#), 94
- [turn_summary_string](#), 94
- [turn_summary_text](#), 94
- [tutorial_page](#), 94
- [tutorial_string](#), 94
- [tutorial_text](#), 94
- [year](#), 95
- [Game.h](#)
 - [BUILD_SETTLEMENT](#), 316
 - [GamePhase](#), 316
 - [LOSS_CREDITS](#), 316
 - [LOSS_DEMAND](#), 316
 - [LOSS_EMISSIONS](#), 316
 - [N_GAME_PHASES](#), 316
 - [SYSTEM_MANAGEMENT](#), 316
 - [VICTORY](#), 316
- [GAME_CHANNEL](#)
 - [constants.h](#), 297
- [GAME_HEIGHT](#)
 - [constants.h](#), 298
- [game_loop_broken](#)
 - [Game](#), 89
- [game_menu_up](#)
 - [ContextMenu](#), 35
- [game_phase](#)
 - [Game](#), 90
 - [HexTile](#), 165
 - [TileImprovement](#), 242
- [GAME_STATE_CHANNEL](#)
 - [constants.h](#), 298
- [GAME_WIDTH](#)
 - [constants.h](#), 298
- [GamePhase](#)
 - [Game.h](#), 316
- [getCurrentTrackKey](#)
 - [AssetsManager](#), 11
- [getFont](#)
 - [AssetsManager](#), 11
- [getSound](#)
 - [AssetsManager](#), 12
- [getSoundBuffer](#)
 - [AssetsManager](#), 12
- [getTexture](#)
 - [AssetsManager](#), 13
- [getTileOptionsSubstring](#)
 - [DieselGenerator](#), 48
 - [EnergyStorageSystem](#), 58
 - [Settlement](#), 185
 - [SolarPV](#), 202
 - [TidalTurbine](#), 220
 - [TileImprovement](#), 239
 - [WaveEnergyConverter](#), 262
 - [WindTurbine](#), 280
- [getTrackStatus](#)
 - [AssetsManager](#), 13
- [glass_screen](#)

- HexMap, 120
- GOOD
 - HexTile.h, 319
- has_improvement
 - HexTile, 166
- hasTraffic
 - MessageHub, 174
- header/ContextMenu.h, 285
- header/DieselGenerator.h, 286
- header/EnergyStorageSystem.h, 287
- header/ESC_core/AssetsManager.h, 288
- header/ESC_core/constants.h, 289
- header/ESC_core/doxygen_cite.h, 306
- header/ESC_core/includes.h, 307
- header/ESC_core/MessageHub.h, 308
- header/ESC_core/testing_utils.h, 308
- header/Game.h, 315
- header/HexMap.h, 316
- header/HexTile.h, 317
- header/Settlement.h, 319
- header/SolarPV.h, 320
- header/TidalTurbine.h, 321
- header/TileImprovement.h, 322
- header/WaveEnergyConverter.h, 324
- header/WindTurbine.h, 325
- health
 - TileImprovement, 242
- hex_draw_order_vec
 - HexMap, 120
- hex_map
 - HexMap, 120
- HEX_MAP_CHANNEL
 - constants.h, 298
- hex_map_ptr
 - Game, 90
- HexMap, 95
 - __assembleHexMap, 99
 - __assessNeighbours, 100
 - __buildDrawOrderVector, 100
 - __drawTotalDispatch, 101
 - __enforceOceanContinuity, 103
 - __getMajorityTileType, 103
 - __getNeighboursVector, 104
 - __getNoise, 105
 - __getSelectedTile, 106
 - __getValidMapIndexPositions, 107
 - __handleInitialDraw, 108
 - __handleKeyPressEvents, 108
 - __handleMouseButtonEvents, 109
 - __isLakeTouchingOcean, 109
 - __layTiles, 110
 - __logSettlementPosition, 112
 - __procedurallyGenerateTileResources, 113
 - __procedurallyGenerateTileTypes, 113
 - __sendNoTileSelectedMessage, 114
 - __setUpGlassScreen, 114
 - __setUpInitialDraw, 114
 - __smoothTileTypes, 115
 - ~HexMap, 99
 - assess, 115
 - assets_manager_ptr, 119
 - border_tiles_vec, 119
 - clear, 116
 - dalpha, 119
 - demand_MWh, 119
 - draw, 116
 - event_ptr, 120
 - frame, 120
 - glass_screen, 120
 - hex_draw_order_vec, 120
 - hex_map, 120
 - HexMap, 98
 - initial_draw_tile_idx, 120
 - just_constructed, 121
 - message_hub_ptr, 121
 - n_layers, 121
 - n_tiles, 121
 - position_x, 121
 - position_y, 121
 - processEvent, 117
 - processMessage, 117
 - render_window_ptr, 122
 - reroll, 118
 - settlement_position_logged, 122
 - settlement_position_x, 122
 - settlement_position_y, 122
 - show_resource, 122
 - tile_position_x_vec, 122
 - tile_position_y_vec, 123
 - tile_selected, 123
 - toggleResourceOverlay, 118
- HexTile, 123
 - __buildDieselGenerator, 129
 - __buildEnergyStorage, 130
 - __buildSettlement, 130
 - __buildSolarPV, 131
 - __buildTidalTurbine, 132
 - __buildWaveEnergyConverter, 132
 - __buildWindTurbine, 133
 - __clearDecoration, 133
 - __closeBuildMenu, 134
 - __getTileCoordsSubstring, 134
 - __getTileImprovementSubstring, 135
 - __getTileOptionsSubstring, 135
 - __getTileResourceSubstring, 136
 - __getTileTypeSubstring, 137
 - __handleKeyPressEvents, 138
 - __handleKeyReleaseEvents, 142
 - __handleMouseButtonEvents, 143
 - __isClicked, 143
 - __openBuildMenu, 144
 - __scrapImprovement, 144
 - __sendAssessNeighboursMessage, 145
 - __sendCreditsSpentMessage, 145
 - __sendGameStateRequest, 146
 - __sendInsufficientCreditsMessage, 146

- [__sendTileSelectedMessage, 146](#)
- [__sendTileStateMessage, 147](#)
- [__sendUpdateGamePhaseMessage, 147](#)
- [__setIsSelected, 148](#)
- [__setResourceText, 148](#)
- [__setUpBuildMenu, 149](#)
- [__setUpBuildOption, 150](#)
- [__setUpDieselGeneratorBuildOption, 151](#)
- [__setUpEnergyStorageSystemBuildOption, 152](#)
- [__setUpMagnifyingGlassSprite, 152](#)
- [__setUpNodeSprite, 152](#)
- [__setUpResourceChipSprite, 153](#)
- [__setUpSelectOutlineSprite, 153](#)
- [__setUpSolarPVBuildOption, 153](#)
- [__setUpTidalTurbineBuildOption, 154](#)
- [__setUpTileExplosionReel, 154](#)
- [__setUpTileSprite, 155](#)
- [__setUpWaveEnergyConverterBuildOption, 155](#)
- [__setUpWindTurbineBuildOption, 156](#)
- [~HexTile, 129](#)
- [assess, 156](#)
- [assets_manager_ptr, 163](#)
- [build_menu_backing, 163](#)
- [build_menu_backing_text, 164](#)
- [build_menu_open, 164](#)
- [build_menu_options_text_vec, 164](#)
- [build_menu_options_vec, 164](#)
- [credits, 164](#)
- [decorateTile, 157](#)
- [decoration_cleared, 164](#)
- [draw, 158](#)
- [draw_explosion, 165](#)
- [event_ptr, 165](#)
- [explosion_frame, 165](#)
- [explosion_sprite_reel, 165](#)
- [frame, 165](#)
- [game_phase, 165](#)
- [has_improvement, 166](#)
- [HexTile, 128](#)
- [is_selected, 166](#)
- [magnifying_glass_sprite, 166](#)
- [major_radius, 166](#)
- [message_hub_ptr, 166](#)
- [minor_radius, 166](#)
- [node_sprite, 167](#)
- [position_x, 167](#)
- [position_y, 167](#)
- [processEvent, 159](#)
- [processMessage, 160](#)
- [render_window_ptr, 167](#)
- [resource_assessed, 167](#)
- [resource_assessment, 167](#)
- [resource_chip_sprite, 168](#)
- [resource_text, 168](#)
- [scrap_improvement_frame, 168](#)
- [select_outline_sprite, 168](#)
- [setTileResource, 160, 161](#)
- [setTileType, 161, 162](#)
- [show_node, 168](#)
- [show_resource, 168](#)
- [tile_decoration_sprite, 169](#)
- [tile_improvement_ptr, 169](#)
- [tile_resource, 169](#)
- [tile_sprite, 169](#)
- [tile_type, 169](#)
- [toggleResourceOverlay, 163](#)
- [HexTile.h](#)
 - [ABOVE_AVERAGE, 319](#)
 - [AVERAGE, 319](#)
 - [BELOW_AVERAGE, 319](#)
 - [FOREST, 319](#)
 - [GOOD, 319](#)
 - [LAKE, 319](#)
 - [MOUNTAINS, 319](#)
 - [N_TILE_RESOURCES, 319](#)
 - [N_TILE_TYPES, 319](#)
 - [NONE_TYPE, 319](#)
 - [OCEAN, 319](#)
 - [PLAINS, 319](#)
 - [POOR, 319](#)
 - [TileResource, 318](#)
 - [TileType, 319](#)
- [increase_turn_advance_alpha](#)
 - [Game, 90](#)
- [incrementMessageRead](#)
 - [MessageHub, 174](#)
- [initial_draw_tile_idx](#)
 - [HexMap, 120](#)
- [int_payload](#)
 - [Message, 171](#)
- [is_broken](#)
 - [TileImprovement, 242](#)
- [is_running](#)
 - [TileImprovement, 242](#)
- [is_selected](#)
 - [HexTile, 166](#)
 - [TileImprovement, 243](#)
- [isEmpty](#)
 - [MessageHub, 175](#)
- [just_built](#)
 - [TileImprovement, 243](#)
- [just_constructed](#)
 - [HexMap, 121](#)
- [just_upgraded](#)
 - [TileImprovement, 243](#)
- [KG_CO2E_PER_LITRE_DIESEL](#)
 - [constants.h, 298](#)
- [LAKE](#)
 - [HexTile.h, 319](#)
- [LAKE_BLUE](#)
 - [constants.h, 293](#)
- [LITRES_DIESEL_PER_MWH_PRODUCTION](#)
 - [constants.h, 298](#)

- loadAssets
 - main.cpp, [337](#)
- loadFont
 - AssetsManager, [14](#)
- loadSound
 - AssetsManager, [14](#)
- loadTexture
 - AssetsManager, [15](#)
- loadTrack
 - AssetsManager, [16](#)
- LOSS_CREDITS
 - Game.h, [316](#)
- LOSS_DEMAND
 - Game.h, [316](#)
- LOSS_EMISSIONS
 - Game.h, [316](#)
- magnifying_glass_sprite
 - HexTile, [166](#)
- main
 - main.cpp, [340](#)
- main.cpp
 - constructRenderWindow, [336](#)
 - loadAssets, [337](#)
 - main, [340](#)
 - playBrandAnimation, [341](#)
 - showTitleScreen, [344](#)
- major_radius
 - HexTile, [166](#)
- max_daily_production_MWh
 - SolarPV, [205](#)
 - TidalTurbine, [223](#)
 - WaveEnergyConverter, [265](#)
 - WindTurbine, [283](#)
- max_production_MWh
 - DieselGenerator, [51](#)
- MAX_STORAGE_LEVELS
 - constants.h, [299](#)
- MAX_UPGRADE_LEVELS
 - constants.h, [299](#)
- MAXIMUM_DAILY_DEMAND_PER_CAPITA
 - constants.h, [299](#)
- MEAN_DAILY_DEMAND_RATIOS
 - constants.h, [299](#)
- MEAN_DAILY_SOLAR_CAPACITY_FACTORS
 - constants.h, [299](#)
- MEAN_DAILY_WAVE_CAPACITY_FACTORS
 - constants.h, [300](#)
- MEAN_DAILY_WIND_CAPACITY_FACTORS
 - constants.h, [300](#)
- MEAN_POPULATION_GROWTH_RATE
 - constants.h, [300](#)
- MENU
 - ContextMenu.h, [286](#)
- menu_frame
 - ContextMenu, [35](#)
- MENU_FRAME_GREY
 - constants.h, [293](#)
- Message, [170](#)
- bool_payload, [170](#)
- channel, [170](#)
- double_payload, [170](#)
- int_payload, [171](#)
- number_of_reads, [171](#)
- string_payload, [171](#)
- subject, [171](#)
- vector_payload, [171](#)
- message_deadlock
 - Game, [90](#)
- message_deadlock_frame
 - Game, [90](#)
- message_hub
 - Game, [90](#)
- message_hub_ptr
 - ContextMenu, [35](#)
 - HexMap, [121](#)
 - HexTile, [166](#)
 - TileImprovement, [243](#)
- message_map
 - MessageHub, [179](#)
- MessageHub, [172](#)
 - ~MessageHub, [173](#)
 - addChannel, [173](#)
 - clear, [174](#)
 - clearMessages, [174](#)
 - hasTraffic, [174](#)
 - incrementMessageRead, [174](#)
 - isEmpty, [175](#)
 - message_map, [179](#)
 - MessageHub, [173](#)
 - popMessage, [176](#)
 - printState, [176](#)
 - receiveMessage, [177](#)
 - removeChannel, [178](#)
 - sendMessage, [178](#)
- minor_radius
 - HexTile, [166](#)
- MONOCHROME_SCREEN_BACKGROUND
 - constants.h, [293](#)
- MONOCHROME_TEXT_AMBER
 - constants.h, [293](#)
- MONOCHROME_TEXT_GREEN
 - constants.h, [294](#)
- MONOCHROME_TEXT_RED
 - constants.h, [294](#)
- month
 - Game, [91](#)
 - TileImprovement, [243](#)
- MOUNTAINS
 - HexTile.h, [319](#)
- MOUNTAINS_GREY
 - constants.h, [294](#)
- N_CONSOLE_STATES
 - ContextMenu.h, [286](#)
- N_GAME_PHASES
 - Game.h, [316](#)
- n_layers

- HexMap, 121
- N_TILE_IMPROVEMENT_TYPES
 - TileImprovement.h, 324
- N_TILE_RESOURCES
 - HexTile.h, 319
- N_TILE_TYPES
 - HexTile.h, 319
- n_tiles
 - HexMap, 121
- net_credit_flow
 - Game, 91
- nextTrack
 - AssetsManager, 16
- NO_TILE_SELECTED_CHANNEL
 - constants.h, 300
- node_sprite
 - HexTile, 167
- NONE_STATE
 - ContextMenu, 286
- NONE_TYPE
 - HexTile.h, 319
- number_of_reads
 - Message, 171
- OCEAN
 - HexTile.h, 319
- OCEAN_BLUE
 - constants.h, 294
- operation_maintenance_cost
 - TileImprovement, 243
- overproduction_MWh
 - Game, 91
- overproduction_penalty
 - Game, 91
- past_demand_MWh
 - Game, 91
- pauseTrack
 - AssetsManager, 17
- PLAINS
 - HexTile.h, 319
- PLAINS_YELLOW
 - constants.h, 294
- playBrandAnimation
 - main.cpp, 341
- playTrack
 - AssetsManager, 17
- POOR
 - HexTile.h, 319
- popMessage
 - MessageHub, 176
- population
 - Game, 91
- position_x
 - ContextMenu, 36
 - HexMap, 121
 - HexTile, 167
 - TileImprovement, 244
- position_y
 - ContextMenu, 36
 - HexMap, 121
 - HexTile, 167
 - TileImprovement, 244
- previousTrack
 - AssetsManager, 17
- printGold
 - testing_utils.cpp, 329
 - testing_utils.h, 310
- printGreen
 - testing_utils.cpp, 329
 - testing_utils.h, 310
- printRed
 - testing_utils.cpp, 330
 - testing_utils.h, 311
- printState
 - MessageHub, 176
- processEvent
 - ContextMenu, 32
 - DieselGenerator, 49
 - EnergyStorageSystem, 59
 - HexMap, 117
 - HexTile, 159
 - Settlement, 185
 - SolarPV, 203
 - TidalTurbine, 220
 - TileImprovement, 239
 - WaveEnergyConverter, 263
 - WindTurbine, 280
- processMessage
 - ContextMenu, 32
 - DieselGenerator, 49
 - EnergyStorageSystem, 59
 - HexMap, 117
 - HexTile, 160
 - Settlement, 186
 - SolarPV, 203
 - TidalTurbine, 221
 - TileImprovement, 239
 - WaveEnergyConverter, 263
 - WindTurbine, 281
- production_menu_backing
 - TileImprovement, 244
- production_menu_backing_text
 - TileImprovement, 244
- production_menu_open
 - TileImprovement, 244
- production_MWh
 - DieselGenerator, 51
 - SolarPV, 205
 - TidalTurbine, 223
 - WaveEnergyConverter, 265
 - WindTurbine, 283
- production_vec_MWh
 - SolarPV, 205
 - TidalTurbine, 223
 - WaveEnergyConverter, 265
 - WindTurbine, 283

- quit_game
 - Game, [92](#)
- READY
 - ContextMenu.h, [286](#)
- receiveMessage
 - MessageHub, [177](#)
- removeChannel
 - MessageHub, [178](#)
- render_window_ptr
 - ContextMenu, [36](#)
 - Game, [92](#)
 - HexMap, [122](#)
 - HexTile, [167](#)
 - TileImprovement, [244](#)
- reroll
 - HexMap, [118](#)
- resource_assessed
 - HexTile, [167](#)
- resource_assessment
 - HexTile, [167](#)
- RESOURCE_ASSESSMENT_COST
 - constants.h, [301](#)
- RESOURCE_CHIP_GREY
 - constants.h, [295](#)
- resource_chip_sprite
 - HexTile, [168](#)
- resource_text
 - HexTile, [168](#)
- rotor_drotation
 - TidalTurbine, [223](#)
 - WindTurbine, [283](#)
- run
 - Game, [85](#)
- SCRAP_COST
 - constants.h, [301](#)
- scrap_improvement_frame
 - HexTile, [168](#)
- SECONDS_PER_FRAME
 - constants.h, [301](#)
- SECONDS_PER_MONTH
 - constants.h, [301](#)
- SECONDS_PER_YEAR
 - constants.h, [301](#)
- select_outline_sprite
 - HexTile, [168](#)
- sendMessage
 - MessageHub, [178](#)
- setIsSelected
 - DieselGenerator, [50](#)
 - EnergyStorageSystem, [59](#)
 - Settlement, [186](#)
 - SolarPV, [203](#)
 - TidalTurbine, [221](#)
 - TileImprovement, [240](#)
 - WaveEnergyConverter, [263](#)
 - WindTurbine, [281](#)
- setTileResource
 - HexTile, [160](#), [161](#)
- setTileType
 - HexTile, [161](#), [162](#)
- SETTLEMENT
 - TileImprovement.h, [324](#)
- Settlement, [179](#)
 - __handleKeyPressEvents, [182](#)
 - __handleMouseButtonEvents, [183](#)
 - __setUpCoinSprite, [183](#)
 - __setUpTileImprovementSpriteStatic, [183](#)
 - ~Settlement, [182](#)
 - coin_sprite, [187](#)
 - draw, [184](#)
 - draw_coin, [187](#)
 - getTileOptionsSubstring, [185](#)
 - processEvent, [185](#)
 - processMessage, [186](#)
 - setIsSelected, [186](#)
 - Settlement, [181](#)
 - smoke_da, [187](#)
 - smoke_dx, [187](#)
 - smoke_dy, [187](#)
 - smoke_prob, [187](#)
 - smoke_sprite_list, [188](#)
- SETTLEMENT_CHANNEL
 - constants.h, [301](#)
- settlement_position_logged
 - HexMap, [122](#)
- settlement_position_x
 - HexMap, [122](#)
- settlement_position_y
 - HexMap, [122](#)
- show_frame_clock_overlay
 - Game, [92](#)
- show_node
 - HexTile, [168](#)
- show_resource
 - HexMap, [122](#)
 - HexTile, [168](#)
- show_tutorial
 - Game, [92](#)
- showTitleScreen
 - main.cpp, [344](#)
- smoke_da
 - DieselGenerator, [51](#)
 - Settlement, [187](#)
- smoke_dx
 - DieselGenerator, [51](#)
 - Settlement, [187](#)
- smoke_dy
 - DieselGenerator, [51](#)
 - Settlement, [187](#)
- smoke_prob
 - DieselGenerator, [51](#)
 - Settlement, [187](#)
- smoke_sprite_list
 - DieselGenerator, [52](#)
 - Settlement, [188](#)

- SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION
 - constants.h, [302](#)
- SOLAR_PV
 - TileImprovement.h, [324](#)
- SOLAR_PV_BUILD_COST
 - constants.h, [302](#)
- SOLAR_PV_WATER_BUILD_MULTIPLIER
 - constants.h, [302](#)
- SolarPV, [188](#)
 - __breakdown, [192](#)
 - __computeCapacityFactors, [192](#)
 - __computeDispatch, [193](#)
 - __computeProduction, [194](#)
 - __computeProductionCosts, [194](#)
 - __drawProductionMenu, [195](#)
 - __drawUpgradeOptions, [195](#)
 - __handleKeyPressEvents, [197](#)
 - __handleMouseButtonEvents, [198](#)
 - __repair, [198](#)
 - __sendImprovementStateMessage, [199](#)
 - __setUpTileImprovementSpriteStatic, [199](#)
 - __upgradePowerCapacity, [199](#)
 - ~SolarPV, [192](#)
 - advanceTurn, [200](#)
 - capacity_factor_vec, [204](#)
 - capacity_kW, [204](#)
 - dispatch_MWh, [205](#)
 - dispatch_vec_MWh, [205](#)
 - dispatchable_MWh, [205](#)
 - draw, [201](#)
 - getTileOptionsSubstring, [202](#)
 - max_daily_production_MWh, [205](#)
 - processEvent, [203](#)
 - processMessage, [203](#)
 - production_MWh, [205](#)
 - production_vec_MWh, [205](#)
 - setIsSelected, [203](#)
 - SolarPV, [191](#)
 - update, [204](#)
- sound_map
 - AssetsManager, [18](#)
- soundbuffer_map
 - AssetsManager, [18](#)
- source/ContextMenu.cpp, [326](#)
- source/DieselGenerator.cpp, [326](#)
- source/EnergyStorageSystem.cpp, [327](#)
- source/ESC_core/AssetsManager.cpp, [327](#)
- source/ESC_core/MessageHub.cpp, [327](#)
- source/ESC_core/testing_utils.cpp, [328](#)
- source/Game.cpp, [334](#)
- source/HexMap.cpp, [334](#)
- source/HexTile.cpp, [335](#)
- source/main.cpp, [335](#)
- source/Settlement.cpp, [348](#)
- source/SolarPV.cpp, [348](#)
- source/TidalTurbine.cpp, [348](#)
- source/TileImprovement.cpp, [349](#)
- source/WaveEnergyConverter.cpp, [349](#)
- source/WindTurbine.cpp, [350](#)
- STARTING_CREDITS
 - constants.h, [302](#)
- STARTING_POPULATION
 - constants.h, [302](#)
- STDEV_DAILY_DEMAND_RATIOS
 - constants.h, [302](#)
- STDEV_DAILY_SOLAR_CAPACITY_FACTORS
 - constants.h, [303](#)
- STDEV_DAILY_WAVE_CAPACITY_FACTORS
 - constants.h, [303](#)
- STDEV_DAILY_WIND_CAPACITY_FACTORS
 - constants.h, [303](#)
- STDEV_POPULATION_GROWTH_RATE
 - constants.h, [304](#)
- stopTrack
 - AssetsManager, [17](#)
- storage_kWh
 - TileImprovement, [245](#)
- storage_level
 - TileImprovement, [245](#)
- storage_upgrade_sprite
 - TileImprovement, [245](#)
- storage_upgrade_sprite_vec
 - TileImprovement, [245](#)
- string_payload
 - Message, [171](#)
- subject
 - Message, [171](#)
- substring_idx
 - Game, [92](#)
- SYSTEM_MANAGEMENT
 - Game.h, [316](#)
- testFloatEquals
 - testing_utils.cpp, [330](#)
 - testing_utils.h, [311](#)
- testGreaterThan
 - testing_utils.cpp, [331](#)
 - testing_utils.h, [312](#)
- testGreaterThanOrEqualTo
 - testing_utils.cpp, [331](#)
 - testing_utils.h, [312](#)
- testing_utils.cpp
 - expectedErrorNotDetected, [329](#)
 - printGold, [329](#)
 - printGreen, [329](#)
 - printRed, [330](#)
 - testFloatEquals, [330](#)
 - testGreaterThan, [331](#)
 - testGreaterThanOrEqualTo, [331](#)
 - testLessThan, [332](#)
 - testLessThanOrEqualTo, [333](#)
 - testTruth, [333](#)
- testing_utils.h
 - expectedErrorNotDetected, [309](#)
 - printGold, [310](#)
 - printGreen, [310](#)
 - printRed, [311](#)

- testFloatEquals, [311](#)
- testGreaterThan, [312](#)
- testGreaterThanOrEqualTo, [312](#)
- testLessThan, [313](#)
- testLessThanOrEqualTo, [314](#)
- testTruth, [314](#)
- testLessThan
 - testing_utils.cpp, [332](#)
 - testing_utils.h, [313](#)
- testLessThanOrEqualTo
 - testing_utils.cpp, [333](#)
 - testing_utils.h, [314](#)
- testTruth
 - testing_utils.cpp, [333](#)
 - testing_utils.h, [314](#)
- texture_map
 - AssetsManager, [18](#)
- TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION
 - constants.h, [304](#)
- TIDAL_TURBINE
 - TileImprovement.h, [324](#)
- TIDAL_TURBINE_BUILD_COST
 - constants.h, [304](#)
- TidalTurbine, [206](#)
 - __breakdown, [210](#)
 - __computeCapacityFactors, [210](#)
 - __computeDispatch, [210](#)
 - __computeProduction, [211](#)
 - __computeProductionCosts, [212](#)
 - __drawProductionMenu, [212](#)
 - __drawUpgradeOptions, [213](#)
 - __handleKeyPressEvents, [214](#)
 - __handleMouseButtonEvents, [215](#)
 - __repair, [215](#)
 - __sendImprovementStateMessage, [216](#)
 - __setUpTileImprovementSpriteAnimated, [216](#)
 - __upgradePowerCapacity, [217](#)
 - ~TidalTurbine, [209](#)
 - advanceTurn, [217](#)
 - bobbing_y, [222](#)
 - capacity_factor_vec, [222](#)
 - capacity_kW, [222](#)
 - dispatch_MWh, [222](#)
 - dispatch_vec_MWh, [223](#)
 - dispatchable_MWh, [223](#)
 - draw, [218](#)
 - getTileOptionsSubstring, [220](#)
 - max_daily_production_MWh, [223](#)
 - processEvent, [220](#)
 - processMessage, [221](#)
 - production_MWh, [223](#)
 - production_vec_MWh, [223](#)
 - rotor_drotation, [223](#)
 - setIsSelected, [221](#)
 - TidalTurbine, [208](#)
 - update, [222](#)
- TILE
 - ContextMenu.h, [286](#)
- tile_decoration_sprite
 - HexTile, [169](#)
- tile_improvement_ptr
 - HexTile, [169](#)
- tile_improvement_sprite_animated
 - TileImprovement, [245](#)
- tile_improvement_sprite_static
 - TileImprovement, [245](#)
- tile_improvement_string
 - TileImprovement, [246](#)
- tile_improvement_type
 - TileImprovement, [246](#)
- tile_position_x_vec
 - HexMap, [122](#)
- tile_position_y_vec
 - HexMap, [123](#)
- tile_resource
 - HexTile, [169](#)
 - TileImprovement, [246](#)
- TILE_RESOURCE_CUMULATIVE_PROBABILITIES
 - constants.h, [304](#)
- tile_resource_scalar
 - TileImprovement, [246](#)
- tile_selected
 - HexMap, [123](#)
- TILE_SELECTED_CHANNEL
 - constants.h, [304](#)
- tile_sprite
 - HexTile, [169](#)
- TILE_STATE_CHANNEL
 - constants.h, [305](#)
- tile_type
 - HexTile, [169](#)
- TILE_TYPE_CUMULATIVE_PROBABILITIES
 - constants.h, [305](#)
- TileImprovement, [224](#)
 - __breakdown, [230](#)
 - __closeProductionMenu, [230](#)
 - __closeUpgradeMenu, [230](#)
 - __drawDispatch, [230](#)
 - __handleKeyPressEvents, [231](#)
 - __handleMouseButtonEvents, [232](#)
 - __openProductionMenu, [232](#)
 - __openUpgradeMenu, [232](#)
 - __repair, [233](#)
 - __sendCreditsSpentMessage, [233](#)
 - __sendGameStateRequest, [234](#)
 - __sendInsufficientCreditsMessage, [234](#)
 - __sendTileStateRequest, [234](#)
 - __setUpDispatchIllustration, [234](#)
 - __setUpProductionMenu, [235](#)
 - __setUpUpgradeMenu, [235](#)
 - __upgradeStorageCapacity, [236](#)
 - ~TileImprovement, [229](#)
 - advanceTurn, [237](#)
 - assets_manager_ptr, [241](#)
 - credits, [241](#)
 - demand_MWh, [241](#)

- demand_vec_MWh, 241
- dispatch_backing, 241
- dispatch_text, 241
- draw, 237
- event_ptr, 242
- frame, 242
- game_phase, 242
- getTileOptionsSubstring, 239
- health, 242
- is_broken, 242
- is_running, 242
- is_selected, 243
- just_built, 243
- just_upgraded, 243
- message_hub_ptr, 243
- month, 243
- operation_maintenance_cost, 243
- position_x, 244
- position_y, 244
- processEvent, 239
- processMessage, 239
- production_menu_backing, 244
- production_menu_backing_text, 244
- production_menu_open, 244
- render_window_ptr, 244
- setIsSelected, 240
- storage_kWh, 245
- storage_level, 245
- storage_upgrade_sprite, 245
- storage_upgrade_sprite_vec, 245
- tile_improvement_sprite_animated, 245
- tile_improvement_sprite_static, 245
- tile_improvement_string, 246
- tile_improvement_type, 246
- tile_resource, 246
- tile_resource_scalar, 246
- TileImprovement, 228
- update, 240
- upgrade_arrow_sprite, 246
- upgrade_frame, 246
- upgrade_level, 247
- upgrade_menu_backing, 247
- upgrade_menu_backing_text, 247
- upgrade_menu_open, 247
- upgrade_plus_sprite, 247
- TileImprovement.h
 - DIESEL_GENERATOR, 324
 - N_TILE_IMPROVEMENT_TYPES, 324
 - SETTLEMENT, 324
 - SOLAR_PV, 324
 - TIDAL_TURBINE, 324
 - TileImprovementType, 323
 - WAVE_ENERGY_CONVERTER, 324
 - WIND_TURBINE, 324
- TileImprovementType
 - TileImprovement.h, 323
- TileResource
 - HexTile.h, 318
- TileType
 - HexTile.h, 319
- time_since_start_s
 - Game, 92
- toggleResourceOverlay
 - HexMap, 118
 - HexTile, 163
- track_map
 - AssetsManager, 19
- transition_from_title
 - Game, 93
- turn
 - Game, 93
- turn_advance_alpha
 - Game, 93
- turn_emissions_tonnes
 - Game, 93
- turn_end
 - Game, 93
- turn_fuel_cost
 - Game, 93
- turn_operation_maintenance_cost
 - Game, 94
- turn_summary_string
 - Game, 94
- turn_summary_text
 - Game, 94
- tutorial_page
 - Game, 94
- TUTORIAL_PAGES
 - constants.h, 305
- tutorial_string
 - Game, 94
- tutorial_text
 - Game, 94
- update
 - SolarPV, 204
 - TidalTurbine, 222
 - TileImprovement, 240
 - WaveEnergyConverter, 264
 - WindTurbine, 282
- upgrade_arrow_sprite
 - TileImprovement, 246
- upgrade_frame
 - TileImprovement, 246
- upgrade_level
 - TileImprovement, 247
- upgrade_menu_backing
 - TileImprovement, 247
- upgrade_menu_backing_text
 - TileImprovement, 247
- upgrade_menu_open
 - TileImprovement, 247
- upgrade_plus_sprite
 - TileImprovement, 247
- vector_payload
 - Message, 171

VICTORY

- Game.h, 316

visual_screen

- ContextMenu, 36

visual_screen_frame_bottom

- ContextMenu, 36

VISUAL_SCREEN_FRAME_GREY

- constants.h, 295

visual_screen_frame_left

- ContextMenu, 36

visual_screen_frame_right

- ContextMenu, 37

visual_screen_frame_top

- ContextMenu, 37

WAVE_ENERGY_CONVERTER

- TileImprovement.h, 324

WAVE_ENERGY_CONVERTER_BUILD_COST

- constants.h, 305

WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION

- constants.h, 305

WaveEnergyConverter, 248

- __breakdown, 251
- __computeCapacityFactors, 252
- __computeDispatch, 252
- __computeProduction, 253
- __computeProductionCosts, 254
- __drawProductionMenu, 254
- __drawUpgradeOptions, 255
- __handleKeyPressEvents, 256
- __handleMouseButtonEvents, 257
- __repair, 258
- __sendImprovementStateMessage, 258
- __setUpTileImprovementSpriteAnimated, 258
- __upgradePowerCapacity, 259
- ~WaveEnergyConverter, 251
- advanceTurn, 259
- bobbing_y, 264
- capacity_factor_vec, 264
- capacity_kW, 264
- dispatch_MWh, 265
- dispatch_vec_MWh, 265
- dispatchable_MWh, 265
- draw, 260
- getTileOptionsSubstring, 262
- max_daily_production_MWh, 265
- processEvent, 263
- processMessage, 263
- production_MWh, 265
- production_vec_MWh, 265
- setIsSelected, 263
- update, 264
- WaveEnergyConverter, 250

WIND_OP_MAINT_COST_PER_MWH_PRODUCTION

- constants.h, 305

WIND_TURBINE

- TileImprovement.h, 324

WIND_TURBINE_BUILD_COST

- constants.h, 306

WIND_TURBINE_WATER_BUILD_MULTIPLIER

- constants.h, 306

WindTurbine, 266

- __breakdown, 270
- __computeCapacityFactors, 270
- __computeDispatch, 270
- __computeProduction, 271
- __computeProductionCosts, 272
- __drawProductionMenu, 272
- __drawUpgradeOptions, 273
- __handleKeyPressEvents, 274
- __handleMouseButtonEvents, 275
- __repair, 276
- __sendImprovementStateMessage, 276
- __setUpTileImprovementSpriteAnimated, 276
- __upgradePowerCapacity, 277
- ~WindTurbine, 269
- advanceTurn, 277
- capacity_factor_vec, 282
- capacity_kW, 282
- dispatch_MWh, 282
- dispatch_vec_MWh, 282
- dispatchable_MWh, 283
- draw, 278
- getTileOptionsSubstring, 280
- max_daily_production_MWh, 283
- processEvent, 280
- processMessage, 281
- production_MWh, 283
- production_vec_MWh, 283
- rotor_drotation, 283
- setIsSelected, 281
- update, 282
- WindTurbine, 268

year

- Game, 95