

Road To Zero - The Microgrid Management Game

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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()	49
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	50
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	51
4.3.4.10 smoke_sprite_list	52
4.4 EnergyStorageSystem Class Reference	52
4.4.1 Detailed Description	53
4.4.2 Constructor & Destructor Documentation	53
4.4.2.1 EnergyStorageSystem()	54
4.4.2.2 ~EnergyStorageSystem()	54
4.4.3 Member Function Documentation	55
4.4.3.1 __handleKeyPressEvents()	55
4.4.3.2 __handleMouseButtonEvents()	55

4.4.3.3 __setUpProductionMenu()	56
4.4.3.4 __setUpTileImprovementSpriteStatic()	56
4.4.3.5 __upgrade()	57
4.4.3.6 draw()	57
4.4.3.7 getTileOptionsSubstring()	58
4.4.3.8 processEvent()	58
4.4.3.9 processMessage()	59
4.4.3.10 setIsSelected()	59
4.4.4 Member Data Documentation	59
4.4.4.1 capacity_MWh	59
4.4.4.2 charge_MWh	60
4.5 Game Class Reference	60
4.5.1 Detailed Description	63
4.5.2 Constructor & Destructor Documentation	64
4.5.2.1 Game()	64
4.5.2.2 ~Game()	65
4.5.3 Member Function Documentation	65
4.5.3.1 __advanceTurn()	65
4.5.3.2 __checkTerminatingConditions()	66
4.5.3.3 __computeCurrentDemand()	67
4.5.3.4 __draw()	67
4.5.3.5 __drawFrameClockOverlay()	68
4.5.3.6 __drawHUD()	68
4.5.3.7 __drawLossCredits()	70
4.5.3.8 __drawLossDemand()	71
4.5.3.9 __drawLossEmissions()	71
4.5.3.10 __drawTurnAdvanceBanner()	72
4.5.3.11 __drawTurnSummary()	73
4.5.3.12 __drawVictory()	74
4.5.3.13 __handleImprovementStateMessage()	74
4.5.3.14 __handleKeyPressEvents()	75
4.5.3.15 __handleMouseButtonEvents()	76
4.5.3.16 __insufficientCreditsAlarm()	76
4.5.3.17 __processEvent()	77
4.5.3.18 __processMessage()	78
4.5.3.19 __sendCreditsEarnedMessage()	79
4.5.3.20 __sendGameStateMessage()	79
4.5.3.21 __sendTurnAdvanceMessage()	80
4.5.3.22 __summarizeTurn()	81
4.5.3.23 __toggleFrameClockOverlay()	82
4.5.3.24 __updatePopulation()	83
4.5.3.25 run()	83

4.5.4 Member Data Documentation	84
4.5.4.1 assets_manager_ptr	84
4.5.4.2 check_terminating_conditions	85
4.5.4.3 clock	85
4.5.4.4 consecutive_zero_emissions_months	85
4.5.4.5 context_menu_ptr	85
4.5.4.6 credits	85
4.5.4.7 cumulative_emissions_tonnes	85
4.5.4.8 demand_MWh	86
4.5.4.9 demand_remaining_MWh	86
4.5.4.10 demand_served_MWh	86
4.5.4.11 demand_vec_MWh	86
4.5.4.12 dispatch_income	86
4.5.4.13 draw_turn_advance_banner	86
4.5.4.14 event	87
4.5.4.15 frame	87
4.5.4.16 game_loop_broken	87
4.5.4.17 game_phase	87
4.5.4.18 hex_map_ptr	87
4.5.4.19 increase_turn_advance_alpha	87
4.5.4.20 message_deadlock	88
4.5.4.21 message_deadlock_frame	88
4.5.4.22 message_hub	88
4.5.4.23 month	88
4.5.4.24 net_credit_flow	88
4.5.4.25 overproduction_MWh	88
4.5.4.26 overproduction_penalty	89
4.5.4.27 past_demand_MWh	89
4.5.4.28 population	89
4.5.4.29 quit_game	89
4.5.4.30 render_window_ptr	89
4.5.4.31 show_frame_clock_overlay	89
4.5.4.32 show_tutorial	90
4.5.4.33 substring_idx	90
4.5.4.34 time_since_start_s	90
4.5.4.35 turn	90
4.5.4.36 turn_advance_alpha	90
4.5.4.37 turn_emissions_tonnes	90
4.5.4.38 turn_end	91
4.5.4.39 turn_fuel_cost	91
4.5.4.40 turn_operation_maintenance_cost	91
4.5.4.41 turn_summary_string	91

4.5.4.42 turn_summary_text	91
4.5.4.43 year	91
4.6 HexMap Class Reference	92
4.6.1 Detailed Description	94
4.6.2 Constructor & Destructor Documentation	95
4.6.2.1 HexMap()	95
4.6.2.2 ~HexMap()	96
4.6.3 Member Function Documentation	96
4.6.3.1 __assembleHexMap()	96
4.6.3.2 __assessNeighbours()	96
4.6.3.3 __buildDrawOrderVector()	97
4.6.3.4 __drawTotalDispatch()	98
4.6.3.5 __enforceOceanContinuity()	99
4.6.3.6 __getMajorityTileType()	100
4.6.3.7 __getNeighboursVector()	101
4.6.3.8 __getNoise()	102
4.6.3.9 __getSelectedTile()	103
4.6.3.10 __getValidMapIndexPositions()	104
4.6.3.11 __handleKeyPressEvents()	104
4.6.3.12 __handleMouseButtonEvents()	105
4.6.3.13 __isLakeTouchingOcean()	105
4.6.3.14 __layTiles()	106
4.6.3.15 __logSettlementPosition()	108
4.6.3.16 __procedurallyGenerateTileResources()	109
4.6.3.17 __procedurallyGenerateTileTypes()	109
4.6.3.18 __sendNoTileSelectedMessage()	110
4.6.3.19 __setUpGlassScreen()	110
4.6.3.20 __smoothTileTypes()	111
4.6.3.21 assess()	111
4.6.3.22 clear()	111
4.6.3.23 draw()	112
4.6.3.24 processEvent()	113
4.6.3.25 processMessage()	113
4.6.3.26 reroll()	114
4.6.3.27 toggleResourceOverlay()	114
4.6.4 Member Data Documentation	115
4.6.4.1 assets_manager_ptr	115
4.6.4.2 border_tiles_vec	115
4.6.4.3 demand_MWh	115
4.6.4.4 event_ptr	115
4.6.4.5 frame	116
4.6.4.6 glass_screen	116

4.6.4.7 hex_draw_order_vec	116
4.6.4.8 hex_map	116
4.6.4.9 message_hub_ptr	116
4.6.4.10 n_layers	116
4.6.4.11 n_tiles	117
4.6.4.12 position_x	117
4.6.4.13 position_y	117
4.6.4.14 render_window_ptr	117
4.6.4.15 settlement_position_logged	117
4.6.4.16 settlement_position_x	117
4.6.4.17 settlement_position_y	118
4.6.4.18 show_resource	118
4.6.4.19 tile_position_x_vec	118
4.6.4.20 tile_position_y_vec	118
4.6.4.21 tile_selected	118
4.7 HexTile Class Reference	119
4.7.1 Detailed Description	123
4.7.2 Constructor & Destructor Documentation	123
4.7.2.1 HexTile()	123
4.7.2.2 ~HexTile()	124
4.7.3 Member Function Documentation	124
4.7.3.1 __buildDieselGenerator()	125
4.7.3.2 __buildEnergyStorage()	125
4.7.3.3 __buildSettlement()	126
4.7.3.4 __buildSolarPV()	126
4.7.3.5 __buildTidalTurbine()	127
4.7.3.6 __buildWaveEnergyConverter()	128
4.7.3.7 __buildWindTurbine()	128
4.7.3.8 __clearDecoration()	129
4.7.3.9 __closeBuildMenu()	129
4.7.3.10 __getTileCoordsSubstring()	130
4.7.3.11 __getTileImprovementSubstring()	130
4.7.3.12 __getTileOptionsSubstring()	131
4.7.3.13 __getTileResourceSubstring()	132
4.7.3.14 __getTileTypeSubstring()	133
4.7.3.15 __handleKeyPressEvents()	134
4.7.3.16 __handleKeyReleaseEvents()	137
4.7.3.17 __handleMouseButtonEvents()	138
4.7.3.18 __isClicked()	139
4.7.3.19 __openBuildMenu()	139
4.7.3.20 __scrapImprovement()	140
4.7.3.21 __sendAssessNeighboursMessage()	140

4.7.3.22	__sendCreditsSpentMessage()	141
4.7.3.23	__sendGameStateRequest()	141
4.7.3.24	__sendInsufficientCreditsMessage()	142
4.7.3.25	__sendTileSelectedMessage()	142
4.7.3.26	__sendTileStateMessage()	142
4.7.3.27	__sendUpdateGamePhaseMessage()	143
4.7.3.28	__setIsSelected()	143
4.7.3.29	__setResourceText()	143
4.7.3.30	__setUpBuildMenu()	144
4.7.3.31	__setUpBuildOption()	145
4.7.3.32	__setUpDieselGeneratorBuildOption()	146
4.7.3.33	__setUpEnergyStorageSystemBuildOption()	147
4.7.3.34	__setUpMagnifyingGlassSprite()	147
4.7.3.35	__setUpNodeSprite()	148
4.7.3.36	__setUpResourceChipSprite()	148
4.7.3.37	__setUpSelectOutlineSprite()	148
4.7.3.38	__setUpSolarPVBuildOption()	149
4.7.3.39	__setUpTidalTurbineBuildOption()	149
4.7.3.40	__setUpTileExplosionReel()	150
4.7.3.41	__setUpTileSprite()	150
4.7.3.42	__setUpWaveEnergyConverterBuildOption()	150
4.7.3.43	__setUpWindTurbineBuildOption()	151
4.7.3.44	assess()	152
4.7.3.45	decorateTile()	152
4.7.3.46	draw()	153
4.7.3.47	processEvent()	154
4.7.3.48	processMessage()	155
4.7.3.49	setTileResource() [1/2]	156
4.7.3.50	setTileResource() [2/2]	156
4.7.3.51	setTileType() [1/2]	157
4.7.3.52	setTileType() [2/2]	157
4.7.3.53	toggleResourceOverlay()	158
4.7.4	Member Data Documentation	158
4.7.4.1	assets_manager_ptr	158
4.7.4.2	build_menu_backing	159
4.7.4.3	build_menu_backing_text	159
4.7.4.4	build_menu_open	159
4.7.4.5	build_menu_options_text_vec	159
4.7.4.6	build_menu_options_vec	159
4.7.4.7	credits	159
4.7.4.8	decoration_cleared	160
4.7.4.9	draw_explosion	160

4.7.4.10 event_ptr	160
4.7.4.11 explosion_frame	160
4.7.4.12 explosion_sprite_reel	160
4.7.4.13 frame	160
4.7.4.14 game_phase	161
4.7.4.15 has_improvement	161
4.7.4.16 is_selected	161
4.7.4.17 magnifying_glass_sprite	161
4.7.4.18 major_radius	161
4.7.4.19 message_hub_ptr	161
4.7.4.20 minor_radius	162
4.7.4.21 node_sprite	162
4.7.4.22 position_x	162
4.7.4.23 position_y	162
4.7.4.24 render_window_ptr	162
4.7.4.25 resource_assessed	162
4.7.4.26 resource_assessment	163
4.7.4.27 resource_chip_sprite	163
4.7.4.28 resource_text	163
4.7.4.29 scrap_improvement_frame	163
4.7.4.30 select_outline_sprite	163
4.7.4.31 show_node	163
4.7.4.32 show_resource	164
4.7.4.33 tile_decoration_sprite	164
4.7.4.34 tile_improvement_ptr	164
4.7.4.35 tile_resource	164
4.7.4.36 tile_sprite	164
4.7.4.37 tile_type	164
4.8 Message Struct Reference	165
4.8.1 Detailed Description	165
4.8.2 Member Data Documentation	165
4.8.2.1 bool_payload	165
4.8.2.2 channel	165
4.8.2.3 double_payload	166
4.8.2.4 int_payload	166
4.8.2.5 number_of_reads	166
4.8.2.6 string_payload	166
4.8.2.7 subject	166
4.8.2.8 vector_payload	166
4.9 MessageHub Class Reference	167
4.9.1 Detailed Description	167
4.9.2 Constructor & Destructor Documentation	168

4.9.2.1 MessageHub()	168
4.9.2.2 ~MessageHub()	168
4.9.3 Member Function Documentation	168
4.9.3.1 addChannel()	168
4.9.3.2 clear()	169
4.9.3.3 clearMessages()	169
4.9.3.4 hasTraffic()	169
4.9.3.5 incrementMessageRead()	170
4.9.3.6 isEmpty()	170
4.9.3.7 popMessage()	171
4.9.3.8 printState()	171
4.9.3.9 receiveMessage()	172
4.9.3.10 removeChannel()	173
4.9.3.11 sendMessage()	173
4.9.4 Member Data Documentation	174
4.9.4.1 message_map	174
4.10 Settlement Class Reference	174
4.10.1 Detailed Description	176
4.10.2 Constructor & Destructor Documentation	176
4.10.2.1 Settlement()	176
4.10.2.2 ~Settlement()	177
4.10.3 Member Function Documentation	177
4.10.3.1 __handleKeyPressEvents()	177
4.10.3.2 __handleMouseButtonEvents()	178
4.10.3.3 __setUpCoinSprite()	178
4.10.3.4 __setUpTileImprovementSpriteStatic()	179
4.10.3.5 draw()	179
4.10.3.6 getTileOptionsSubstring()	180
4.10.3.7 processEvent()	181
4.10.3.8 processMessage()	181
4.10.3.9 setIsSelected()	181
4.10.4 Member Data Documentation	182
4.10.4.1 coin_sprite	182
4.10.4.2 draw_coin	182
4.10.4.3 smoke_da	182
4.10.4.4 smoke_dx	182
4.10.4.5 smoke_dy	182
4.10.4.6 smoke_prob	183
4.10.4.7 smoke_sprite_list	183
4.11 SolarPV Class Reference	183
4.11.1 Detailed Description	185
4.11.2 Constructor & Destructor Documentation	186

4.11.2.1 SolarPV()	186
4.11.2.2 ~SolarPV()	187
4.11.3 Member Function Documentation	187
4.11.3.1 __breakdown()	187
4.11.3.2 __computeCapacityFactors()	188
4.11.3.3 __computeDispatch()	188
4.11.3.4 __computeProduction()	189
4.11.3.5 __computeProductionCosts()	189
4.11.3.6 __drawProductionMenu()	190
4.11.3.7 __drawUpgradeOptions()	190
4.11.3.8 __handleKeyPressEvents()	192
4.11.3.9 __handleMouseButtonEvents()	192
4.11.3.10 __repair()	193
4.11.3.11 __sendImprovementStateMessage()	193
4.11.3.12 __setUpTileImprovementSpriteStatic()	194
4.11.3.13 __upgradePowerCapacity()	194
4.11.3.14 advanceTurn()	195
4.11.3.15 draw()	195
4.11.3.16 getTileOptionsSubstring()	197
4.11.3.17 processEvent()	198
4.11.3.18 processMessage()	198
4.11.3.19 setIsSelected()	198
4.11.3.20 update()	199
4.11.4 Member Data Documentation	199
4.11.4.1 capacity_factor_vec	199
4.11.4.2 capacity_kW	199
4.11.4.3 dispatch_MWh	199
4.11.4.4 dispatch_vec_MWh	200
4.11.4.5 dispatchable_MWh	200
4.11.4.6 max_daily_production_MWh	200
4.11.4.7 production_MWh	200
4.11.4.8 production_vec_MWh	200
4.12 TidalTurbine Class Reference	201
4.12.1 Detailed Description	203
4.12.2 Constructor & Destructor Documentation	203
4.12.2.1 TidalTurbine()	203
4.12.2.2 ~TidalTurbine()	204
4.12.3 Member Function Documentation	204
4.12.3.1 __breakdown()	205
4.12.3.2 __computeCapacityFactors()	205
4.12.3.3 __computeDispatch()	205
4.12.3.4 __computeProduction()	206

4.12.3.5	__computeProductionCosts()	206
4.12.3.6	__drawProductionMenu()	207
4.12.3.7	__drawUpgradeOptions()	207
4.12.3.8	__handleKeyPressEvents()	209
4.12.3.9	__handleMouseButtonEvents()	210
4.12.3.10	__repair()	210
4.12.3.11	__sendImprovementStateMessage()	211
4.12.3.12	__setUpTileImprovementSpriteAnimated()	211
4.12.3.13	__upgradePowerCapacity()	212
4.12.3.14	advanceTurn()	212
4.12.3.15	draw()	213
4.12.3.16	getTileOptionsSubstring()	214
4.12.3.17	processEvent()	215
4.12.3.18	processMessage()	216
4.12.3.19	setIsSelected()	216
4.12.3.20	update()	216
4.12.4	Member Data Documentation	217
4.12.4.1	bobbing_y	217
4.12.4.2	capacity_factor_vec	217
4.12.4.3	capacity_kW	217
4.12.4.4	dispatch_MWh	217
4.12.4.5	dispatch_vec_MWh	217
4.12.4.6	dispatchable_MWh	218
4.12.4.7	max_daily_production_MWh	218
4.12.4.8	production_MWh	218
4.12.4.9	production_vec_MWh	218
4.12.4.10	rotor_drotation	218
4.13	TileImprovement Class Reference	219
4.13.1	Detailed Description	223
4.13.2	Constructor & Destructor Documentation	223
4.13.2.1	TileImprovement()	223
4.13.2.2	~TileImprovement()	224
4.13.3	Member Function Documentation	224
4.13.3.1	__breakdown()	225
4.13.3.2	__closeProductionMenu()	225
4.13.3.3	__closeUpgradeMenu()	225
4.13.3.4	__drawDispatch()	226
4.13.3.5	__handleKeyPressEvents()	226
4.13.3.6	__handleMouseButtonEvents()	227
4.13.3.7	__openProductionMenu()	227
4.13.3.8	__openUpgradeMenu()	228
4.13.3.9	__repair()	228

4.13.3.10	<code>__sendCreditsSpentMessage()</code>	228
4.13.3.11	<code>__sendGameStateRequest()</code>	229
4.13.3.12	<code>__sendInsufficientCreditsMessage()</code>	229
4.13.3.13	<code>__sendTileStateRequest()</code>	229
4.13.3.14	<code>__setUpDispatchIllustration()</code>	230
4.13.3.15	<code>__setUpProductionMenu()</code>	230
4.13.3.16	<code>__setUpUpgradeMenu()</code>	231
4.13.3.17	<code>__upgradeStorageCapacity()</code>	231
4.13.3.18	<code>advanceTurn()</code>	232
4.13.3.19	<code>draw()</code>	232
4.13.3.20	<code>getTileOptionsSubstring()</code>	234
4.13.3.21	<code>processEvent()</code>	234
4.13.3.22	<code>processMessage()</code>	235
4.13.3.23	<code>setIsSelected()</code>	235
4.13.3.24	<code>update()</code>	235
4.13.4	Member Data Documentation	236
4.13.4.1	<code>assets_manager_ptr</code>	236
4.13.4.2	<code>credits</code>	236
4.13.4.3	<code>demand_MWh</code>	236
4.13.4.4	<code>demand_vec_MWh</code>	236
4.13.4.5	<code>dispatch_backing</code>	236
4.13.4.6	<code>dispatch_text</code>	237
4.13.4.7	<code>event_ptr</code>	237
4.13.4.8	<code>frame</code>	237
4.13.4.9	<code>game_phase</code>	237
4.13.4.10	<code>health</code>	237
4.13.4.11	<code>is_broken</code>	237
4.13.4.12	<code>is_running</code>	238
4.13.4.13	<code>is_selected</code>	238
4.13.4.14	<code>just_built</code>	238
4.13.4.15	<code>just_upgraded</code>	238
4.13.4.16	<code>message_hub_ptr</code>	238
4.13.4.17	<code>month</code>	238
4.13.4.18	<code>operation_maintenance_cost</code>	239
4.13.4.19	<code>position_x</code>	239
4.13.4.20	<code>position_y</code>	239
4.13.4.21	<code>production_menu_backing</code>	239
4.13.4.22	<code>production_menu_backing_text</code>	239
4.13.4.23	<code>production_menu_open</code>	239
4.13.4.24	<code>render_window_ptr</code>	240
4.13.4.25	<code>storage_kWh</code>	240
4.13.4.26	<code>storage_level</code>	240

4.13.4.27	storage_upgrade_sprite	240
4.13.4.28	storage_upgrade_sprite_vec	240
4.13.4.29	tile_improvement_sprite_animated	240
4.13.4.30	tile_improvement_sprite_static	241
4.13.4.31	tile_improvement_string	241
4.13.4.32	tile_improvement_type	241
4.13.4.33	tile_resource	241
4.13.4.34	tile_resource_scalar	241
4.13.4.35	upgrade_arrow_sprite	241
4.13.4.36	upgrade_frame	242
4.13.4.37	upgrade_level	242
4.13.4.38	upgrade_menu_backing	242
4.13.4.39	upgrade_menu_backing_text	242
4.13.4.40	upgrade_menu_open	242
4.13.4.41	upgrade_plus_sprite	242
4.14	WaveEnergyConverter Class Reference	243
4.14.1	Detailed Description	245
4.14.2	Constructor & Destructor Documentation	245
4.14.2.1	WaveEnergyConverter()	245
4.14.2.2	~WaveEnergyConverter()	246
4.14.3	Member Function Documentation	246
4.14.3.1	__breakdown()	247
4.14.3.2	__computeCapacityFactors()	247
4.14.3.3	__computeDispatch()	247
4.14.3.4	__computeProduction()	248
4.14.3.5	__computeProductionCosts()	249
4.14.3.6	__drawProductionMenu()	249
4.14.3.7	__drawUpgradeOptions()	250
4.14.3.8	__handleKeyPressEvents()	251
4.14.3.9	__handleMouseButtonEvents()	252
4.14.3.10	__repair()	253
4.14.3.11	__sendImprovementStateMessage()	253
4.14.3.12	__setUpTileImprovementSpriteAnimated()	253
4.14.3.13	__upgradePowerCapacity()	254
4.14.3.14	advanceTurn()	254
4.14.3.15	draw()	255
4.14.3.16	getTileOptionsSubstring()	257
4.14.3.17	processEvent()	258
4.14.3.18	processMessage()	258
4.14.3.19	setIsSelected()	258
4.14.3.20	update()	259
4.14.4	Member Data Documentation	259

4.14.4.1 bobbing_y	259
4.14.4.2 capacity_factor_vec	259
4.14.4.3 capacity_kW	259
4.14.4.4 dispatch_MWh	260
4.14.4.5 dispatch_vec_MWh	260
4.14.4.6 dispatchable_MWh	260
4.14.4.7 max_daily_production_MWh	260
4.14.4.8 production_MWh	260
4.14.4.9 production_vec_MWh	260
4.15 WindTurbine Class Reference	261
4.15.1 Detailed Description	263
4.15.2 Constructor & Destructor Documentation	263
4.15.2.1 WindTurbine()	263
4.15.2.2 ~WindTurbine()	264
4.15.3 Member Function Documentation	264
4.15.3.1 __breakdown()	265
4.15.3.2 __computeCapacityFactors()	265
4.15.3.3 __computeDispatch()	265
4.15.3.4 __computeProduction()	266
4.15.3.5 __computeProductionCosts()	267
4.15.3.6 __drawProductionMenu()	267
4.15.3.7 __drawUpgradeOptions()	268
4.15.3.8 __handleKeyPressEvents()	269
4.15.3.9 __handleMouseButtonEvents()	270
4.15.3.10 __repair()	271
4.15.3.11 __sendImprovementStateMessage()	271
4.15.3.12 __setUpTileImprovementSpriteAnimated()	271
4.15.3.13 __upgradePowerCapacity()	272
4.15.3.14 advanceTurn()	272
4.15.3.15 draw()	273
4.15.3.16 getTileOptionsSubstring()	274
4.15.3.17 processEvent()	275
4.15.3.18 processMessage()	276
4.15.3.19 setIsSelected()	276
4.15.3.20 update()	276
4.15.4 Member Data Documentation	277
4.15.4.1 capacity_factor_vec	277
4.15.4.2 capacity_kW	277
4.15.4.3 dispatch_MWh	277
4.15.4.4 dispatch_vec_MWh	277
4.15.4.5 dispatchable_MWh	277
4.15.4.6 max_daily_production_MWh	278

4.15.4.7 production_MWh	278
4.15.4.8 production_vec_MWh	278
4.15.4.9 rotor_drotation	278
5 File Documentation	279
5.1 header/ContextMenu.h File Reference	279
5.1.1 Detailed Description	280
5.1.2 Enumeration Type Documentation	280
5.1.2.1 ConsoleState	280
5.2 header/DieselGenerator.h File Reference	280
5.2.1 Detailed Description	281
5.3 header/EnergyStorageSystem.h File Reference	281
5.3.1 Detailed Description	282
5.4 header/ESC_core/AssetsManager.h File Reference	282
5.4.1 Detailed Description	283
5.5 header/ESC_core/constants.h File Reference	283
5.5.1 Detailed Description	287
5.5.2 Function Documentation	287
5.5.2.1 FOREST_GREEN()	287
5.5.2.2 LAKE_BLUE()	287
5.5.2.3 MENU_FRAME_GREY()	287
5.5.2.4 MONOCHROME_SCREEN_BACKGROUND()	287
5.5.2.5 MONOCHROME_TEXT_AMBER()	288
5.5.2.6 MONOCHROME_TEXT_GREEN()	288
5.5.2.7 MONOCHROME_TEXT_RED()	288
5.5.2.8 MOUNTAINS_GREY()	288
5.5.2.9 OCEAN_BLUE()	288
5.5.2.10 PLAINS_YELLOW()	289
5.5.2.11 RESOURCE_CHIP_GREY()	289
5.5.2.12 VISUAL_SCREEN_FRAME_GREY()	289
5.5.3 Variable Documentation	289
5.5.3.1 BUILD_SETTLEMENT_COST	289
5.5.3.2 CLEAR_FOREST_COST	289
5.5.3.3 CLEAR_MOUNTAINS_COST	290
5.5.3.4 CLEAR_PLAINS_COST	290
5.5.3.5 COST_PER_LITRE_DIESEL	290
5.5.3.6 CREDITS_PER_MWH_SERVED	290
5.5.3.7 DAILY_TIDAL_CAPACITY_FACTOR	290
5.5.3.8 DIESEL_GENERATOR_BUILD_COST	290
5.5.3.9 DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION	291
5.5.3.10 EMISSIONS_LIFETIME_LIMIT_TONNES	291
5.5.3.11 ENERGY_STORAGE_SYSTEM_BUILD_COST	291

5.5.3.12 FLOAT_TOLERANCE	291
5.5.3.13 FRAMES_PER_SECOND	291
5.5.3.14 GAME_CHANNEL	291
5.5.3.15 GAME_HEIGHT	292
5.5.3.16 GAME_STATE_CHANNEL	292
5.5.3.17 GAME_WIDTH	292
5.5.3.18 HEX_MAP_CHANNEL	292
5.5.3.19 KG_CO2E_PER_LITRE_DIESEL	292
5.5.3.20 LITRES_DIESEL_PER_MWH_PRODUCTION	292
5.5.3.21 MAX_STORAGE_LEVELS	293
5.5.3.22 MAX_UPGRADE_LEVELS	293
5.5.3.23 MAXIMUM_DAILY_DEMAND_PER_CAPITA	293
5.5.3.24 MEAN_DAILY_DEMAND_RATIOS	293
5.5.3.25 MEAN_DAILY_SOLAR_CAPACITY_FACTORS	293
5.5.3.26 MEAN_DAILY_WAVE_CAPACITY_FACTORS	294
5.5.3.27 MEAN_DAILY_WIND_CAPACITY_FACTORS	294
5.5.3.28 MEAN_POPULATION_GROWTH_RATE	294
5.5.3.29 NO_TILE_SELECTED_CHANNEL	294
5.5.3.30 RESOURCE_ASSESSMENT_COST	294
5.5.3.31 SCRAP_COST	295
5.5.3.32 SECONDS_PER_FRAME	295
5.5.3.33 SECONDS_PER_MONTH	295
5.5.3.34 SECONDS_PER_YEAR	295
5.5.3.35 SETTLEMENT_CHANNEL	295
5.5.3.36 SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION	295
5.5.3.37 SOLAR_PV_BUILD_COST	296
5.5.3.38 SOLAR_PV_WATER_BUILD_MULTIPLIER	296
5.5.3.39 STARTING_CREDITS	296
5.5.3.40 STARTING_POPULATION	296
5.5.3.41 STDEV_DAILY_DEMAND_RATIOS	296
5.5.3.42 STDEV_DAILY_SOLAR_CAPACITY_FACTORS	297
5.5.3.43 STDEV_DAILY_WAVE_CAPACITY_FACTORS	297
5.5.3.44 STDEV_DAILY_WIND_CAPACITY_FACTORS	297
5.5.3.45 STDEV_POPULATION_GROWTH_RATE	297
5.5.3.46 TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION	298
5.5.3.47 TIDAL_TURBINE_BUILD_COST	298
5.5.3.48 TILE_RESOURCE_CUMULATIVE_PROBABILITIES	298
5.5.3.49 TILE_SELECTED_CHANNEL	298
5.5.3.50 TILE_STATE_CHANNEL	298
5.5.3.51 TILE_TYPE_CUMULATIVE_PROBABILITIES	299
5.5.3.52 WAVE_ENERGY_CONVERTER_BUILD_COST	299
5.5.3.53 WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION	299

5.5.3.54 WIND_OP_MAINT_COST_PER_MWH_PRODUCTION	299
5.5.3.55 WIND_TURBINE_BUILD_COST	299
5.5.3.56 WIND_TURBINE_WATER_BUILD_MULTIPLIER	299
5.6 header/ESC_core/doxygen_cite.h File Reference	300
5.6.1 Detailed Description	300
5.7 header/ESC_core/includes.h File Reference	300
5.7.1 Detailed Description	301
5.8 header/ESC_core/MessageHub.h File Reference	301
5.8.1 Detailed Description	301
5.9 header/ESC_core/testing_utils.h File Reference	302
5.9.1 Detailed Description	303
5.9.2 Function Documentation	303
5.9.2.1 expectedErrorNotDetected()	303
5.9.2.2 printGold()	303
5.9.2.3 printGreen()	304
5.9.2.4 printRed()	304
5.9.2.5 testFloatEquals()	304
5.9.2.6 testGreaterThan()	305
5.9.2.7 testGreaterThanOrEqualTo()	305
5.9.2.8 testLessThan()	306
5.9.2.9 testLessThanOrEqualTo()	307
5.9.2.10 testTruth()	307
5.10 header/Game.h File Reference	308
5.10.1 Enumeration Type Documentation	309
5.10.1.1 GamePhase	309
5.11 header/HexMap.h File Reference	309
5.11.1 Detailed Description	310
5.12 header/HexTile.h File Reference	310
5.12.1 Detailed Description	311
5.12.2 Enumeration Type Documentation	312
5.12.2.1 TileResource	312
5.12.2.2 TileType	312
5.13 header/Settlement.h File Reference	313
5.13.1 Detailed Description	313
5.14 header/SolarPV.h File Reference	314
5.14.1 Detailed Description	314
5.15 header/TidalTurbine.h File Reference	315
5.15.1 Detailed Description	315
5.16 header/TileImprovement.h File Reference	316
5.16.1 Detailed Description	316
5.16.2 Enumeration Type Documentation	316
5.16.2.1 TileImprovementType	316

5.17 header/WaveEnergyConverter.h File Reference	317
5.17.1 Detailed Description	318
5.18 header/WindTurbine.h File Reference	318
5.18.1 Detailed Description	319
5.19 source/ContextMenu.cpp File Reference	319
5.19.1 Detailed Description	319
5.20 source/DieselGenerator.cpp File Reference	319
5.20.1 Detailed Description	319
5.21 source/EnergyStorageSystem.cpp File Reference	320
5.21.1 Detailed Description	320
5.22 source/ESC_core/AssetsManager.cpp File Reference	320
5.22.1 Detailed Description	320
5.23 source/ESC_core/MessageHub.cpp File Reference	320
5.23.1 Detailed Description	321
5.24 source/ESC_core/testing_utils.cpp File Reference	321
5.24.1 Detailed Description	321
5.24.2 Function Documentation	322
5.24.2.1 expectedErrorNotDetected()	322
5.24.2.2 printGold()	322
5.24.2.3 printGreen()	322
5.24.2.4 printRed()	323
5.24.2.5 testFloatEquals()	323
5.24.2.6 testGreaterThan()	324
5.24.2.7 testGreaterThanOrEqualTo()	324
5.24.2.8 testLessThan()	325
5.24.2.9 testLessThanOrEqualTo()	326
5.24.2.10 testTruth()	326
5.25 source/Game.cpp File Reference	327
5.25.1 Detailed Description	327
5.26 source/HexMap.cpp File Reference	327
5.26.1 Detailed Description	328
5.27 source/HexTile.cpp File Reference	328
5.27.1 Detailed Description	328
5.28 source/main.cpp File Reference	328
5.28.1 Detailed Description	329
5.28.2 Function Documentation	329
5.28.2.1 constructRenderWindow()	329
5.28.2.2 loadAssets()	329
5.28.2.3 main()	332
5.29 source/Settlement.cpp File Reference	333
5.29.1 Detailed Description	333
5.30 source/SolarPV.cpp File Reference	333

5.30.1 Detailed Description	334
5.31 source/TidalTurbine.cpp File Reference	334
5.31.1 Detailed Description	334
5.32 source/TileImprovement.cpp File Reference	334
5.32.1 Detailed Description	334
5.33 source/WaveEnergyConverter.cpp File Reference	335
5.33.1 Detailed Description	335
5.34 source/WindTurbine.cpp File Reference	335
5.34.1 Detailed Description	335
Bibliography	337
Index	339

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	92
HexTile	119
Message	165
MessageHub	167
TileImprovement	219
DieselGenerator	37
EnergyStorageSystem	52
Settlement	174
SolarPV	183
TidalTurbine	201
WaveEnergyConverter	243
WindTurbine	261

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	92
HexTile	A class which defines a hex tile of the hex map	119
Message	A structure which defines a standard message format	165
MessageHub	A class which acts as a central hub for inter-object message traffic	167
Settlement	A settlement class (child class of TileImprovement)	174
SolarPV	A settlement class (child class of TileImprovement)	183
TidalTurbine	A settlement class (child class of TileImprovement)	201
TileImprovement	A base class for the tile improvement hierarchy	219
WaveEnergyConverter	A settlement class (child class of TileImprovement)	243
WindTurbine	A settlement class (child class of TileImprovement)	261

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	279
header/ DieselGenerator.h	
Header file for the DieselGenerator class	280
header/ EnergyStorageSystem.h	
Header file for the EnergyStorageSystem class	281
header/ Game.h	308
header/ HexMap.h	
Header file for the HexMap class	309
header/ HexTile.h	
Header file for the Game class	310
header/ Settlement.h	
Header file for the Settlement class	313
header/ SolarPV.h	
Header file for the SolarPV class	314
header/ TidalTurbine.h	
Header file for the TidalTurbine class	315
header/ TileImprovement.h	
Header file for the TileImprovement class	316
header/ WaveEnergyConverter.h	
Header file for the WaveEnergyConverter class	317
header/ WindTurbine.h	
Header file for the WindTurbine class	318
header/ESC_core/ AssetsManager.h	
Header file for the AssetsManager class	282
header/ESC_core/ constants.h	
Header file for various constants	283
header/ESC_core/ doxygen_cite.h	
Header file which simply cites the doxygen tool	300
header/ESC_core/ includes.h	
Header file for various includes	300
header/ESC_core/ MessageHub.h	
Header file for the MessageHub class	301
header/ESC_core/ testing_utils.h	
Header file for various testing utilities	302

source/ ContextMenu.cpp	Implementation file for the ContextMenu class	319
source/ DieselGenerator.cpp	Implementation file for the DieselGenerator class	319
source/ EnergyStorageSystem.cpp	Implementation file for the EnergyStorageSystem class	320
source/ Game.cpp	Implementation file for the Game class	327
source/ HexMap.cpp	Implementation file for the HexMap class	327
source/ HexTile.cpp	Implementation file for the HexTile class	328
source/ main.cpp	Implementation file for main() for Road To Zero	328
source/ Settlement.cpp	Implementation file for the Settlement class	333
source/ SolarPV.cpp	Implementation file for the SolarPV class	333
source/ TidalTurbine.cpp	Implementation file for the TidalTurbine class	334
source/ TileImprovement.cpp	Implementation file for the TileImprovement class	334
source/ WaveEnergyConverter.cpp	Implementation file for the WaveEnergyConverter class	335
source/ WindTurbine.cpp	Implementation file for the WindTurbine class	335
source/ESC_core/ AssetsManager.cpp	Implementation file for the AssetsManager class	320
source/ESC_core/ MessageHub.cpp	Implementation file for the MessageHub class	320
source/ESC_core/ testing_utils.cpp	Implementation file for various testing utilities	321

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(MONOCROME_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]: 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 = 100;
526     this->upgrade_level = 1;
527
528     this->production_MWh = 0;
529     this->max_production_MWh = 72;
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.

```
921 {
922     std::cout << "DieselGenerator at " << this << " destroyed" << std::endl;
923
924     return;
925 }    /* ~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 += 100;
203     this->upgrade_level++;
204
205     this->production_MWh = 0;
206     this->max_production_MWh += 72;
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
674     if (this->is_running) {
675         this->health--;
676
677         if (this->health <= 0) {
678             this->__breakdown();
679         }
680     }
681
682     // 4. send tile state request (if selected)
683     if (this->is_selected) {
684         this->__sendTileStateRequest();
685     }
686
687     return;
688 } /* 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](#).

```
752 {
753     // 1. if just built, call base method and return
754     if (this->just_built) {
755         TileImprovement::draw();
756
757         return;
758     }
759
760     // 2. handle upgrade effects
761     if (this->just_upgraded) {
762         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
763             this->tile_improvement_sprite_animated[i].setColor(
764                 sf::Color(
765                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
766                     255,
767                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
768                     255
769                 )
770             );
771
772             this->tile_improvement_sprite_animated[i].setScale(
773                 sf::Vector2f(
774                     1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
775                     1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
776                 )
777             );
778         }
779     }
780 }
```

```

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

```

```

864         this->smoke_dx + 2 * (((double)rand() / RAND_MAX) - 1) / FRAMES_PER_SECOND,
865         this->smoke_dy
866     );
867
868     (*iter).rotate(((double)rand() / RAND_MAX));
869
870     iter++;
871 }
872
873
874 // 6. handle dispatch illustration
875 if (this->production_MWh > 0) {
876     this->dispatch_text.setString(std::to_string(this->production_MWh));
877     this->__drawDispatch();
878 }
879
880
881 // 7. draw production menu
882 if (this->production_menu_open) {
883     this->render_window_ptr->draw(this->production_menu_backing);
884     this->render_window_ptr->draw(this->production_menu_backing_text);
885
886     this->__drawProductionMenu();
887 }
888
889
890 // 8. handle broken effects
891 if (this->is_broken) {
892     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
893         this->tile_improvement_sprite_animated[i].setColor(
894             sf::Color(
895                 255,
896                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
897                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
898                 255
899             )
900         );
901     }
902 }
903
904 this->frame++;
905 return;
906 } /* 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]: + 100 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](#).

```

703 {
704     TileImprovement :: processEvent();
705
706     if (this->event_ptr->type == sf::Event::KeyPressed) {
707         this->__handleKeyPressEvents();
708     }
709
710     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
711         this->__handleMouseButtonEvents();
712     }
713
714     return;
715 } /* processEvent() */

```

4.3.3.14 processMessage()

```

void DieselGenerator::processMessage (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

730 {
731     TileImprovement :: processMessage();
732
733     //...
734
735     return;
736 } /* 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:

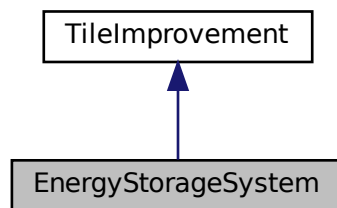
- header/[DieselGenerator.h](#)
- source/[DieselGenerator.cpp](#)

4.4 EnergyStorageSystem Class Reference

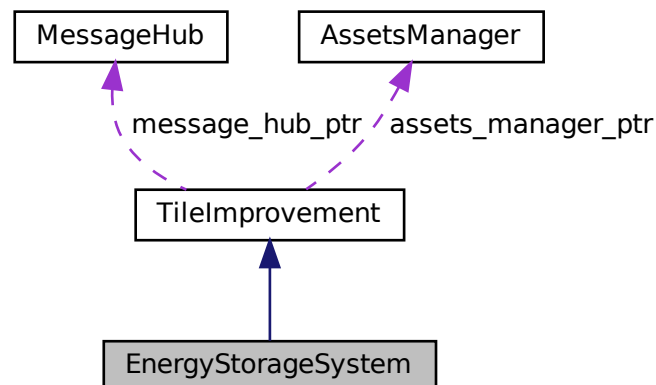
A settlement class (child class of [TileImprovement](#)).

```
#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             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 }
```

```

236
237         default: {
238             // do nothing!
239
240             break;
241         }
242     }
243
244     return;
245 } /* __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 } /* 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:

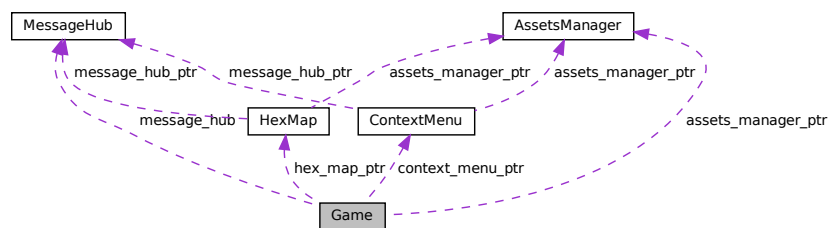
- header/[EnergyStorageSystem.h](#)
- source/[EnergyStorageSystem.cpp](#)

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](#) *)
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.
- 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 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.
- [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 [__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 [__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 )
```

Constructor for the `Game` class.

```
1565 {
1566     // 1. set attributes
1567
1568     // 1.1. private
1569     this->render_window_ptr = render_window_ptr;
1570
1571     this->assets_manager_ptr = assets_manager_ptr;
1572
1573     // 1.2. public
1574     this->game_phase = GamePhase :: BUILD_SETTLEMENT;
1575
1576     this->quit_game = false;
1577     this->game_loop_broken = false;
1578     this->show_frame_clock_overlay = false;
1579     this->check_terminating_conditions = false;
1580     this->show_tutorial = false;
1581     this->turn_end = false;
1582     this->draw_turn_advance_banner = false;
1583     this->increase_turn_advance_alpha = true;
1584
1585     this->frame = 0;
1586     this->time_since_start_s = 0;
1587
1588     this->message_deadlock = false;
1589     this->message_deadlock_frame = 0;
1590
1591     double seconds_since_epoch = time(NULL);
1592     double years_since_epoch = seconds_since_epoch / SECONDS_PER_YEAR;
1593
1594     this->year = 1970 + (int)years_since_epoch;
1595     this->month = (years_since_epoch - (int)years_since_epoch) * 12 + 1;
1596     while (this->month > 12) {
1597         this->month -= 12;
1598     }
1599
1600     this->population = 0;
1601     this->credits = STARTING_CREDITS;
1602     this->demand_MWh = 0;
1603     this->cumulative_emissions_tonnes = 0;
1604
1605     this->past_demand_MWh = 0;
1606     this->turn_advance_alpha = 0;
1607
1608     this->demand_vec_MWh.resize(30, 0);
1609
1610     this->demand_served_MWh = 0;
1611     this->demand_remaining_MWh = 0;
1612     this->overproduction_MWh = 0;
1613     this->turn_fuel_cost = 0;
1614     this->turn_operation_maintenance_cost = 0;
1615     this->turn_emissions_tonnes = 0;
1616
1617     this->overproduction_penalty = 0;
1618     this->dispatch_income = 0;
1619     this->net_credit_flow = 0;
1620
1621     this->consecutive_zero_emissions_months = 0;
1622
1623     this->substring_idx = 0;
1624     this->turn_summary_string = "";
1625
1626     this->turn_summary_text.setFont (
1627         *(this->assets_manager_ptr->getFont ("Glass_TTY_VT220"))
1628     );
1629     this->turn_summary_text.setCharacterSize(16);
1630     this->turn_summary_text.setFillColor(MONOCROME_TEXT_GREEN);
1631     this->turn_summary_text.setPosition(GAME_WIDTH - 400 + 64, 64);
1632 }
```

```

1633     this->hex_map_ptr = new HexMap(
1634         6,
1635         &(this->event),
1636         this->render_window_ptr,
1637         this->assets_manager_ptr,
1638         &(this->message_hub)
1639     );
1640
1641     this->context_menu_ptr = new ContextMenu(
1642         &(this->event),
1643         this->render_window_ptr,
1644         this->assets_manager_ptr,
1645         &(this->message_hub)
1646     );
1647
1648     // 2. add message channel(s)
1649     this->message_hub.addChannel(GAME_CHANNEL);
1650     this->message_hub.addChannel(GAME_STATE_CHANNEL);
1651
1652     this->__sendGameStateMessage();
1653
1654     std::cout << "Game constructed at " << this << std::endl;
1655
1656     return;
1657 } /* Game() */

```

4.5.2.2 ~Game()

```

Game::~~Game (
    void )

```

Destructor for the [Game](#) class.

```

1787 {
1788     // 1. clean up attributes
1789     delete this->hex_map_ptr;
1790     delete this->context_menu_ptr;
1791
1792     std::cout << "Game at " << this << " destroyed" << std::endl;
1793
1794     return;
1795 } /* ~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 __draw()

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

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

```
1479 {
1480     // 1. HUD
1481     this->__drawHUD();
1482
1483     // 2. frame / clock overlay
1484     if (this->show_frame_clock_overlay) {
1485         this->__drawFrameClockOverlay();
1486     }
1487
1488     // 3. tutorial or turn summary
1489     if (this->show_tutorial) {
1490
1491     }
1492
1493     else if (not this->turn_summary_string.empty()) {
1494         this->__drawTurnSummary();
1495     }
1496
1497     // 4. turn advance banner
1498     if (this->draw_turn_advance_banner) {
1499         this->__drawTurnAdvanceBanner();
1500     }
1501
1502     // 5. terminating conditions
1503     switch (this->game_phase) {
1504         case (GamePhase :: LOSS_DEMAND): {
1505             this->__drawLossDemand();
1506
1507             break;
1508         }
1509
1510         case (GamePhase :: LOSS_CREDITS): {
1511             this->__drawLossCredits();
1512
1513             break;
1514         }
1515     }
1516 }
```

```

1517
1518     case (GamePhase :: LOSS_EMISSIONS): {
1519         this->__drawLossEmissions();
1520
1521         break;
1522     }
1523
1524
1525     case (GamePhase :: VICTORY): {
1526         this->__drawVictory();
1527
1528         break;
1529     }
1530
1531
1532     default: {
1533         // do nothing!
1534
1535         break;
1536     }
1537 }
1538
1539 return;
1540 } /* draw() */

```

4.5.3.5 __drawFrameClockOverlay()

```

void Game::__drawFrameClockOverlay (
    void ) [private]

```

Helper method to draw frame clock overlay.

```

1302 {
1303     std::string frame_clock_string = "FRAME: ";
1304     frame_clock_string += std::to_string(this->frame);
1305     frame_clock_string += "\nTIME SINCE START [s]: ";
1306     frame_clock_string += std::to_string(this->time_since_start_s);
1307
1308     sf::Text frame_clock_text(
1309         frame_clock_string,
1310         *(this->assets_manager_ptr->getFont("DroidSansMono")),
1311         16
1312     );
1313
1314     sf::RectangleShape frame_clock_backing(
1315         sf::Vector2f(
1316             1.02 * frame_clock_text.getLocalBounds().width,
1317             1.20 * frame_clock_text.getLocalBounds().height
1318         )
1319     );
1320     frame_clock_backing.setFillColor(sf::Color(0, 0, 0, 255));
1321
1322     this->render_window_ptr->draw(frame_clock_backing);
1323     this->render_window_ptr->draw(frame_clock_text);
1324
1325     return;
1326 } /* __drawFrameClockOverlay() */

```

4.5.3.6 __drawHUD()

```

void Game::__drawHUD (
    void ) [private]

```

Helper method to heads-up display (HUD).

```

1341 {
1342     // 1. first line (top)
1343     std::string HUD_string = "YEAR: ";
1344     HUD_string += std::to_string(this->year);
1345
1346     HUD_string += "    MONTH: ";

```

```

1347     HUD_string += std::to_string(this->month);
1348
1349     HUD_string += "    POPULATION: ";
1350     HUD_string += std::to_string(this->population);
1351
1352     HUD_string += "    CREDITS: ";
1353     HUD_string += std::to_string(this->credits);
1354     HUD_string += " K";
1355
1356     HUD_string += "    CURRENT DEMAND: ";
1357     HUD_string += std::to_string(this->demand_MWh);
1358     HUD_string += " MWh";
1359
1360     sf::Text HUD_text(
1361         HUD_string,
1362         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
1363         16
1364     );
1365
1366     HUD_text.setPosition(
1367         (800 - HUD_text.getLocalBounds().width) / 2,
1368         8
1369     );
1370
1371     HUD_text.setFillColor(MONOCROME_TEXT_GREEN);
1372
1373     this->render_window_ptr->draw(HUD_text);
1374
1375
1376     // 2. second line (top)
1377     HUD_string = "CUMULATIVE EMISSIONS: ";
1378     HUD_string += std::to_string(this->cumulative_emissions_tonnes);
1379     HUD_string += " tonnes (CO2e)";
1380
1381     HUD_string += "    LIFETIME LIMIT: ";
1382     HUD_string += std::to_string(EMISSIONS_LIFETIME_LIMIT_TONNES);
1383     HUD_string += " tonnes (CO2e)";
1384
1385     HUD_text.setString(HUD_string);
1386
1387     HUD_text.setPosition(
1388         (800 - HUD_text.getLocalBounds().width) / 2,
1389         35
1390     );
1391
1392     this->render_window_ptr->draw(HUD_text);
1393
1394
1395     // 3. third line (bottom)
1396     HUD_string = "GAME PHASE: ";
1397
1398     switch (this->game_phase) {
1399     case (GamePhase :: BUILD_SETTLEMENT): {
1400         HUD_string += "BUILD SETTLEMENT";
1401
1402         break;
1403     }
1404
1405     case (GamePhase :: SYSTEM_MANAGEMENT): {
1406         HUD_string += "SYSTEM MANAGEMENT";
1407
1408         break;
1409     }
1410
1411     case (GamePhase :: LOSS_EMISSIONS): {
1412         HUD_string += "LOSS (EMISSIONS)";
1413
1414         break;
1415     }
1416
1417     case (GamePhase :: LOSS_DEMAND): {
1418         HUD_string += "LOSS (DEMAND)";
1419
1420         break;
1421     }
1422
1423     case (GamePhase :: LOSS_CREDITS): {
1424         HUD_string += "LOSS (CREDITS)";
1425
1426         break;
1427     }
1428
1429     }
1430
1431
1432
1433

```

```

1434         case (GamePhase :: VICTORY): {
1435             HUD_string += "VICTORY";
1436
1437             break;
1438         }
1439
1440         default: {
1441             HUD_string += "???";
1442
1443             break;
1444         }
1445     }
1446 }
1447
1448 HUD_string += "    TURN: ";
1449 HUD_string += std::to_string(this->turn);
1450
1451 HUD_string += "    CONSECUTIVE ZERO EMISSIONS MONTHS: ";
1452 HUD_string += std::to_string(this->consecutive_zero_emissions_months);
1453
1454 HUD_text.setString(HUD_string);
1455
1456 HUD_text.setPosition(
1457     (800 - HUD_text.getLocalBounds().width) / 2,
1458     GAME_HEIGHT - 35
1459 );
1460
1461 this->render_window_ptr->draw(HUD_text);
1462
1463 return;
1464 } /* __drawHUD() */

```

4.5.3.7 __drawLossCredits()

```

void Game::__drawLossCredits (
    void ) [private]

```

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

```

987 {
988     // 1. construct loss text and backing rectangle
989     std::string loss_credits_string = "    LOSS! - RAN OUT OF CREDITS    \n";
990     loss_credits_string += "    press any key to restart    ";
991
992     sf::Text loss_credits_text(
993         loss_credits_string,
994         (*(this->assets_manager_ptr->getFont("DroidSansMono"))),
995         32
996     );
997
998     loss_credits_text.setOrigin(
999         loss_credits_text.getLocalBounds().width / 2,
1000         loss_credits_text.getLocalBounds().height / 2
1001     );
1002
1003     loss_credits_text.setPosition(400, GAME_HEIGHT / 2);
1004
1005     sf::RectangleShape backing_rectangle(
1006         sf::Vector2f(
1007             800,
1008             1.5 * loss_credits_text.getLocalBounds().height
1009         )
1010     );
1011
1012     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
1013
1014     backing_rectangle.setOrigin(
1015         backing_rectangle.getLocalBounds().width / 2,
1016         backing_rectangle.getLocalBounds().height / 2
1017     );
1018
1019     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1020
1021     // 3. colour cycle and draw
1022     if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
1023         loss_credits_text.setFillColor(MONOCHROME_TEXT_RED);
1024     }
1025
1026     else {

```

```

1027         loss_credits_text.setFillColor(sf::Color(255, 255, 255, 255));
1028     }
1029
1030     this->render_window_ptr->draw(backing_rectangle);
1031     this->render_window_ptr->draw(loss_credits_text);
1032
1033     return;
1034 } /* __drawLossCredits() */

```

4.5.3.8 __drawLossDemand()

```

void Game::__drawLossDemand (
    void ) [private]

```

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

```

925 {
926     // 1. construct alarm text and backing rectangle
927     std::string loss_demand_string = "    LOSS! - FAILED TO MEET DEMAND    \n";
928     loss_demand_string           += "    press any key to restart    ";
929
930     sf::Text loss_demand_text(
931         loss_demand_string,
932         (*this->assets_manager_ptr->getFont("DroidSansMono")),
933         32
934     );
935
936     loss_demand_text.setOrigin(
937         loss_demand_text.getLocalBounds().width / 2,
938         loss_demand_text.getLocalBounds().height / 2
939     );
940
941     loss_demand_text.setPosition(400, GAME_HEIGHT / 2);
942
943     sf::RectangleShape backing_rectangle(
944         sf::Vector2f(
945             800,
946             1.5 * loss_demand_text.getLocalBounds().height
947         )
948     );
949
950     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
951
952     backing_rectangle.setOrigin(
953         backing_rectangle.getLocalBounds().width / 2,
954         backing_rectangle.getLocalBounds().height / 2
955     );
956
957     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
958
959     // 3. colour cycle and draw
960     if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
961         loss_demand_text.setFillColor(MONOCHROME_TEXT_RED);
962     }
963
964     else {
965         loss_demand_text.setFillColor(sf::Color(255, 255, 255, 255));
966     }
967
968     this->render_window_ptr->draw(backing_rectangle);
969     this->render_window_ptr->draw(loss_demand_text);
970
971     return;
972 } /* __drawLossDemand() */

```

4.5.3.9 __drawLossEmissions()

```

void Game::__drawLossEmissions (
    void ) [private]

```

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

```

1049 {
1050     // 1. construct loss text and backing rectangle
1051     std::string loss_emissions_string = "    LOSS! - EXCESSIVE EMISSIONS    \n";
1052     loss_emissions_string += "    press any key to restart    ";
1053
1054     sf::Text loss_emissions_text(
1055         loss_emissions_string,
1056         (*this->assets_manager_ptr->getFont("DroidSansMono")),
1057         32
1058     );
1059
1060     loss_emissions_text.setOrigin(
1061         loss_emissions_text.getLocalBounds().width / 2,
1062         loss_emissions_text.getLocalBounds().height / 2
1063     );
1064
1065     loss_emissions_text.setPosition(400, GAME_HEIGHT / 2);
1066
1067     sf::RectangleShape backing_rectangle(
1068         sf::Vector2f(
1069             800,
1070             1.5 * loss_emissions_text.getLocalBounds().height
1071         )
1072     );
1073
1074     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
1075
1076     backing_rectangle.setOrigin(
1077         backing_rectangle.getLocalBounds().width / 2,
1078         backing_rectangle.getLocalBounds().height / 2
1079     );
1080
1081     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1082
1083     // 3. colour cycle and draw
1084     if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
1085         loss_emissions_text.setFillColor(MONochrome_TEXT_RED);
1086     }
1087
1088     else {
1089         loss_emissions_text.setFillColor(sf::Color(255, 255, 255, 255));
1090     }
1091
1092     this->render_window_ptr->draw(backing_rectangle);
1093     this->render_window_ptr->draw(loss_emissions_text);
1094
1095     return;
1096 } /* __drawLossEmissions() */

```

4.5.3.10 __drawTurnAdvanceBanner()

```

void Game::__drawTurnAdvanceBanner (
    void ) [private]

```

Helper method to draw turn advance banner.

```

1173 {
1174     // 1. construct advance banner text
1175     std::string turn_advance_banner_string = "    Turn: ";
1176     turn_advance_banner_string += std::to_string(this->turn);
1177     turn_advance_banner_string += "\n";
1178     turn_advance_banner_string += "Year: ";
1179     turn_advance_banner_string += std::to_string(this->year);
1180     turn_advance_banner_string += "    Month: ";
1181     turn_advance_banner_string += std::to_string(this->month);
1182
1183     sf::Text turn_advance_banner_text(
1184         turn_advance_banner_string,
1185         (*this->assets_manager_ptr->getFont("DroidSansMono")),
1186         24
1187     );
1188
1189     turn_advance_banner_text.setOrigin(
1190         turn_advance_banner_text.getLocalBounds().width / 2,
1191         turn_advance_banner_text.getLocalBounds().height / 2
1192     );
1193
1194     turn_advance_banner_text.setPosition(400, GAME_HEIGHT / 2);

```

```

1195
1196     turn_advance_banner_text.setFillColor(sf::Color(0, 0, 0, this->turn_advance_alpha));
1197
1198
1199     // 2. construct advance banner backing
1200     sf::RectangleShape backing_rectangle(
1201         sf::Vector2f(
1202             800,
1203             1.5 * turn_advance_banner_text.getLocalBounds().height
1204         )
1205     );
1206
1207     sf::Color backing_colour = RESOURCE_CHIP_GREY;
1208     backing_colour.a = this->turn_advance_alpha;
1209
1210     backing_rectangle.setFillColor(backing_colour);
1211
1212     backing_rectangle.setOrigin(
1213         backing_rectangle.getLocalBounds().width / 2,
1214         backing_rectangle.getLocalBounds().height / 2
1215     );
1216
1217     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1218
1219
1220     // 3. draw
1221     this->render_window_ptr->draw(backing_rectangle);
1222     this->render_window_ptr->draw(turn_advance_banner_text);
1223
1224     // 4. adjust alpha, check terminating conditions
1225     if (this->increase_turn_advance_alpha) {
1226         this->turn_advance_alpha += 180 * SECONDS_PER_FRAME;
1227
1228         if (this->turn_advance_alpha >= 255) {
1229             this->turn_advance_alpha = 255;
1230             this->increase_turn_advance_alpha = false;
1231         }
1232     }
1233
1234     else {
1235         this->turn_advance_alpha -= 180 * SECONDS_PER_FRAME;
1236
1237         if (this->turn_advance_alpha <= 0) {
1238             this->draw_turn_advance_banner = false;
1239         }
1240     }
1241
1242     return;
1243 } /* __drawTurnAdvanceBanner() */

```

4.5.3.11 __drawTurnSummary()

```

void Game::__drawTurnSummary (
    void ) [private]

```

Helper method to draw turn summary.

```

1258 {
1259     if (this->substring_idx < this->turn_summary_string.size()) {
1260         this->assets_manager_ptr->getSound("console string print")->play();
1261
1262         this->turn_summary_text.setString(
1263             this->turn_summary_string.substr(0, this->substring_idx)
1264         );
1265
1266         while (
1267             (this->turn_summary_string.substr(0, this->substring_idx).back() == ' ') or
1268             (this->turn_summary_string.substr(0, this->substring_idx).back() == '\n')
1269         ) {
1270             this->substring_idx++;
1271
1272             if (this->substring_idx == this->turn_summary_string.size() - 1) {
1273                 this->turn_summary_text.setString(
1274                     this->turn_summary_string.substr(0, this->substring_idx)
1275                 );
1276
1277                 break;
1278             }
1279         }

```

```

1280
1281         this->substring_idx++;
1282     }
1283
1284     this->render_window_ptr->draw(this->turn_summary_text);
1285
1286     return;
1287 } /* __drawTurnSummary() */

```

4.5.3.12 __drawVictory()

```

void Game::__drawVictory (
    void ) [private]

```

Helper method to draw victory pop-up.

```

1111 {
1112     // 1. construct victory text and backing rectangle
1113     std::string victory_string = "          **** VICTORY! ****      \n";
1114     victory_string           += "          press any key to restart  ";
1115
1116     sf::Text victory_text(
1117         victory_string,
1118         (*(this->assets_manager_ptr->getFont("DroidSansMono"))),
1119         32
1120     );
1121
1122     victory_text.setOrigin(
1123         victory_text.getLocalBounds().width / 2,
1124         victory_text.getLocalBounds().height / 2
1125     );
1126
1127     victory_text.setPosition(400, GAME_HEIGHT / 2);
1128
1129     sf::RectangleShape backing_rectangle(
1130         sf::Vector2f(
1131             800,
1132             1.5 * victory_text.getLocalBounds().height
1133         )
1134     );
1135
1136     backing_rectangle.setFillColor(RESOURCE_CHIP_GREY);
1137
1138     backing_rectangle.setOrigin(
1139         backing_rectangle.getLocalBounds().width / 2,
1140         backing_rectangle.getLocalBounds().height / 2
1141     );
1142
1143     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
1144
1145     // 3. colour cycle and draw
1146     if (this->frame % FRAMES_PER_SECOND <= FRAMES_PER_SECOND / 2) {
1147         victory_text.setFillColor(MONOCHROME_TEXT_GREEN);
1148     }
1149
1150     else {
1151         victory_text.setFillColor(sf::Color(255, 255, 255, 255));
1152     }
1153
1154     this->render_window_ptr->draw(backing_rectangle);
1155     this->render_window_ptr->draw(victory_text);
1156
1157     return;
1158 } /* __drawVictory() */

```

4.5.3.13 __handleImprovementStateMessage()

```

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

```


Helper method to handle improvement state messages.

```

350 {
351     // 1. dispatch
352     if (improvement_state_message.int_payload.count("dispatch_MWh") > 0) {
353         this->demand_served_MWh += improvement_state_message.int_payload["dispatch_MWh"];
354     }
355
356     // 2. fuel costs
357     if (improvement_state_message.int_payload.count("fuel_cost") > 0) {
358         this->turn_fuel_cost += improvement_state_message.int_payload["fuel_cost"];
359     }
360
361     // 3. operation and maintenance costs
362     if (improvement_state_message.int_payload.count("operation_maintenance_cost") > 0) {
363         this->turn_operation_maintenance_cost +=
364             improvement_state_message.int_payload["operation_maintenance_cost"];
365     }
366
367     // 4. emissions
368     if (improvement_state_message.int_payload.count("emissions_tonnes_CO2e") > 0) {
369         double emissions_tonnes_CO2e =
370             improvement_state_message.int_payload["emissions_tonnes_CO2e"];
371
372         this->cumulative_emissions_tonnes += emissions_tonnes_CO2e;
373         this->turn_emissions_tonnes += emissions_tonnes_CO2e;
374     }
375
376     return;
377 } /* __handleImprovementStateMessage() */

```

4.5.3.14 __handleKeyPressEvents()

```

void Game::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

263 {
264     switch (this->event.key.code) {
265         case (sf::Keyboard::Enter): {
266             if (this->game_phase == GamePhase::SYSTEM_MANAGEMENT) {
267                 this->__advanceTurn();
268             }
269
270             break;
271         }
272
273         case (sf::Keyboard::Tilde): {
274             this->__toggleFrameClockOverlay();
275
276             break;
277         }
278
279         case (sf::Keyboard::Tab): {
280             this->hex_map_ptr->toggleResourceOverlay();
281
282             break;
283         }
284
285         default: {
286             // do nothing!
287
288             break;
289         }
290     }
291
292     return;
293 } /* __handleKeyPressEvents() */

```

4.5.3.15 __handleMouseButtonEvents()

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

Helper method to handle mouse button events.

```
311 {
312     switch (this->event.mouseButton.button) {
313         case (sf::Mouse::Left): {
314             //...
315
316             break;
317         }
318
319         case (sf::Mouse::Right): {
320             //...
321
322             break;
323         }
324
325         default: {
326             // do nothing!
327
328             break;
329         }
330     }
331 }
332
333
334 return;
335 } /* __handleMouseButtonEvents() */
```

4.5.3.16 __insufficientCreditsAlarm()

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

Helper method to sound and display and insufficient credits alarm.

```
692 {
693     // 1. sound buzzer
694     this->assets_manager_ptr->getSound("insufficient credits")->play();
695
696     // 2. construct alarm text and backing rectangle
697     sf::Text insufficient_credits_text(
698         "INSUFFICIENT CREDITS",
699         (*this->assets_manager_ptr->getFont("DroidSansMono")),
700         32
701     );
702
703     insufficient_credits_text.setOrigin(
704         insufficient_credits_text.getLocalBounds().width / 2,
705         insufficient_credits_text.getLocalBounds().height / 2
706     );
707
708     insufficient_credits_text.setPosition(400, GAME_HEIGHT / 2);
709
710     sf::RectangleShape backing_rectangle(
711         sf::Vector2f(
712             1.1 * insufficient_credits_text.getLocalBounds().width,
713             1.5 * insufficient_credits_text.getLocalBounds().height
714         )
715     );
716
717     backing_rectangle.setFill-color(RESOURCE_CHIP_GREY);
718
719     backing_rectangle.setOrigin(
720         backing_rectangle.getLocalBounds().width / 2,
721         backing_rectangle.getLocalBounds().height / 2
722     );
723
724     backing_rectangle.setPosition(400, (GAME_HEIGHT / 2) + 8);
725
726     // 3. display loop (blocking ~3 seconds)
727     bool red_flag = true;
728     int alarm_frame = 0;
```

```

729     double time_since_alarm_s = 0;
730
731     sf::Clock alarm_clock;
732
733     while (alarm_frame < 2.5 * FRAMES_PER_SECOND) {
734
735         time_since_alarm_s = alarm_clock.getElapsedTime().asSeconds();
736
737         if (time_since_alarm_s >= (alarm_frame + 1) * SECONDS_PER_FRAME) {
738             while (this->render_window_ptr->pollEvent(this->event)) {
739                 // do nothing!
740             }
741
742             this->render_window_ptr->clear();
743
744             this->hex_map_ptr->draw();
745             this->context_menu_ptr->draw();
746             this->__draw();
747
748             if (alarm_frame % (FRAMES_PER_SECOND / 3) == 0) {
749                 if (red_flag) {
750                     red_flag = false;
751                 }
752
753                 else {
754                     red_flag = true;
755                 }
756             }
757
758             if (red_flag) {
759                 insufficient_credits_text.setFillColor(MONOCHROME_TEXT_RED);
760             }
761
762             else {
763                 insufficient_credits_text.setFillColor(sf::Color(255, 255, 255));
764             }
765
766             this->render_window_ptr->draw(backing_rectangle);
767             this->render_window_ptr->draw(insufficient_credits_text);
768
769             this->render_window_ptr->display();
770
771             alarm_frame++;
772             this->frame++;
773         }
774     }
775
776     // check track status, move to next if stopped
777     if (this->assets_manager_ptr->getTrackStatus() == sf::SoundSource::Stopped) {
778         this->assets_manager_ptr->nextTrack();
779         this->assets_manager_ptr->playTrack();
780     }
781 }
782
783 return;
784 } /* __insufficientCreditsAlarm( */

```

4.5.3.17 __processEvent()

```

void Game::__processEvent (
    void ) [private]

```

Helper method to process [Game](#). To be called once per event.

```

392 {
393     if (this->event.type == sf::Event::Closed) {
394         this->quit_game = true;
395         this->game_loop_broken = true;
396     }
397
398     if (this->event.type == sf::Event::KeyPressed) {
399         this->__handleKeyPressEvents();
400     }
401
402     if (this->event.type == sf::Event::MouseButtonPressed) {
403         this->__handleMouseButtonEvents();
404     }
405
406     return;
407 } /* __processEvent() */

```

4.5.3.18 __processMessage()

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

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

```
563 {
564     if (not this->message_hub.isEmpty(GAME_CHANNEL)) {
565         Message game_channel_message = this->message_hub.receiveMessage(GAME_CHANNEL);
566
567         if (game_channel_message.subject == "quit game") {
568             this->quit_game = true;
569             this->game_loop_broken = true;
570
571             std::cout << "Quit game message received by " << this << std::endl;
572             this->message_hub.popMessage(GAME_CHANNEL);
573         }
574
575         if (game_channel_message.subject == "restart game") {
576             this->game_loop_broken = true;
577
578             std::cout << "Restart game message received by " << this << std::endl;
579             this->message_hub.popMessage(GAME_CHANNEL);
580         }
581
582         if (game_channel_message.subject == "state request") {
583             std::cout << "Game state request message received by " << this << std::endl;
584
585             this->__sendGameStateMessage();
586             this->message_hub.popMessage(GAME_CHANNEL);
587         }
588
589         if (game_channel_message.subject == "credits spent") {
590             this->credits -= game_channel_message.int_payload["credits spent"];
591
592             std::cout << "Credits spent message ( " <<
593                 game_channel_message.int_payload["credits spent"] << " ) received by "
594                 << this << std::endl;
595
596             std::cout << "Current credits (Game): " << this->credits << " K" <<
597                 std::endl;
598
599             this->message_hub.popMessage(GAME_CHANNEL);
600         }
601
602         if (game_channel_message.subject == "insufficient credits") {
603             std::cout << "Insufficient credits message received by " << this <<
604                 std::endl;
605
606             this->__insufficientCreditsAlarm();
607
608             this->message_hub.popMessage(GAME_CHANNEL);
609         }
610
611         if (game_channel_message.subject == "update game phase") {
612             std::cout << "Update game phase message received by " << this << std::endl;
613
614             if (
615                 game_channel_message.string_payload["game phase"] == "system management"
616             ) {
617                 this->game_phase = GamePhase :: SYSTEM_MANAGEMENT;
618                 this->__advanceTurn();
619             }
620
621             else if (
622                 game_channel_message.string_payload["game phase"] == "loss emissions"
623             ) {
624                 this->game_phase = GamePhase :: LOSS_EMISSIONS;
625             }
626
627             else if (
628                 game_channel_message.string_payload["game phase"] == "loss demand"
629             ) {
630                 this->game_phase = GamePhase :: LOSS_DEMAND;
631             }
632
633             else if (
634                 game_channel_message.string_payload["game phase"] == "loss credits"
635             ) {
636                 this->game_phase = GamePhase :: LOSS_CREDITS;
637             }
638
639             else if (
640                 game_channel_message.string_payload["game phase"] == "victory"
```

```

641         } {
642             this->game_phase = GamePhase :: VICTORY;
643         }
644
645         this->message_hub.popMessage(GAME_CHANNEL);
646     }
647
648     if (game_channel_message.subject == "improvement state") {
649         std::cout << "Improvement state message received by " << this << std::endl;
650
651         this->__handleImprovementStateMessage(game_channel_message);
652
653         this->message_hub.popMessage(GAME_CHANNEL);
654     }
655 }
656
657 if (not this->message_hub.isEmpty(GAME_STATE_CHANNEL)) {
658     Message game_state_message =
659         this->message_hub.receiveMessage(GAME_STATE_CHANNEL);
660
661     if (game_state_message.subject == "turn advance") {
662         if (game_state_message.number_of_reads > 0) {
663             std::cout << "Turn advance message received by " << this << std::endl;
664             this->message_hub.popMessage(GAME_STATE_CHANNEL);
665         }
666     }
667
668     if (game_state_message.subject == "game state") {
669         if (game_state_message.number_of_reads > 0) {
670             std::cout << "Game state message received by " << this << std::endl;
671             this->message_hub.popMessage(GAME_STATE_CHANNEL);
672         }
673     }
674 }
675
676 return;
677 } /* __processMessage() */

```

4.5.3.19 __sendCreditsEarnedMessage()

```

void Game::__sendCreditsEarnedMessage (
    void ) [private]

```

Helper method to format and send a credits earned message.

```

538 {
539     Message credits_earned_message;
540
541     credits_earned_message.channel = SETTLEMENT_CHANNEL;
542     credits_earned_message.subject = "credits earned";
543
544     this->message_hub.sendMessage(credits_earned_message);
545
546     std::cout << "Credits earned message sent by " << this << std::endl;
547     return;
548 } /* __sendCreditsEarnedMessage() */

```

4.5.3.20 __sendGameStateMessage()

```

void Game::__sendGameStateMessage (
    void ) [private]

```

Helper method to format and send a game state message.

```

422 {
423     Message game_state_message;
424
425     game_state_message.channel = GAME_STATE_CHANNEL;
426     game_state_message.subject = "game state";
427
428     game_state_message.int_payload["year"] = this->year;

```

```

429     game_state_message.int_payload["month"] = this->month;
430     game_state_message.int_payload["population"] = this->population;
431     game_state_message.int_payload["credits"] = this->credits;
432     game_state_message.int_payload["demand_MWh"] = this->demand_MWh;
433     game_state_message.int_payload["cumulative_emissions_tonnes"] =
434         this->cumulative_emissions_tonnes;
435
436     game_state_message.int_payload["reads"] = 0;
437
438     switch (this->game_phase) {
439     case (GamePhase :: BUILD_SETTLEMENT): {
440         game_state_message.string_payload["game phase"] = "build settlement";
441
442         break;
443     }
444
445     case (GamePhase :: SYSTEM_MANAGEMENT): {
446         game_state_message.string_payload["game phase"] = "system management";
447
448         break;
449     }
450
451     case (GamePhase :: LOSS_EMISSIONS): {
452         game_state_message.string_payload["game phase"] = "loss emissions";
453
454         break;
455     }
456
457     case (GamePhase :: LOSS_DEMAND): {
458         game_state_message.string_payload["game phase"] = "loss demand";
459
460         break;
461     }
462
463     case (GamePhase :: LOSS_CREDITS): {
464         game_state_message.string_payload["game phase"] = "loss credits";
465
466         break;
467     }
468
469     case (GamePhase :: VICTORY): {
470         game_state_message.string_payload["game phase"] = "victory";
471
472         break;
473     }
474
475     default: {
476         // do nothing!
477
478         break;
479     }
480
481     }
482
483     game_state_message.vector_payload["demand_vec_MWh"] = this->demand_vec_MWh;
484
485     this->message_hub.sendMessage(game_state_message);
486
487     std::cout << "Game state message sent by " << this << std::endl;
488     return;
489 } /* __sendGameStateMessage() */

```

4.5.3.21 __sendTurnAdvanceMessage()

```

void Game::__sendTurnAdvanceMessage (
    void ) [private]

```

Helper method to format and send a turn advance message.

```

509 {
510     Message turn_advance_message;
511
512     turn_advance_message.channel = GAME_STATE_CHANNEL;
513     turn_advance_message.subject = "turn advance";

```

```

514
515     turn_advance_message.int_payload["credits"] = this->credits;
516     turn_advance_message.int_payload["month"] = this->month;
517     turn_advance_message.int_payload["demand_MWh"] = this->demand_MWh;
518
519     this->message_hub.sendMessage(turn_advance_message);
520
521     std::cout << "Turn advance message sent by " << this << std::endl;
522     return;
523 } /* __sendTurnAdvanceMessage() */

```

4.5.3.22 __summarizeTurn()

```

void Game::__summarizeTurn (
    void ) [private]

```

Helper method to generate end of turn summary.

```

799 {
800     if (this->turn - 1 == 0) {
801         return;
802     }
803
804     this->substring_idx = 0;
805
806     // 1. handle dispatch and demand
807     if (this->demand_served_MWh > this->past_demand_MWh) {
808         this->overproduction_MWh = this->demand_served_MWh - this->past_demand_MWh;
809         this->demand_served_MWh -= this->overproduction_MWh;
810
811         this->overproduction_penalty =
812             round(CREDITS_PER_MWH_SERVED * this->overproduction_MWh);
813     }
814
815     else if (this->demand_served_MWh < this->past_demand_MWh) {
816         this->demand_remaining_MWh = this->past_demand_MWh - this->demand_served_MWh;
817     }
818
819     // 2. compute dispatch income
820     this->dispatch_income = round(CREDITS_PER_MWH_SERVED * this->demand_served_MWh);
821
822     if (this->dispatch_income > 0) {
823         this->__sendCreditsEarnedMessage();
824     }
825
826     // 3. compute net credit flow
827     this->net_credit_flow = this->dispatch_income -
828         this->overproduction_penalty -
829         this->turn_fuel_cost -
830         this->turn_operation_maintenance_cost;
831
832     this->credits += this->net_credit_flow;
833
834     // 4. assemble turn summary string
835     this->turn_summary_string.clear();
836
837     //16 line x 32 char console " \n";
838     this->turn_summary_string = "      **** TURN ";
839     this->turn_summary_string += std::to_string(this->turn - 1);
840     this->turn_summary_string += " SUMMARY **** \n";
841     this->turn_summary_string += " \n";
842
843     this->turn_summary_string += "DEMAND: ";
844     this->turn_summary_string += std::to_string(this->past_demand_MWh);
845     this->turn_summary_string += " MWh\n";
846
847     this->turn_summary_string += "DEMAND SERVED: ";
848     this->turn_summary_string += std::to_string(this->demand_served_MWh);
849     this->turn_summary_string += " MWh\n";
850
851     if (this->overproduction_MWh > 0) {
852         this->turn_summary_string += "OVERPRODUCTION: ";
853         this->turn_summary_string += std::to_string(this->overproduction_MWh);
854         this->turn_summary_string += " MWh\n";
855     }
856
857     else if (this->demand_remaining_MWh > 0) {
858         this->turn_summary_string += "DEMAND REMAINING: ";
859         this->turn_summary_string += std::to_string(this->demand_remaining_MWh);

```

```

860         this->turn_summary_string += " MWh\n";
861     }
862
863     this->turn_summary_string += "                                \n";
864     this->turn_summary_string += "                                \n";
865
866     this->turn_summary_string += "DISPATCH INCOME:  +";
867     this->turn_summary_string += std::to_string(this->dispatch_income);
868     this->turn_summary_string += " K\n";
869
870     this->turn_summary_string += "FUEL COST:          -";
871     this->turn_summary_string += std::to_string(this->turn_fuel_cost);
872     this->turn_summary_string += " K\n";
873
874     this->turn_summary_string += "OP & MAINT COST:  -";
875     this->turn_summary_string += std::to_string(this->turn_operation_maintenance_cost);
876     this->turn_summary_string += " K\n";
877
878     this->turn_summary_string += "OVERPRODUCTION:  -";
879     this->turn_summary_string += std::to_string(this->overproduction_penalty);
880     this->turn_summary_string += " K\n";
881
882     this->turn_summary_string += "-----\n";
883
884     this->turn_summary_string += "NET:                ";
885
886     if (this->net_credit_flow > 0) {
887         this->turn_summary_string += "+";
888     }
889
890     this->turn_summary_string += std::to_string(this->net_credit_flow);
891     this->turn_summary_string += " K\n";
892
893     this->turn_summary_string += "                                \n";
894
895     this->turn_summary_string += "EMISSIONS: ";
896     this->turn_summary_string += std::to_string(this->turn_emissions_tonnes);
897     this->turn_summary_string += " tonnes CO2e\n";
898
899     if (this->turn_emissions_tonnes <= 0) {
900         this->consecutive_zero_emissions_months++;
901     }
902
903     else {
904         this->consecutive_zero_emissions_months = 0;
905     }
906
907     // 5. send game state message
908     this->__sendGameStateMessage();
909
910     return;
911 } /* _summarizeTurn() */

```

4.5.3.23 __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() */

```


4.5.3.24 __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() */
```

4.5.3.25 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).

```
1675 {
1676     // 1. play brand animation
1677     //...
1678
1679     // 2. show splash screen
1680     //...
1681
1682     // 3. start game loop
1683     while (not this->game_loop_broken) {
1684         this->time_since_start_s = this->clock.getElapsedTime().asSeconds();
1685
1686         if (this->time_since_start_s >= (this->frame + 1) * SECONDS_PER_FRAME) {
1687             // 6.1. process events
1688             while (this->render_window_ptr->pollEvent(this->event)) {
1689                 if (
1690                     (this->game_phase == GamePhase :: BUILD_SETTLEMENT) or
1691                     (this->game_phase == GamePhase :: SYSTEM_MANAGEMENT)
1692                 ) {
1693                     this->hex_map_ptr->processEvent();
1694                     this->context_menu_ptr->processEvent();
1695                     this->__processEvent();
1696                 }
1697
1698                 else {
1699                     if (this->event.type == sf::Event::KeyPressed) {
1700                         this->game_loop_broken = true;
1701                     }
1702                 }
1703             }
1704
1705             // 6.2. process messages
1706             while (this->message_hub.hasTraffic()) {
1707                 this->hex_map_ptr->processMessage();
1708                 this->context_menu_ptr->processMessage();
1709                 this->__processMessage();
1710
1711                 this->check_terminating_conditions = true;
1712
1713                 if (not this->message_deadlock) {
```

```

1715         this->message_deadlock_frame++;
1716
1717         if (this->message_deadlock_frame > 5 * FRAMES_PER_SECOND) {
1718             this->message_hub.printState();
1719             this->message_deadlock = true;
1720         }
1721     }
1722 }
1723 this->message_deadlock = false;
1724 this->message_deadlock_frame = 0;
1725
1726
1727 // 6.3. handle turn end summary
1728 if (this->turn_end) {
1729     std::cout << "**** END OF TURN " << std::to_string(this->turn - 1) <<
1730         " ****" << std::endl;
1731
1732     this->__summarizeTurn();
1733
1734     this->turn_end = false;
1735
1736     this->draw_turn_advance_banner = true;
1737     this->turn_advance_alpha = 0;
1738     this->increase_turn_advance_alpha = true;
1739 }
1740
1741
1742 // 6.4. check terminating conditions
1743 if (this->check_terminating_conditions) {
1744     this->__checkTerminatingConditions();
1745     this->check_terminating_conditions = false;
1746 }
1747
1748
1749 // 6.5. draw frame
1750 this->render_window_ptr->clear();
1751
1752 this->hex_map_ptr->draw();
1753 this->context_menu_ptr->draw();
1754 this->__draw();
1755
1756 this->render_window_ptr->display();
1757
1758
1759 // 6.6. increment frame
1760 this->frame++;
1761 }
1762
1763 // check track status, move to next if stopped
1764 if (this->assets_manager_ptr->getTrackStatus() == sf::SoundSource::Stopped) {
1765     this->assets_manager_ptr->nextTrack();
1766     this->assets_manager_ptr->playTrack();
1767 }
1768
1769 }
1770
1771 return this->quit_game;
1772 } /* 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 frame

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

The current frame of the game.

4.5.4.16 game_loop_broken

```
bool Game::game_loop_broken
```

Boolean indicating whether or not the game loop is broken.

4.5.4.17 game_phase

```
GamePhase Game::game_phase
```

The current phase of the game.

4.5.4.18 hex_map_ptr

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

Pointer to the hex map (defines game world).

4.5.4.19 increase_turn_advance_alpha

```
bool Game::increase_turn_advance_alpha
```

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

4.5.4.20 message_deadlock

```
bool Game::message_deadlock
```

A boolean indicating whether a message deadlock has been detected.

4.5.4.21 message_deadlock_frame

```
int Game::message_deadlock_frame
```

A frame counter for detecting message deadlock.

4.5.4.22 message_hub

```
MessageHub Game::message_hub
```

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

4.5.4.23 month

```
int Game::month
```

Current game month.

4.5.4.24 net_credit_flow

```
int Game::net_credit_flow
```

The net credit flow at the end of a turn.

4.5.4.25 overproduction_MWh

```
int Game::overproduction_MWh
```

The amount of overproduction at the end of a turn.

4.5.4.26 overproduction_penalty

```
int Game::overproduction_penalty
```

The penalty for overproduction.

4.5.4.27 past_demand_MWh

```
int Game::past_demand_MWh
```

The demand in the previous turn.

4.5.4.28 population

```
int Game::population
```

Current population.

4.5.4.29 quit_game

```
bool Game::quit_game
```

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

4.5.4.30 render_window_ptr

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

A pointer to the render window.

4.5.4.31 show_frame_clock_overlay

```
bool Game::show_frame_clock_overlay
```

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

4.5.4.32 show_tutorial

```
bool Game::show_tutorial
```

A boolean indicating whether or not to show the tutorial.

4.5.4.33 substring_idx

```
size_t Game::substring_idx
```

The index of the turn summary substring.

4.5.4.34 time_since_start_s

```
double Game::time_since_start_s
```

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

4.5.4.35 turn

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

The current game turn.

4.5.4.36 turn_advance_alpha

```
double Game::turn_advance_alpha
```

The alpha value for the turn advance banner.

4.5.4.37 turn_emissions_tonnes

```
int Game::turn_emissions_tonnes
```

The amount of emissions at the end of a turn.

4.5.4.38 turn_end

```
bool Game::turn_end
```

A boolean indicating a turn end.

4.5.4.39 turn_fuel_cost

```
int Game::turn_fuel_cost
```

The cost of fuel at the end of a turn.

4.5.4.40 turn_operation_maintenance_cost

```
int Game::turn_operation_maintenance_cost
```

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

4.5.4.41 turn_summary_string

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

A string representation of the end of turn summary.

4.5.4.42 turn_summary_text

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

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

4.5.4.43 year

```
int Game::year
```

Current game year.

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

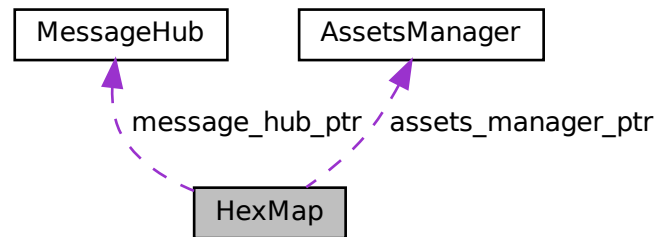
- [header/Game.h](#)
- [source/Game.cpp](#)

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.
- 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.
- int [demand_MWh](#)
Current energy demand [MWh].
- 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.
- 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.

```
1317 {
1318     // 1. set attributes
1319
1320     // 1.1. private
1321     this->event_ptr = event_ptr;
1322     this->render_window_ptr = render_window_ptr;
1323
1324     this->assets_manager_ptr = assets_manager_ptr;
1325     this->message_hub_ptr = message_hub_ptr;
1326
1327     // 1.2. public
1328     this->show_resource = false;
1329     this->tile_selected = false;
1330     this->settlement_position_logged = false;
1331
1332     this->frame = 0;
1333
1334     this->n_layers = n_layers;
1335     if (this->n_layers < 0) {
1336         this->n_layers = 0;
1337     }
1338
1339     this->demand_MWh = 0;
1340
1341     this->position_x = 400;
1342     this->position_y = 400;
1343
1344     this->settlement_position_x = 0;
1345     this->settlement_position_y = 0;
1346
1347     // 2. assemble n layer hex map
1348     this->__assembleHexMap();
1349
1350     // 3. set up and position drawable attributes
1351     this->__setUpGlassScreen();
1352
1353     // 4. add message channel(s)
1354     this->message_hub_ptr->addChannel(TILE_SELECTED_CHANNEL);
1355     this->message_hub_ptr->addChannel(NO_TILE_SELECTED_CHANNEL);
1356     this->message_hub_ptr->addChannel(TILE_STATE_CHANNEL);
1357     this->message_hub_ptr->addChannel(HEX_MAP_CHANNEL);
1358
1359     std::cout << "HexMap constructed at " << this << std::endl;
1360
1361     return;
1362 } /* HexMap(), intended */
```

4.6.2.2 ~HexMap()

```
HexMap::~HexMap (
    void )
```

Destructor for the [HexMap](#) class.

```
1689 {
1690     this->clear();
1691
1692     std::cout << "HexMap at " << this << " destroyed" << std::endl;
1693
1694     return;
1695 } /* ~HexMap() */
```

4.6.3 Member Function Documentation

4.6.3.1 __assembleHexMap()

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

Helper method to assemble the hex map.

```
875 {
876     // 1. seed RNG (using milliseconds since 1 Jan 1970)
877     unsigned long long int milliseconds_since_epoch =
878         std::chrono::duration_cast<std::chrono::milliseconds>(
879             std::chrono::system_clock::now().time_since_epoch()
880         ).count();
881     srand(milliseconds_since_epoch);
882
883     // 2. lay tiles
884     this->__layTiles();
885     this->__buildDrawOrderVector();
886
887     // 3. procedurally generate types
888     this->__procedurallyGenerateTileTypes();
889
890     // 4. procedurally generate resources
891     this->__procedurallyGenerateTileResources();
892
893     return;
894 } /* __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.
----------------	--

```
1123 {
1124     std::vector<HexTile*> neighbours_vec = this->__getNeighboursVector(hex_ptr);
1125 }
```

```

1126     for (size_t i = 0; i < neighbours_vec.size(); i++) {
1127         neighbours_vec[i]->assess();
1128     }
1129
1130     return;
1131 } /* __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     return;
325 } /* __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.

```
1147 {
1148     // 1. compute total production / dispatch
1149     int total_production_dispatch_MWh = 0;
1150
1151     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
1152     std::map<double, HexTile*>::iterator hex_map_iter_y;
1153
1154     TileImprovement* tile_improvement_ptr;
1155
1156     for (
1157         hex_map_iter_x = this->hex_map.begin();
1158         hex_map_iter_x != this->hex_map.end();
1159         hex_map_iter_x++
1160     ) {
1161         for (
1162             hex_map_iter_y = hex_map_iter_x->second.begin();
1163             hex_map_iter_y != hex_map_iter_x->second.end();
1164             hex_map_iter_y++
1165         ) {
1166             if (
1167                 (hex_map_iter_y->second->has_improvement) and
1168                 (hex_map_iter_y->second->tile_improvement_ptr->tile_improvement_type !=
1169                     TileImprovementType :: SETTLEMENT)
1170             ) {
1171                 tile_improvement_ptr = hex_map_iter_y->second->tile_improvement_ptr;
1172
1173                 switch (tile_improvement_ptr->tile_improvement_type) {
1174                     case (TileImprovementType :: DIESEL_GENERATOR): {
1175                         total_production_dispatch_MWh +=
1176                             ((DieselGenerator*)tile_improvement_ptr)->production_MWh;
1177
1178                         break;
1179                     }
1180
1181                     case (TileImprovementType :: SOLAR_PV): {
1182                         total_production_dispatch_MWh +=
1183                             ((SolarPV*)tile_improvement_ptr)->dispatch_MWh;
1184
1185                         break;
1186                     }
1187
1188                     case (TileImprovementType :: TIDAL_TURBINE): {
1189                         total_production_dispatch_MWh +=
1190                             ((TidalTurbine*)tile_improvement_ptr)->dispatch_MWh;
1191
1192                         break;
1193                     }
1194
1195                     case (TileImprovementType :: WAVE_ENERGY_CONVERTER): {
1196                         total_production_dispatch_MWh +=
1197                             ((WaveEnergyConverter*)tile_improvement_ptr)->dispatch_MWh;
1198
1199                         break;
1200                     }
1201
1202                     case (TileImprovementType :: WIND_TURBINE): {
1203                         total_production_dispatch_MWh +=
1204                             ((WindTurbine*)tile_improvement_ptr)->dispatch_MWh;
1205
1206                         break;
1207                     }
1208
1209                     default: {
1210                         // do nothing!
1211
1212                         break;
1213                     }
1214                 }
1215             }
1216         }
1217     }
1218
1219     // 2. construct total text
```



```

1225     sf::Text total_production_dispatch_text (
1226         std::to_string(total_production_dispatch_MWh),
1227         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
1228         16
1229     );
1230
1231     total_production_dispatch_text.setOrigin(
1232         total_production_dispatch_text.getLocalBounds().width / 2,
1233         total_production_dispatch_text.getLocalBounds().height / 2
1234     );
1235
1236     total_production_dispatch_text.setPosition(800 - 20, 20 - 4);
1237
1238     sf::Color text_colour;
1239
1240     if (total_production_dispatch_MWh < this->demand_MWh) {
1241         text_colour = MONOCHROME_TEXT_RED;
1242     }
1243
1244     else if (total_production_dispatch_MWh > this->demand_MWh) {
1245         text_colour = MONOCHROME_TEXT_AMBER;
1246     }
1247
1248     else {
1249         text_colour = MONOCHROME_TEXT_GREEN;
1250     }
1251
1252     total_production_dispatch_text.setFillColor(text_colour);
1253
1254     // 4. construct total backing
1255     sf::RectangleShape total_production_dispatch_backing(sf::Vector2f(32, 32));
1256
1257     total_production_dispatch_backing.setOrigin(
1258         total_production_dispatch_backing.getLocalBounds().width / 2,
1259         total_production_dispatch_backing.getLocalBounds().height / 2
1260     );
1261
1262     total_production_dispatch_backing.setPosition(800 - 20, 20);
1263
1264     total_production_dispatch_backing.setFillColor(MONOCHROME_SCREEN_BACKGROUND);
1265
1266     total_production_dispatch_backing.setOutlineColor(MENU_FRAME_GREY);
1267     total_production_dispatch_backing.setOutlineThickness(2);
1268
1269     // 4. draw
1270     if (total_production_dispatch_MWh > 0) {
1271         this->render_window_ptr->draw(total_production_dispatch_backing);
1272         this->render_window_ptr->draw(total_production_dispatch_text);
1273     }
1274
1275     return;
1276 } /* __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.

```

786 {
787     std::cout << "enforcing ocean continuity ..." << std::endl;
788
789     bool tile_changed = false;
790
791     // 1. scan tiles and enforce (where appropriate)
792     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
793     std::map<double, HexTile*>::iterator hex_map_iter_y;
794     HexTile* hex_ptr;
795     for (
796         hex_map_iter_x = this->hex_map.begin();
797         hex_map_iter_x != this->hex_map.end();
798         hex_map_iter_x++
799     ) {
800         for (
801             hex_map_iter_y = hex_map_iter_x->second.begin();
802             hex_map_iter_y != hex_map_iter_x->second.end();
803             hex_map_iter_y++

```

```

804         ) {
805             hex_ptr = hex_map_iter_y->second;
806
807             if (this->__isLakeTouchingOcean(hex_ptr)) {
808                 hex_ptr->setTileType(TileType :: OCEAN);
809                 tile_changed = true;
810             }
811         }
812     }
813
814     if (tile_changed) {
815         this->__enforceOceanContinuity();
816     }
817     else {
818         return;
819     }
820 } /* __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

<i>hex_ptr</i>	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.

```

642 {
643     // 1. init type count map
644     std::map<TileType, int> type_count_map;
645     type_count_map[hex_ptr->tile_type] = 1;
646
647     // 2. survey neighbours, count type instances
648     std::vector<HexTile*> neighbours_vec = this->__getNeighboursVector(hex_ptr);
649
650     for (size_t i = 0; i < neighbours_vec.size(); i++) {
651         if (type_count_map.count(neighbours_vec[i]->tile_type) <= 0) {
652             type_count_map[neighbours_vec[i]->tile_type] = 1;
653         }
654         else {
655             type_count_map[neighbours_vec[i]->tile_type] += 1;
656         }
657     }
658
659     // 3. find majority tile type
660     int max_count = -1 * std::numeric_limits<int>::infinity();
661     TileType majority_tile_type = hex_ptr->tile_type;
662
663     std::map<TileType, int>::iterator map_iter;
664     for (
665         map_iter = type_count_map.begin();
666         map_iter != type_count_map.end();
667         map_iter++)
668     ){
669         if (map_iter->second > max_count) {
670             max_count = map_iter->second;
671             majority_tile_type = map_iter->first;
672         }
673     }
674
675     // 4. detect ties
676     for (
677         map_iter = type_count_map.begin();

```

```

678         map_iter != type_count_map.end();
679         map_iter++
680     ){
681         if (
682             map_iter->second == max_count and
683             map_iter->first != majority_tile_type
684         ) {
685             majority_tile_type = hex_ptr->tile_type;
686             break;
687         }
688     }
689
690     return majority_tile_type;
691 } /* __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

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

Returns

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

```

584 {
585     std::vector<HexTile*> neighbours_vec;
586
587     // 1. build potential neighbour positions
588     std::vector<double> potential_neighbour_x_vec(6, 0);
589     std::vector<double> potential_neighbour_y_vec(6, 0);
590
591     for (int i = 0; i < 6; i++) {
592         potential_neighbour_x_vec[i] = hex_ptr->position_x +
593             2 * hex_ptr->minor_radius * cos((60 * i) * (M_PI / 180));
594
595         potential_neighbour_y_vec[i] = hex_ptr->position_y +
596             2 * hex_ptr->minor_radius * sin((60 * i) * (M_PI / 180));
597     }
598
599     // 2. populate neighbours vector
600     std::vector<double> map_index_positions;
601     double potential_x = 0;
602     double potential_y = 0;
603
604     for (int i = 0; i < 6; i++) {
605         potential_x = potential_neighbour_x_vec[i];
606         potential_y = potential_neighbour_y_vec[i];
607
608         map_index_positions = this->__getValidMapIndexPositions(
609             potential_x,
610             potential_y
611         );
612
613         if (not (map_index_positions[0] == -1)) {
614             neighbours_vec.push_back(
615                 this->hex_map[map_index_positions[0]][map_index_positions[1]]
616             );
617         }
618     }
619
620     return neighbours_vec;
621 } /* __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].

```
349 {
350     // 1. generate random amplitude, wave number, direction, and phase vectors
351     std::vector<double> random_amplitude_vec(n_components, 0);
352     std::vector<double> random_wave_number_vec(n_components, 0);
353     std::vector<double> random_frequency_vec(n_components, 0);
354     std::vector<double> random_direction_vec(n_components, 0);
355     std::vector<double> random_phase_vec(n_components, 0);
356
357     for (int i = 0; i < n_components; i++) {
358         random_amplitude_vec[i] = 10 * ((double)rand() / RAND_MAX);
359
360         random_wave_number_vec[i] = 2 * M_PI * ((double)rand() / RAND_MAX);
361
362         random_frequency_vec[i] = ((double)rand() / RAND_MAX);
363
364         random_direction_vec[i] = 2 * M_PI * ((double)rand() / RAND_MAX);
365
366         random_phase_vec[i] = 2 * M_PI * ((double)rand() / RAND_MAX);
367     }
368
369     // 2. generate noise vec
370     double amp = 0;
371     double wave_no = 0;
372     double freq = 0;
373     double dir = 0;
374     double phase = 0;
375
376     double x = 0;
377     double y = 0;
378     double t = time(NULL);
379
380     double max_noise = -1 * std::numeric_limits<double>::infinity();
381     double min_noise = std::numeric_limits<double>::infinity();
382
383     double noise = 0;
384     std::vector<double> noise_vec(n_elements, 0);
385
386     for (int i = 0; i < n_elements; i++) {
387         x = this->tile_position_x_vec[i] - this->position_x;
388         y = this->tile_position_y_vec[i] - this->position_y;
389
390         for (int j = 0; j < n_components; j++) {
391             amp = random_amplitude_vec[j];
392             wave_no = random_wave_number_vec[j];
393             freq = random_frequency_vec[j];
394             dir = random_direction_vec[j];
395             phase = random_phase_vec[j];
396
397             noise += (amp / (j + 1)) * cos(
398                 wave_no * (j + 1) * (x * sin(dir) + y * cos(dir)) +
399                 2 * M_PI * (j + 1) * freq * t +
400                 phase
401             );
402         }
403
404         noise_vec[i] = noise;
405
406         if (noise > max_noise) {
```

```

407         max_noise = noise;
408     }
409
410     else if (noise < min_noise) {
411         min_noise = noise;
412     }
413
414     noise = 0;
415 }
416
417 // 3. normalize noise vec
418 for (int i = 0; i < n_elements; i++) {
419     noise_vec[i] = (noise_vec[i] - min_noise) / (max_noise - min_noise);
420
421     if (noise_vec[i] < 0) {
422         noise_vec[i] = 0;
423     }
424     else if (noise_vec[i] > 1) {
425         noise_vec[i] = 1;
426     }
427 }
428
429 return noise_vec;
430 } /* __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).

```

911 {
912     HexTile* selected_tile_ptr = NULL;
913
914     bool break_flag = false;
915     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
916     std::map<double, HexTile*>::iterator hex_map_iter_y;
917
918     for (
919         hex_map_iter_x = this->hex_map.begin();
920         hex_map_iter_x != this->hex_map.end();
921         hex_map_iter_x++
922     ) {
923         for (
924             hex_map_iter_y = hex_map_iter_x->second.begin();
925             hex_map_iter_y != hex_map_iter_x->second.end();
926             hex_map_iter_y++
927         ) {
928             if (hex_map_iter_y->second->is_selected) {
929                 selected_tile_ptr = hex_map_iter_y->second;
930                 break_flag = true;
931             }
932
933             if (break_flag) {
934                 break;
935             }
936         }
937
938         if (break_flag) {
939             break;
940         }
941     }
942
943     return selected_tile_ptr;
944 } /* __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.

```
530 {
531     std::vector<double> map_index_positions = {-1, -1};
532
533     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
534     std::map<double, HexTile*>::iterator hex_map_iter_y;
535     HexTile* hex_ptr;
536
537     double distance = 0;
538
539     for (
540         hex_map_iter_x = this->hex_map.begin();
541         hex_map_iter_x != this->hex_map.end();
542         hex_map_iter_x++
543     ) {
544         for (
545             hex_map_iter_y = hex_map_iter_x->second.begin();
546             hex_map_iter_y != hex_map_iter_x->second.end();
547             hex_map_iter_y++
548         ) {
549             hex_ptr = hex_map_iter_y->second;
550
551             distance = sqrt(
552                 pow(hex_ptr->position_x - potential_x, 2) +
553                 pow(hex_ptr->position_y - potential_y, 2)
554             );
555
556             if (distance <= hex_ptr->minor_radius / 4) {
557                 map_index_positions = {hex_ptr->position_x, hex_ptr->position_y};
558                 return map_index_positions;
559             }
560         }
561     }
562
563     return map_index_positions;
564 } /* __isInHexMap() */
```

4.6.3.11 `__handleKeyPressEvents()`

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

Helper method to handle key press events.

```
1015 {
1016     switch (this->event_ptr->key.code) {
1017         case (sf::Keyboard::Escape): {
1018             this->tile_selected = false;
1019         }
```

```

1020
1021
1022         default: {
1023             // do nothing!
1024
1025             break;
1026         }
1027     }
1028
1029     return;
1030 } /* __handleKeyPressEvents() */

```

4.6.3.12 __handleMouseButtonEvents()

```

void HexMap::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

1045 {
1046     switch (this->event_ptr->mouseButton.button) {
1047         case (sf::Mouse::Left): {
1048             HexTile* hex_ptr = this->__getSelectedTile();
1049
1050             if (hex_ptr != NULL) {
1051                 this->tile_selected = true;
1052             }
1053
1054             else if (this->tile_selected) {
1055                 this->tile_selected = false;
1056                 this->__sendNoTileSelectedMessage();
1057             }
1058
1059             break;
1060         }
1061
1062         case (sf::Mouse::Right): {
1063             if (this->tile_selected) {
1064                 this->tile_selected = false;
1065                 this->__sendNoTileSelectedMessage();
1066             }
1067
1068             break;
1069         }
1070
1071         default: {
1072             // do nothing!
1073
1074             break;
1075         }
1076     }
1077
1078     return;
1079 } /* __handleMouseButtonEvents() */

```

4.6.3.13 __isLakeTouchingOcean()

```

bool HexMap::__isLakeTouchingOcean (
    HexTile * hex_ptr ) [private]
753 {
754     // 1. if not lake tile, return
755     if (not (hex_ptr->tile_type == TileType::LAKE)) {
756         return false;
757     }
758
759     // 2. scan neighbours for ocean tiles
760     std::vector<HexTile*> neighbours_vec = this->__getNeighboursVector(hex_ptr);
761
762     for (size_t i = 0; i < neighbours_vec.size(); i++) {

```

```

763         if (neighbours_vec[i]->tile_type == TileType :: OCEAN) {
764             return true;
765         }
766     }
767
768     return false;
769 } /* __isLakeTouchingOcean() */

```

4.6.3.14 __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     // 2. fill out first row (reflect across origin tile)
107     for (int i = 0; i < this->n_layers; i++) {
108         hex_ptr = new HexTile(
109             this->position_x + 2 * (i + 1) * hex_ptr->minor_radius,
110             this->position_y,
111             this->event_ptr,
112             this->render_window_ptr,
113             this->assets_manager_ptr,
114             this->message_hub_ptr
115         );
116
117         this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
118         this->tile_position_x_vec.push_back(hex_ptr->position_x);
119         this->tile_position_y_vec.push_back(hex_ptr->position_y);
120         this->n_tiles++;
121
122         if (i == this->n_layers - 1) {
123             this->border_tiles_vec.push_back(hex_ptr);
124         }
125
126         hex_ptr = new HexTile(
127             this->position_x - 2 * (i + 1) * hex_ptr->minor_radius,
128             this->position_y,
129             this->event_ptr,
130             this->render_window_ptr,
131             this->assets_manager_ptr,
132             this->message_hub_ptr
133         );
134
135         this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
136         this->tile_position_x_vec.push_back(hex_ptr->position_x);
137         this->tile_position_y_vec.push_back(hex_ptr->position_y);
138         this->n_tiles++;
139
140         if (i == this->n_layers - 1) {
141             this->border_tiles_vec.push_back(hex_ptr);
142         }
143     }
144
145     // 3. fill out subsequent rows (reflect across first row)
146     HexTile* first_row_left_tile = hex_ptr;
147
148     int offset_count = 1;
149
150
151

```



```

152     double x_offset = 0;
153     double y_offset = 0;
154
155     for (
156         int row_width = 2 * this->n_layers;
157         row_width > this->n_layers;
158         row_width--
159     ) {
160         // 3.1. upper row
161         x_offset = first_row_left_tile->position_x +
162             2 * offset_count * first_row_left_tile->minor_radius *
163             cos(60 * (M_PI / 180));
164
165         y_offset = first_row_left_tile->position_y -
166             2 * offset_count * first_row_left_tile->minor_radius *
167             sin(60 * (M_PI / 180));
168
169         hex_ptr = new HexTile(
170             x_offset,
171             y_offset,
172             this->event_ptr,
173             this->render_window_ptr,
174             this->assets_manager_ptr,
175             this->message_hub_ptr
176         );
177
178         this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
179         this->tile_position_x_vec.push_back(hex_ptr->position_x);
180         this->tile_position_y_vec.push_back(hex_ptr->position_y);
181         this->n_tiles++;
182
183         this->border_tiles_vec.push_back(hex_ptr);
184
185         for (int i = 1; i < row_width; i++) {
186             x_offset += 2 * first_row_left_tile->minor_radius;
187
188             hex_ptr = new HexTile(
189                 x_offset,
190                 y_offset,
191                 this->event_ptr,
192                 this->render_window_ptr,
193                 this->assets_manager_ptr,
194                 this->message_hub_ptr
195             );
196
197             this->hex_map[hex_ptr->position_x][hex_ptr->position_y] = hex_ptr;
198             this->tile_position_x_vec.push_back(hex_ptr->position_x);
199             this->tile_position_y_vec.push_back(hex_ptr->position_y);
200             this->n_tiles++;
201
202             if (row_width == this->n_layers + 1 or i == row_width - 1) {
203                 this->border_tiles_vec.push_back(hex_ptr);
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() */

```

4.6.3.15 __logSettlementPosition()

```

void HexMap::__logSettlementPosition (
    void ) [private]

```

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

```

959 {
960     bool break_flag = false;
961
962     std::map<double, std::map<double, HexTile*>>::iterator hex_map_iter_x;
963     std::map<double, HexTile*>::iterator hex_map_iter_y;
964
965     for (
966         hex_map_iter_x = this->hex_map.begin();
967         hex_map_iter_x != this->hex_map.end();
968         hex_map_iter_x++
969     ) {
970         for (
971             hex_map_iter_y = hex_map_iter_x->second.begin();
972             hex_map_iter_y != hex_map_iter_x->second.end();
973             hex_map_iter_y++
974         ) {
975             if (
976                 (hex_map_iter_y->second->has_improvement) and
977                 (hex_map_iter_y->second->tile_improvement_ptr->tile_improvement_type ==
978                     TileImprovementType :: SETTLEMENT)
979             ) {
980                 this->settlement_position_x = hex_map_iter_y->second->position_x;
981                 this->settlement_position_y = hex_map_iter_y->second->position_y;
982
983                 this->settlement_position_logged = true;
984
985                 std::cout << "Settlement position logged, (" <<
986                     this->settlement_position_x << ", " <<
987                     this->settlement_position_y << ") " << std::endl;
988
989                 break_flag = true;
990                 break;
991             }
992         }
993
994         if (break_flag) {
995             break;
996         }
997     }
998
999     return;
1000 } /* __logSettlementPosition() */

```

4.6.3.16 __procedurallyGenerateTileResources()

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

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

```
835 {
836     // 1. get random cosine series noise vec
837     std::vector<double> noise_vec = this->__getNoise(this->n_tiles);
838
839     // 2. set tile resources based on random cosine series noise
840     int noise_idx = 0;
841
842     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
843     std::map<double, HexTile*>::iterator hex_map_iter_y;
844     for (
845         hex_map_iter_x = this->hex_map.begin();
846         hex_map_iter_x != this->hex_map.end();
847         hex_map_iter_x++
848     ) {
849         for (
850             hex_map_iter_y = hex_map_iter_x->second.begin();
851             hex_map_iter_y != hex_map_iter_x->second.end();
852             hex_map_iter_y++
853         ) {
854             hex_map_iter_y->second->setTileResource(noise_vec[noise_idx]);
855             noise_idx++;
856         }
857     }
858
859     return;
860 } /* __procedurallyGenerateTileResources() */
```

4.6.3.17 __procedurallyGenerateTileTypes()

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

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

```
445 {
446     // 1. get random cosine series noise vec
447     std::vector<double> noise_vec = this->__getNoise(this->n_tiles);
448
449     // 2. set initial tile types based on either random cosine series noise or white
450     //     noise (decided by coin toss)
451     int noise_idx = 0;
452
453     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
454     std::map<double, HexTile*>::iterator hex_map_iter_y;
455     for (
456         hex_map_iter_x = this->hex_map.begin();
457         hex_map_iter_x != this->hex_map.end();
458         hex_map_iter_x++
459     ) {
460         for (
461             hex_map_iter_y = hex_map_iter_x->second.begin();
462             hex_map_iter_y != hex_map_iter_x->second.end();
463             hex_map_iter_y++
464         ) {
465             if ((double)rand() / RAND_MAX > 0.5) {
466                 hex_map_iter_y->second->setTileType(noise_vec[noise_idx]);
467             }
468             else {
469                 hex_map_iter_y->second->setTileType((double)rand() / RAND_MAX);
470             }
471             noise_idx++;
472         }
473     }
474
475     // 3. smooth tile types (majority rules)
476     this->__smoothTileTypes();
477
478     // 4. set border tile type to ocean
479     for (size_t i = 0; i < this->border_tiles_vec.size(); i++) {
480         this->border_tiles_vec[i]->setTileType(TileType :: OCEAN);
481     }
482 }
```

```

481     }
482
483     // 5. enforce ocean continuity (i.e. all lake tiles touching ocean become ocean)
484     this->__enforceOceanContinuity();
485
486     // 6. decorate tiles
487     for (
488         hex_map_iter_x = this->hex_map.begin();
489         hex_map_iter_x != this->hex_map.end();
490         hex_map_iter_x++
491     ) {
492         for (
493             hex_map_iter_y = hex_map_iter_x->second.begin();
494             hex_map_iter_y != hex_map_iter_x->second.end();
495             hex_map_iter_y++
496         ) {
497             hex_map_iter_y->second->decorateTile();
498         }
499     }
500
501     return;
502 } /* __procedurallyGenerateTileTypes() */

```

4.6.3.18 __sendNoTileSelectedMessage()

```

void HexMap::__sendNoTileSelectedMessage (
    void ) [private]

```

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

```

1096 {
1097     Message no_tile_selected_message;
1098
1099     no_tile_selected_message.channel = NO_TILE_SELECTED_CHANNEL;
1100     no_tile_selected_message.subject = "no tile selected";
1101
1102     this->message_hub_ptr->sendMessage(no_tile_selected_message);
1103
1104     std::cout << "No tile selected message sent by " << this << std::endl;
1105     return;
1106 } /* __sendNoTileSelectedMessage() */

```

4.6.3.19 __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() */

```

4.6.3.20 __smoothTileTypes()

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

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

```
706 {
707     std::cout << "smoothing ..." << std::endl;
708
709     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
710     std::map<double, HexTile*>::iterator hex_map_iter_y;
711     HexTile* hex_ptr;
712     TileType majority_tile_type;
713
714     for (
715         hex_map_iter_x = this->hex_map.begin();
716         hex_map_iter_x != this->hex_map.end();
717         hex_map_iter_x++
718     ) {
719         for (
720             hex_map_iter_y = hex_map_iter_x->second.begin();
721             hex_map_iter_y != hex_map_iter_x->second.end();
722             hex_map_iter_y++
723         ) {
724             hex_ptr = hex_map_iter_y->second;
725             majority_tile_type = this->__getMajorityTileType(hex_ptr);
726
727             if (majority_tile_type != hex_ptr->tile_type) {
728                 hex_ptr->setTileType(majority_tile_type);
729             }
730         }
731     }
732
733     return;
734 } /* __smoothTileTypes() */
```

4.6.3.21 assess()

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

Method to assess the resource of the selected tile.

```
1377 {
1378     HexTile* selected_tile_ptr = this->__getSelectedTile();
1379     if (selected_tile_ptr != NULL) {
1380         selected_tile_ptr->assess();
1381     }
1382
1383     return;
1384 } /* assess() */
```

4.6.3.22 clear()

```
void HexMap::clear (
    void )
```

Method to clear the hex map.

```
1651 {
1652     std::map<double, std::map<double, HexTile*>::iterator hex_map_iter_x;
1653     std::map<double, HexTile*>::iterator hex_map_iter_y;
1654     for (
1655         hex_map_iter_x = this->hex_map.begin();
1656         hex_map_iter_x != this->hex_map.end();
1657         hex_map_iter_x++
1658     ) {
1659         for (
```

```

1660         hex_map_iter_y = hex_map_iter_x->second.begin();
1661         hex_map_iter_y != hex_map_iter_x->second.end();
1662         hex_map_iter_y++
1663     ) {
1664         delete hex_map_iter_y->second;
1665     }
1666 }
1667 this->hex_map.clear();
1668
1669 this->tile_position_x_vec.clear();
1670 this->tile_position_y_vec.clear();
1671 this->border_tiles_vec.clear();
1672
1673 return;
1674 } /* clear() */

```

4.6.3.23 draw()

```

void HexMap::draw (
    void )

```

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

```

1575 {
1576     // 1. draw background
1577     sf::Color glass_screen_colour = this->glass_screen.getFillColor();
1578     glass_screen_colour.a = 255;
1579     this->glass_screen.setFillColor(glass_screen_colour);
1580
1581     this->render_window_ptr->draw(this->glass_screen);
1582
1583     // 2. draw tiles (other than the selected tile) in drawing order
1584     for (size_t i = 0; i < this->hex_draw_order_vec.size(); i++) {
1585         if (not this->hex_draw_order_vec[i]->is_selected) {
1586             this->hex_draw_order_vec[i]->draw();
1587         }
1588     }
1589
1590     // 3. draw total production / dispatch overlay
1591     if (this->settlement_position_logged) {
1592         this->__drawTotalDispatch();
1593     }
1594
1595     // 4. draw selected tile
1596     HexTile* selected_tile_ptr = this->__getSelectedTile();
1597     if (selected_tile_ptr != NULL) {
1598         selected_tile_ptr->draw();
1599
1600         if (
1601             (selected_tile_ptr->has_improvement) and
1602             (selected_tile_ptr->tile_improvement_ptr->tile_improvement_type ==
1603              TileImprovementType :: SETTLEMENT)
1604         ) {
1605             this->__drawTotalDispatch();
1606         }
1607     }
1608
1609     // 5. draw resource overlay text indication
1610     if (this->show_resource) {
1611         sf::Text resource_overlay_text(
1612             "**** RENEWABLE RESOURCE OVERLAY ****",
1613             *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
1614             16
1615         );
1616
1617         resource_overlay_text.setPosition(
1618             (800 - resource_overlay_text.getLocalBounds().width) / 2,
1619             GAME_HEIGHT - 70
1620         );
1621
1622         resource_overlay_text.setFillColor(MONOCROME_TEXT_GREEN);
1623
1624         this->render_window_ptr->draw(resource_overlay_text);
1625     }
1626
1627     // 6. draw glass screen
1628     glass_screen_colour = this->glass_screen.getFillColor();
1629     glass_screen_colour.a = 40;
1630     this->glass_screen.setFillColor(glass_screen_colour);

```

```

1631
1632     this->render_window_ptr->draw(this->glass_screen);
1633
1634     this->frame++;
1635     return;
1636 }    /* draw() */

```

4.6.3.24 processEvent()

```

void HexMap::processEvent (
    void )

```

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

```

1462 {
1463     // 1. process HexTile events
1464     std::map<double, std::map<double, HexTile*>>::iterator hex_map_iter_x;
1465     std::map<double, HexTile*>::iterator hex_map_iter_y;
1466     for (
1467         hex_map_iter_x = this->hex_map.begin();
1468         hex_map_iter_x != this->hex_map.end();
1469         hex_map_iter_x++
1470     ) {
1471         for (
1472             hex_map_iter_y = hex_map_iter_x->second.begin();
1473             hex_map_iter_y != hex_map_iter_x->second.end();
1474             hex_map_iter_y++
1475         ) {
1476             hex_map_iter_y->second->processEvent();
1477         }
1478     }
1479
1480     // 2. process HexMap events
1481     if (this->event_ptr->type == sf::Event::KeyPressed) {
1482         this->__handleKeyPressEvents();
1483     }
1484
1485     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1486         this->__handleMouseButtonEvents();
1487     }
1488
1489     return;
1490 }    /* processEvent() */

```

4.6.3.25 processMessage()

```

void HexMap::processMessage (
    void )

```

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

```

1505 {
1506     // 1. process HexTile messages
1507     std::map<double, std::map<double, HexTile*>>::iterator hex_map_iter_x;
1508     std::map<double, HexTile*>::iterator hex_map_iter_y;
1509     for (
1510         hex_map_iter_x = this->hex_map.begin();
1511         hex_map_iter_x != this->hex_map.end();
1512         hex_map_iter_x++
1513     ) {
1514         for (
1515             hex_map_iter_y = hex_map_iter_x->second.begin();
1516             hex_map_iter_y != hex_map_iter_x->second.end();
1517             hex_map_iter_y++
1518         ) {
1519             hex_map_iter_y->second->processMessage();
1520         }
1521     }
1522
1523     // 2. process HexMap messages
1524     if (not this->message_hub_ptr->isEmpty(HEX_MAP_CHANNEL)) {

```

```

1525         Message hex_map_message = this->message_hub_ptr->receiveMessage(
1526             HEX_MAP_CHANNEL
1527         );
1528
1529         if (hex_map_message.subject == "assess neighbours") {
1530             HexTile* hex_ptr = this->__getSelectedTile();
1531             this->__assessNeighbours(hex_ptr);
1532
1533             std::cout << "Assess neighbours message received by " << this << std::endl;
1534             this->message_hub_ptr->popMessage(HEX_MAP_CHANNEL);
1535         }
1536     }
1537
1538     if (not this->message_hub_ptr->isEmpty(GAME_STATE_CHANNEL)) {
1539         Message game_state_message = this->message_hub_ptr->receiveMessage(
1540             GAME_STATE_CHANNEL
1541         );
1542
1543         if (game_state_message.subject == "game state") {
1544             this->demand_MWh = game_state_message.int_payload["demand_MWh"];
1545
1546             this->message_hub_ptr->incrementMessageRead(GAME_STATE_CHANNEL);
1547
1548             std::cout << "Game state message read and passed by " << this <<
1549                 " (demand: " << this->demand_MWh << " MWh)" << std::endl;
1550         }
1551     }
1552
1553     // 3. log settlement position (if applicable)
1554     if (not this->settlement_position_logged) {
1555         this->__logSettlementPosition();
1556     }
1557
1558     return;
1559 } /* processMessage() */

```

4.6.3.26 reroll()

```

void HexMap::reroll (
    void )

```

Method to re-roll the hex map.

```

1399 {
1400     this->clear();
1401     this->__assembleHexMap();
1402
1403     return;
1404 } /* reroll() */

```

4.6.3.27 toggleResourceOverlay()

```

void HexMap::toggleResourceOverlay (
    void )

```

Method to toggle the hex map resource overlay.

```

1419 {
1420     std::map<double, std::map<double, HexTile*>>::iterator hex_map_iter_x;
1421     std::map<double, HexTile*>::iterator hex_map_iter_y;
1422     for (
1423         hex_map_iter_x = this->hex_map.begin();
1424         hex_map_iter_x != this->hex_map.end();
1425         hex_map_iter_x++
1426     ) {
1427         for (
1428             hex_map_iter_y = hex_map_iter_x->second.begin();
1429             hex_map_iter_y != hex_map_iter_x->second.end();
1430             hex_map_iter_y++
1431         ) {
1432             hex_map_iter_y->second->toggleResourceOverlay();

```



```
1433     }
1434 }
1435
1436 if (this->show_resource) {
1437     this->show_resource = false;
1438     this->assets_manager_ptr->getSound("resource overlay toggle off")->play();
1439 }
1440
1441 else {
1442     this->show_resource = true;
1443     this->assets_manager_ptr->getSound("resource overlay toggle on")->play();
1444 }
1445
1446 return;
1447 } /* 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 demand_MWh

```
int HexMap::demand_MWh
```

Current energy demand [MWh].

4.6.4.4 event_ptr

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

A pointer to the event class.

4.6.4.5 frame

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

The current frame of this object.

4.6.4.6 glass_screen

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

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

4.6.4.7 hex_draw_order_vec

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

A vector of hex tiles, in drawing order.

4.6.4.8 hex_map

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

A position-indexed, nested map of hex tiles.

4.6.4.9 message_hub_ptr

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

A pointer to the message hub.

4.6.4.10 n_layers

```
int HexMap::n_layers
```

The number of layers in the hex map.

4.6.4.11 n_tiles

```
int HexMap::n_tiles
```

The number of tiles in the hex map.

4.6.4.12 position_x

```
double HexMap::position_x
```

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

4.6.4.13 position_y

```
double HexMap::position_y
```

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

4.6.4.14 render_window_ptr

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

A pointer to the render window.

4.6.4.15 settlement_position_logged

```
bool HexMap::settlement_position_logged
```

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

4.6.4.16 settlement_position_x

```
double HexMap::settlement_position_x
```

The x position of the settlement.

4.6.4.17 settlement_position_y

```
double HexMap::settlement_position_y
```

The y position of the settlement.

4.6.4.18 show_resource

```
bool HexMap::show_resource
```

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

4.6.4.19 tile_position_x_vec

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

A vector of tile x positions.

4.6.4.20 tile_position_y_vec

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

A vector of tile y position.

4.6.4.21 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:

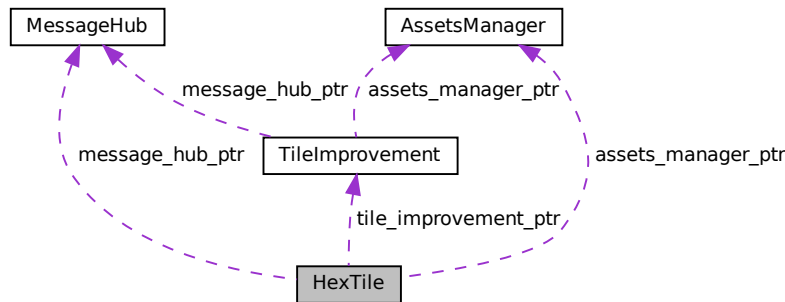
- header/[HexMap.h](#)
- source/[HexMap.cpp](#)

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 [__setUpResourceText](#) (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.

```

2332 {
2333     // 1. set attributes
2334
2335     // 1.1. private
2336     this->event_ptr = event_ptr;
2337     this->render_window_ptr = render_window_ptr;
2338
2339     this->assets_manager_ptr = assets_manager_ptr;
2340     this->message_hub_ptr = message_hub_ptr;
2341
2342     // 1.2. public
2343     this->show_node = false;
2344     this->show_resource = false;
2345     this->resource_assessed = false;
2346     this->resource_assessment = false;
2347     this->is_selected = false;
2348     this->draw_explosion = false;
2349
2350     this->decoration_cleared = false;
2351     this->has_improvement = false;
2352     this->tile_improvement_ptr = NULL;
2353
2354     this->build_menu_open = false;
2355
2356     this->explosion_frame = 0;
2357
2358     this->frame = 0;
2359     this->credits = 0;
2360
2361     this->scrap_improvement_frame = 0;
2362
2363     this->position_x = position_x;
2364     this->position_y = position_y;
2365
2366     this->major_radius = 32;
2367     this->minor_radius = (sqrt(3) / 2) * this->major_radius;
2368
2369     this->game_phase = "build settlement";
2370
2371     // 2. set up and position drawable attributes
2372     this->__setUpNodeSprite();
2373     this->__setUpTileSprite();
2374     this->__setUpSelectOutlineSprite();
2375     this->__setUpResourceChipSprite();
2376     this->__setUpResourceText();
2377     this->__setUpMagnifyingGlassSprite();
2378     this->__setUpTileExplosionReel();
2379
2380     // 3. set tile type and resource (default to none type and average)
2381     this->setTileType(TileType :: NONE_TYPE);
2382     this->setTileResource(TileResource :: AVERAGE);
2383
2384     std::cout << "HexTile constructed at " << this << std::endl;
2385
2386     return;
2387 } /* HexTile() */

```

4.7.2.2 ~HexTile()

```

HexTile::~HexTile (
    void )

```

Destructor for the [HexTile](#) class.

```

2955 {
2956     if (this->tile_improvement_ptr != NULL) {
2957         delete this->tile_improvement_ptr;
2958     }
2959
2960     std::cout << "HexTile at " << this << " destroyed" << std::endl;
2961
2962     return;
2963 } /* ~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.

```
1409 {
1410     int build_cost = DIESEL_GENERATOR_BUILD_COST;
1411
1412     if (this->credits < build_cost) {
1413         std::cout << "Cannot build diesel generator: insufficient credits (need "
1414             << build_cost << " K)" << std::endl;
1415
1416         this->__sendInsufficientCreditsMessage();
1417         return;
1418     }
1419
1420     this->tile_improvement_ptr = new DieselGenerator(
1421         this->position_x,
1422         this->position_y,
1423         this->tile_resource,
1424         this->event_ptr,
1425         this->render_window_ptr,
1426         this->assets_manager_ptr,
1427         this->message_hub_ptr
1428     );
1429
1430     this->has_improvement = true;
1431     this->__closeBuildMenu();
1432
1433     if (not this->resource_assessed) {
1434         this->assess();
1435     }
1436
1437     this->__sendCreditsSpentMessage(build_cost);
1438     this->__sendTileStateMessage();
1439     this->__sendGameStateRequest();
1440
1441     return;
1442 } /* __buildDieselGenerator() */
```

4.7.3.2 __buildEnergyStorage()

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

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

```
1677 {
1678     /*
1679     int build_cost = ENERGY_STORAGE_SYSTEM_BUILD_COST;
1680
1681     if (this->credits < build_cost) {
1682         std::cout << "Cannot build energy storage system: insufficient credits (need "
1683             << build_cost << " K)" << std::endl;
1684
1685         this->__sendInsufficientCreditsMessage();
1686         return;
1687     }
1688
1689     this->tile_improvement_ptr = new EnergyStorageSystem(
1690         this->position_x,
1691         this->position_y,
1692         this->event_ptr,
1693         this->render_window_ptr,
1694         this->assets_manager_ptr,
1695         this->message_hub_ptr
1696     );
1697
1698     this->has_improvement = true;
1699     this->__closeBuildMenu();
1700
1701     if (not this->resource_assessed) {
1702         this->assess();
1703     }
1704 }
```

```

1705     this->__sendCreditsSpentMessage(build_cost);
1706     this->__sendTileStateMessage();
1707     this->__sendGameStateRequest();
1708     */
1709     return;
1710 } /* __buildEnergyStorage() */

```

4.7.3.3 __buildSettlement()

```

void HexTile::__buildSettlement (
    void ) [private]

```

Helper method to build a settlement on this tile.

```

1362 {
1363     if (this->credits < BUILD_SETTLEMENT_COST) {
1364         std::cout << "Cannot build settlement: insufficient credits (need "
1365             << BUILD_SETTLEMENT_COST << " K)" << std::endl;
1366
1367         this->__sendInsufficientCreditsMessage();
1368         return;
1369     }
1370
1371     this->__clearDecoration();
1372
1373     this->tile_improvement_ptr = new Settlement(
1374         this->position_x,
1375         this->position_y,
1376         this->tile_resource,
1377         this->event_ptr,
1378         this->render_window_ptr,
1379         this->assets_manager_ptr,
1380         this->message_hub_ptr
1381     );
1382
1383     this->has_improvement = true;
1384
1385     this->assess();
1386     this->__sendAssessNeighboursMessage();
1387
1388     this->__sendUpdateGamePhaseMessage("system management");
1389     this->__sendCreditsSpentMessage(BUILD_SETTLEMENT_COST);
1390     this->__sendTileStateMessage();
1391     this->__sendGameStateRequest();
1392
1393     return;
1394 } /* __buildSettlement() */

```

4.7.3.4 __buildSolarPV()

```

void HexTile::__buildSolarPV (
    void ) [private]

```

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

```

1457 {
1458     int build_cost = SOLAR_PV_BUILD_COST;
1459
1460     if (this->tile_type == TileType::LAKE) {
1461         build_cost *= SOLAR_PV_WATER_BUILD_MULTIPPLIER;
1462     }
1463
1464     if (this->credits < build_cost) {
1465         std::cout << "Cannot build solar PV array: insufficient credits (need "
1466             << build_cost << " K)" << std::endl;
1467
1468         this->__sendInsufficientCreditsMessage();
1469         return;
1470     }
1471
1472     this->tile_improvement_ptr = new SolarPV(

```

```

1473         this->position_x,
1474         this->position_y,
1475         this->tile_resource,
1476         this->event_ptr,
1477         this->render_window_ptr,
1478         this->assets_manager_ptr,
1479         this->message_hub_ptr
1480     );
1481
1482     this->has_improvement = true;
1483     this->__closeBuildMenu();
1484
1485     if (not this->resource_assessed) {
1486         this->assess();
1487     }
1488
1489     if (this->tile_type == TileType :: LAKE) {
1490         this->decoration_cleared = true;
1491         this->assets_manager_ptr->getSound("splash")->play();
1492     }
1493
1494     this->__sendCreditsSpentMessage(build_cost);
1495     this->__sendTileStateMessage();
1496     this->__sendGameStateRequest();
1497
1498     return;
1499 } /* __buildSolarPV() */

```

4.7.3.5 __buildTidalTurbine()

```

void HexTile::__buildTidalTurbine (
    void ) [private]

```

Helper method to build a tidal turbine on this tile.

```

1577 {
1578     int build_cost = TIDAL_TURBINE_BUILD_COST;
1579
1580     if (this->credits < build_cost) {
1581         std::cout << "Cannot build tidal turbine: insufficient credits (need "
1582             << build_cost << " K)" << std::endl;
1583
1584         this->__sendInsufficientCreditsMessage();
1585         return;
1586     }
1587
1588     this->tile_improvement_ptr = new TidalTurbine(
1589         this->position_x,
1590         this->position_y,
1591         this->tile_resource,
1592         this->event_ptr,
1593         this->render_window_ptr,
1594         this->assets_manager_ptr,
1595         this->message_hub_ptr
1596     );
1597
1598     this->has_improvement = true;
1599     this->decoration_cleared = true;
1600     this->assets_manager_ptr->getSound("splash")->play();
1601     this->__closeBuildMenu();
1602
1603     if (not this->resource_assessed) {
1604         this->assess();
1605     }
1606
1607     this->__sendCreditsSpentMessage(build_cost);
1608     this->__sendTileStateMessage();
1609     this->__sendGameStateRequest();
1610
1611     return;
1612 } /* __buildTidalTurbine() */

```

4.7.3.6 __buildWaveEnergyConverter()

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

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

```
1627 {
1628     int build_cost = WAVE_ENERGY_CONVERTER_BUILD_COST;
1629
1630     if (this->credits < build_cost) {
1631         std::cout << "Cannot build wave energy converter: insufficient credits (need "
1632             << build_cost << " K)" << std::endl;
1633
1634         this->__sendInsufficientCreditsMessage();
1635         return;
1636     }
1637
1638     this->tile_improvement_ptr = new WaveEnergyConverter(
1639         this->position_x,
1640         this->position_y,
1641         this->tile_resource,
1642         this->event_ptr,
1643         this->render_window_ptr,
1644         this->assets_manager_ptr,
1645         this->message_hub_ptr
1646     );
1647
1648     this->has_improvement = true;
1649     this->decoration_cleared = true;
1650     this->assets_manager_ptr->getSound("splash")->play();
1651     this->__closeBuildMenu();
1652
1653     if (not this->resource_assessed) {
1654         this->assess();
1655     }
1656
1657     this->__sendCreditsSpentMessage(build_cost);
1658     this->__sendTileStateMessage();
1659     this->__sendGameStateRequest();
1660
1661     return;
1662 } /* __buildWaveEnergyConverter() */
```

4.7.3.7 __buildWindTurbine()

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

Helper method to build a wind turbine on this tile.

```
1514 {
1515     int build_cost = WIND_TURBINE_BUILD_COST;
1516
1517     if (
1518         (this->tile_type == TileType :: LAKE) or
1519         (this->tile_type == TileType :: OCEAN)
1520     ) {
1521         build_cost *= WIND_TURBINE_WATER_BUILD_MULTIPLIER;
1522     }
1523
1524     if (this->credits < build_cost) {
1525         std::cout << "Cannot build wind turbine: insufficient credits (need "
1526             << build_cost << " K)" << std::endl;
1527
1528         this->__sendInsufficientCreditsMessage();
1529         return;
1530     }
1531
1532     this->tile_improvement_ptr = new WindTurbine(
1533         this->position_x,
1534         this->position_y,
1535         this->tile_resource,
1536         this->event_ptr,
1537         this->render_window_ptr,
1538         this->assets_manager_ptr,
1539         this->message_hub_ptr
```

```

1540     );
1541
1542     this->has_improvement = true;
1543     this->__closeBuildMenu();
1544
1545     if (not this->resource_assessed) {
1546         this->assess();
1547     }
1548
1549     if (
1550         (this->tile_type == TileType :: LAKE) or
1551         (this->tile_type == TileType :: OCEAN)
1552     ) {
1553         this->decoration_cleared = true;
1554         this->assets_manager_ptr->getSound("splash")->play();
1555     }
1556
1557     this->__sendCreditsSpentMessage(build_cost);
1558     this->__sendTileStateMessage();
1559     this->__sendGameStateRequest();
1560
1561     return;
1562 } /* __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
799             break;
800         }
801
802
803         case (TileType :: MOUNTAINS): {
804             this->assets_manager_ptr->getSound("clear mountains tile")->play();
805
806             break;
807         }
808
809
810         case (TileType :: PLAINS): {
811             this->assets_manager_ptr->getSound("clear non-mountains tile")->play();
812
813             break;
814         }
815
816         default: {
817             // do nothing!
818
819             break;
820         }
821     }
822 }
823
824     return;
825 } /* __clearDecoration() */

```

4.7.3.9 __closeBuildMenu()

```

void HexTile::__closeBuildMenu (
    void ) [private]

```

Helper method to close the tile improvement build menu.

```

1337 {
1338     if (not this->build_menu_open) {
1339         return;
1340     }
1341
1342     this->build_menu_open = false;
1343     this->assets_manager_ptr->getSound("build menu close")->play();
1344
1345     return;
1346 } /* __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.

```

1827 {
1828     std::string coords_substring = "TILE COORDS: ";
1829     coords_substring += std::to_string(int(this->position_x - 400));
1830     coords_substring += ", ";
1831     coords_substring += std::to_string(int(this->position_y - 400));
1832     coords_substring += "\n";
1833
1834     return coords_substring;
1835 } /* __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.

```

1986 {
1987     std::string improvement_substring = "TILE IMPROVEMENT: ";
1988
1989     if (this->has_improvement) {
1990         improvement_substring += this->tile_improvement_ptr->tile_improvement_string;
1991         improvement_substring += "\n";
1992     }
1993
1994     else {
1995         improvement_substring += "NONE\n";
1996     }
1997
1998     return improvement_substring;
1999 } /* __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.

```
2016 {
2017     //          32 char x 17 line console "-----\n";
2018     std::string options_substring          = "      **** TILE OPTIONS **** \n";
2019     options_substring                     += " \n";
2020
2021     if (this->game_phase == "build settlement") {
2022         if (
2023             (this->tile_type != TileType :: OCEAN) and
2024             (this->tile_type != TileType :: LAKE)
2025         ) {
2026             options_substring += "[B]:  BUILD SETTLEMENT (";
2027             options_substring += std::to_string(BUILD_SETTLEMENT_COST);
2028             options_substring += " K)\n";
2029         }
2030     }
2031
2032
2033     else if (this->game_phase == "system management") {
2034         if (this->has_improvement) {
2035             options_substring.clear();
2036             options_substring = this->tile_improvement_ptr->getTileOptionsSubstring();
2037         }
2038
2039
2040         else if (not this->resource_assessed) {
2041             options_substring += "[A]:  ASSESS RESOURCE (";
2042             options_substring += std::to_string(RESOURCE_ASSESSMENT_COST);
2043             options_substring += " K)\n";
2044         }
2045
2046
2047         else if (
2048             (not this->decoration_cleared) and
2049             (this->tile_type != TileType :: OCEAN) and
2050             (this->tile_type != TileType :: LAKE)
2051         ) {
2052             options_substring += "[C]:  CLEAR TILE (";
2053
2054             switch (this->tile_type) {
2055                 case (TileType :: FOREST): {
2056                     options_substring += std::to_string(CLEAR_FOREST_COST);
2057
2058                     break;
2059                 }
2060
2061
2062                 case (TileType :: MOUNTAINS): {
2063                     options_substring += std::to_string(CLEAR_MOUNTAINS_COST);
2064
2065                     break;
2066                 }
2067
2068                 case (TileType :: PLAINS): {
2069                     options_substring += std::to_string(CLEAR_PLAINS_COST);
2070
2071                     break;
2072                 }
2073             }
2074
2075             default: {
2076                 //do nothing!
2077
2078                 break;
2079             }
2080         }
2081
2082         options_substring += " K)\n";
2083     }
2084 }
2085
2086
```

```

2087         else if (
2088             (this->decoration_cleared) or
2089             (this->tile_type == TileType :: OCEAN) or
2090             (this->tile_type == TileType :: LAKE)
2091         ) {
2092             options_substring += "[B]: OPEN BUILD MENU\n";
2093         }
2094     }
2095
2096
2097     else if (this->game_phase == "victory") {
2098         options_substring += "          **** VICTORY ****          \n";
2099     }
2100
2101
2102     else {
2103         options_substring += "          **** LOSS ****          \n";
2104     }
2105
2106     return options_substring;
2107 } /* __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.

```

1916 {
1917     std::string resource_substring = "TILE RESOURCE:      ";
1918
1919     if (this->resource_assessed) {
1920         switch (this->tile_resource) {
1921             case (TileResource :: POOR): {
1922                 resource_substring += "POOR\n";
1923
1924                 break;
1925             }
1926
1927             case (TileResource :: BELOW_AVERAGE): {
1928                 resource_substring += "BELOW AVERAGE\n";
1929
1930                 break;
1931             }
1932
1933             case (TileResource :: AVERAGE): {
1934                 resource_substring += "AVERAGE\n";
1935
1936                 break;
1937             }
1938
1939             case (TileResource :: ABOVE_AVERAGE): {
1940                 resource_substring += "ABOVE AVERAGE\n";
1941
1942                 break;
1943             }
1944
1945             case (TileResource :: GOOD): {
1946                 resource_substring += "GOOD\n";
1947
1948                 break;
1949             }
1950
1951             default: {
1952                 resource_substring += "???\n";
1953             }
1954         }
1955     }
1956 }

```

```

1959             break;
1960         }
1961     }
1962 }
1963
1964 else {
1965     resource_substring += "???\n";
1966 }
1967
1968 return resource_substring;
1969 } /* __getTileResourceSubstring() */

```

4.7.3.14 __getTileTypeSubstring()

```

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

```

Helper method to assemble and return tile type substring.

Returns

Tile type substring.

```

1852 {
1853     std::string type_substring = "TILE TYPE: ";
1854
1855     switch (this->tile_type) {
1856     case (TileType :: FOREST): {
1857         type_substring += "FOREST\n";
1858
1859         break;
1860     }
1861
1862     case (TileType :: LAKE): {
1863         type_substring += "LAKE\n";
1864
1865         break;
1866     }
1867
1868     case (TileType :: MOUNTAINS): {
1869         type_substring += "MOUNTAINS\n";
1870
1871         break;
1872     }
1873
1874     case (TileType :: OCEAN): {
1875         type_substring += "OCEAN\n";
1876
1877         break;
1878     }
1879
1880     case (TileType :: PLAINS): {
1881         type_substring += "PLAINS\n";
1882
1883         break;
1884     }
1885
1886     default: {
1887         type_substring += "???\n";
1888
1889         break;
1890     }
1891
1892     }
1893
1894 return type_substring;
1895 } /* __getTileTypeSubstring() */

```

4.7.3.15 __handleKeyPressEvents()

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

Helper method to handle key press events.

```
874 {
875     if (not this->is_selected) {
876         return;
877     }
878
879
880     if (this->event_ptr->key.code == sf::Keyboard::Escape) {
881         this->__setIsSelected(false);
882     }
883
884
885     if (this->build_menu_open) {
886         switch (this->tile_type) {
887             case (TileType :: FOREST): {
888                 switch (this->event_ptr->key.code) {
889                     case (sf::Keyboard::D): {
890                         this->__buildDieselGenerator();
891
892                         break;
893                     }
894
895
896                     case (sf::Keyboard::S): {
897                         this->__buildSolarPV();
898
899                         break;
900                     }
901
902
903                     case (sf::Keyboard::W): {
904                         this->__buildWindTurbine();
905
906                         break;
907                     }
908
909
910                     case (sf::Keyboard::E): {
911                         this->__buildEnergyStorage();
912
913                         break;
914                     }
915
916
917                     default: {
918                         // do nothing!
919
920                         break;
921                     }
922                 }
923
924                 break;
925             }
926
927
928             case (TileType :: LAKE): {
929                 switch (this->event_ptr->key.code) {
930                     case (sf::Keyboard::S): {
931                         this->__buildSolarPV();
932
933                         break;
934                     }
935
936
937                     case (sf::Keyboard::W): {
938                         this->__buildWindTurbine();
939
940                         break;
941                     }
942
943
944                     default: {
945                         // do nothing!
946
947                         break;
948                     }
949                 }
950
951                 break;
```

```

952     }
953
954
955     case (TileType :: MOUNTAINS): {
956         switch (this->event_ptr->key.code) {
957             case (sf::Keyboard::D): {
958                 this->__buildDieselGenerator();
959
960                 break;
961             }
962
963
964             case (sf::Keyboard::S): {
965                 this->__buildSolarPV();
966
967                 break;
968             }
969
970
971             case (sf::Keyboard::W): {
972                 this->__buildWindTurbine();
973
974                 break;
975             }
976
977
978             case (sf::Keyboard::E): {
979                 this->__buildEnergyStorage();
980
981                 break;
982             }
983
984
985             default: {
986                 // do nothing!
987
988                 break;
989             }
990         }
991
992         break;
993     }
994
995
996     case (TileType :: OCEAN): {
997         switch (this->event_ptr->key.code) {
998             case (sf::Keyboard::W): {
999                 this->__buildWindTurbine();
1000
1001                 break;
1002             }
1003
1004
1005             case (sf::Keyboard::T): {
1006                 this->__buildTidalTurbine();
1007
1008                 break;
1009             }
1010
1011
1012             case (sf::Keyboard::A): {
1013                 this->__buildWaveEnergyConverter();
1014
1015                 break;
1016             }
1017
1018
1019             default: {
1020                 // do nothing!
1021
1022                 break;
1023             }
1024         }
1025
1026         break;
1027     }
1028
1029
1030     case (TileType :: PLAINS): {
1031         switch (this->event_ptr->key.code) {
1032             case (sf::Keyboard::D): {
1033                 this->__buildDieselGenerator();
1034
1035                 break;
1036             }
1037
1038

```

```

1039         case (sf::Keyboard::S): {
1040             this->__buildSolarPV();
1041
1042             break;
1043         }
1044
1045
1046         case (sf::Keyboard::W): {
1047             this->__buildWindTurbine();
1048
1049             break;
1050         }
1051
1052
1053         case (sf::Keyboard::E): {
1054             this->__buildEnergyStorage();
1055
1056             break;
1057         }
1058
1059
1060         default: {
1061             // do nothing!
1062
1063             break;
1064         }
1065     }
1066     break;
1067 }
1068
1069
1070
1071     default: {
1072         //do nothing!
1073
1074         break;
1075     }
1076 }
1077 }
1078
1079
1080 if (this->game_phase == "build settlement") {
1081     if (
1082         (this->tile_type != TileType :: OCEAN) and
1083         (this->tile_type != TileType :: LAKE)
1084     ) {
1085         if (this->event_ptr->key.code == sf::Keyboard::B) {
1086             this->__buildSettlement();
1087         }
1088     }
1089 }
1090
1091
1092 else if (this->game_phase == "system management") {
1093     if (this->has_improvement) {
1094         if (this->tile_improvement_ptr->tile_improvement_type != TileImprovementType :: SETTLEMENT)
1095         {
1096             if (this->event_ptr->key.code == sf::Keyboard::P) {
1097                 this->__scrapImprovement();
1098             }
1099
1100             /*
1101             * All other inputs will be caught and handled by
1102             * this->tile_improvement_ptr->processEvent()
1103             */
1104         }
1105
1106         else if (not this->resource_assessed) {
1107             if (this->event_ptr->key.code == sf::Keyboard::A) {
1108                 if (this->credits < RESOURCE_ASSESSMENT_COST) {
1109                     std::cout << "Cannot assess resource: insufficient credits (need "
1110                         << RESOURCE_ASSESSMENT_COST << " K)" << std::endl;
1111
1112                     this->__sendInsufficientCreditsMessage();
1113                 }
1114
1115                 else {
1116                     this->assess();
1117                     this->__sendCreditsSpentMessage(RESOURCE_ASSESSMENT_COST);
1118                     this->__sendTileStateMessage();
1119                     this->__sendGameStateRequest();
1120                 }
1121             }
1122         }
1123     }
1124 }

```

```

1125
1126     else if (
1127         (not this->decoration_cleared) and
1128         (this->tile_type != TileType :: OCEAN) and
1129         (this->tile_type != TileType :: LAKE)
1130     ) {
1131         if (this->event_ptr->key.code == sf::Keyboard::C) {
1132             int clear_cost = 0;
1133
1134             switch (this->tile_type) {
1135                 case (TileType :: FOREST): {
1136                     clear_cost = CLEAR_FOREST_COST;
1137
1138                     break;
1139                 }
1140
1141
1142                 case (TileType :: MOUNTAINS): {
1143                     clear_cost = CLEAR_MOUNTAINS_COST;
1144
1145                     break;
1146                 }
1147
1148
1149                 case (TileType :: PLAINS): {
1150                     clear_cost = CLEAR_PLAINS_COST;
1151
1152                     break;
1153                 }
1154
1155
1156                 default: {
1157                     // do nothing!
1158
1159                     break;
1160                 }
1161             }
1162
1163             if (this->credits < clear_cost) {
1164                 std::cout << "Cannot clear tile: insufficient credits (need "
1165                     << clear_cost << " K)" << std::endl;
1166
1167                 this->__sendInsufficientCreditsMessage();
1168             }
1169
1170             else {
1171                 this->__clearDecoration();
1172                 this->__sendCreditsSpentMessage(clear_cost);
1173                 this->__sendTileStateMessage();
1174                 this->__sendGameStateRequest();
1175             }
1176         }
1177     }
1178
1179     else if (
1180         (this->decoration_cleared) or
1181         (this->tile_type == TileType :: OCEAN) or
1182         (this->tile_type == TileType :: LAKE)
1183     ) {
1184         if (this->event_ptr->key.code == sf::Keyboard::B) {
1185             this->__openBuildMenu();
1186         }
1187     }
1188 }
1189
1190 return;
1191 }
1192 } /* __handleKeyPressEvents() */

```

4.7.3.16 __handleKeyReleaseEvents()

```

void HexTile::__handleKeyReleaseEvents (
    void ) [private]
{
1198 {
1199     if (not this->is_selected) {
1200         return;
1201     }
1202 }
1203

```

```

1204     switch (this->event_ptr->key.code) {
1205         case (sf::Keyboard::P): {
1206             if (this->has_improvement) {
1207                 this->scrap_improvement_frame = 0;
1208
1209                 if (
1210                     this->tile_improvement_ptr->tile_improvement_sprite_static.getTexture() != NULL
1211                 ) {
1212                     this->tile_improvement_ptr->tile_improvement_sprite_static.setColor(
1213                         sf::Color(255, 255, 255, 255)
1214                     );
1215                 }
1216
1217                 else {
1218                     for (
1219                         size_t i = 0;
1220                         i < this->tile_improvement_ptr->tile_improvement_sprite_animated.size();
1221                         i++
1222                     ) {
1223                         this->tile_improvement_ptr->tile_improvement_sprite_animated[i].setColor(
1224                             sf::Color(255, 255, 255, 255)
1225                         );
1226                     }
1227                 }
1228             }
1229
1230             break;
1231         }
1232
1233         default: {
1234             // do nothing!
1235
1236             break;
1237         }
1238     }
1239
1240 }
1241
1242 /*
1243 if (this->event_ptr->key.code == sf::Keyboard::P) {
1244 }
1245 */
1246
1247 return;
1248 } /* __handleKeyReleaseEvents() */
1249

```

4.7.3.17 __handleMouseButtonEvents()

```

void HexTile::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

1262 {
1263     switch (this->event_ptr->mouseButton.button) {
1264         case (sf::Mouse::Left): {
1265             if (this->__isClicked()) {
1266                 std::cout << "Tile (" << this->position_x << ", " <<
1267                     this->position_y << ") was selected" << std::endl;
1268
1269                 this->__setIsSelected(true);
1270
1271                 this->__sendTileSelectedMessage();
1272                 this->__sendTileStateMessage();
1273             }
1274
1275             else {
1276                 this->__setIsSelected(false);
1277             }
1278
1279             break;
1280         }
1281
1282         case (sf::Mouse::Right): {
1283             this->__setIsSelected(false);
1284
1285             break;
1286         }
1287     }
1288 }

```



```

1287     }
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::Vector2i mouse_position = sf::Mouse::getPosition(*render_window_ptr);
844
845     double mouse_x = mouse_position.x;
846     double mouse_y = mouse_position.y;
847
848     double distance = sqrt(
849         pow(this->position_x - mouse_x, 2) +
850         pow(this->position_y - mouse_y, 2)
851     );
852
853     if (distance < this->minor_radius) {
854         return true;
855     }
856     else {
857         return false;
858     }
859 } /* __isClicked() */

```

4.7.3.19 __openBuildMenu()

```

void HexTile::__openBuildMenu (
    void ) [private]

```

Helper method to open the tile improvement build menu.

```

1313 {
1314     if (this->build_menu_open) {
1315         return;
1316     }
1317
1318     this->build_menu_open = true;
1319     this->assets_manager_ptr->getSound("build menu open")->play();
1320
1321     return;
1322 } /* __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.

```
1726 {
1727     // 1. implement key hold confirmation
1728     if (this->scrap_improvement_frame <= FRAMES_PER_SECOND) {
1729         double colour_scalar =
1730             1 - ((double)(this->scrap_improvement_frame) / (FRAMES_PER_SECOND));
1731
1732         if (
1733             this->tile_improvement_ptr->tile_improvement_sprite_static.getTexture() != NULL
1734         ) {
1735             this->tile_improvement_ptr->tile_improvement_sprite_static.setColor(
1736                 sf::Color(255, 255 * colour_scalar, 255 * colour_scalar, 255)
1737             );
1738         }
1739
1740         else {
1741             for (
1742                 size_t i = 0;
1743                 i < this->tile_improvement_ptr->tile_improvement_sprite_animated.size();
1744                 i++
1745             ) {
1746                 this->tile_improvement_ptr->tile_improvement_sprite_animated[i].setColor(
1747                     sf::Color(255, 255 * colour_scalar, 255 * colour_scalar, 255)
1748                 );
1749             }
1750         }
1751
1752         this->scrap_improvement_frame += 4;
1753     }
1754
1755     // 2. carry out scrapping
1756     else {
1757         this->draw_explosion = true;
1758         this->assets_manager_ptr->getSound("clear non-mountains tile")->play();
1759
1760         if (this->tile_improvement_ptr->production_menu_open) {
1761             this->tile_improvement_ptr->production_menu_open = false;
1762             this->assets_manager_ptr->getSound("build menu close")->play();
1763         }
1764
1765         delete this->tile_improvement_ptr;
1766         this->tile_improvement_ptr = NULL;
1767
1768         this->has_improvement = false;
1769
1770         this->scrap_improvement_frame = 0;
1771
1772         if (
1773             (this->tile_type == TileType :: LAKE) or
1774             (this->tile_type == TileType :: OCEAN)
1775         ) {
1776             this->decoration_cleared = false;
1777         }
1778
1779         this->__sendCreditsSpentMessage(SCRAP_COST);
1780         this->__sendTileStateMessage();
1781         this->__sendGameStateRequest();
1782     }
1783 }
1784
1785 return;
1786 } /* __scrapImprovement() */
```

4.7.3.21 __sendAssessNeighboursMessage()

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

Helper method to format and send assess neighbours message.

```

2163 {
2164     Message assess_neighbours_message;
2165
2166     assess_neighbours_message.channel = HEX_MAP_CHANNEL;
2167     assess_neighbours_message.subject = "assess neighbours";
2168
2169     this->message_hub_ptr->sendMessage(assess_neighbours_message);
2170
2171     std::cout << "Assess neighbours message sent by " << this << std::endl;
2172
2173     return;
2174 } /* __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.
----------------------	--

```

2246 {
2247     Message credits_spent_message;
2248
2249     credits_spent_message.channel = GAME_CHANNEL;
2250     credits_spent_message.subject = "credits spent";
2251
2252     credits_spent_message.int_payload["credits spent"] = credits_spent;
2253
2254     this->message_hub_ptr->sendMessage(credits_spent_message);
2255
2256     std::cout << "Credits spent (" << credits_spent << ") message sent by " << this
2257         << std::endl;
2258     return;
2259 } /* __sendCreditsSpentMessage() */

```

4.7.3.23 __sendGameStateRequest()

```

void HexTile::__sendGameStateRequest (
    void ) [private]

```

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

```

2189 {
2190     Message game_state_request;
2191
2192     game_state_request.channel = GAME_CHANNEL;
2193     game_state_request.subject = "state request";
2194
2195     this->message_hub_ptr->sendMessage(game_state_request);
2196
2197     std::cout << "Game state request message sent by " << this << std::endl;
2198     return;
2199 } /* __sendGameStateRequest() */

```

4.7.3.24 __sendInsufficientCreditsMessage()

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

Helper method to format and send an insufficient credits message.

```
2274 {
2275     Message insufficient_credits_message;
2276
2277     insufficient_credits_message.channel = GAME_CHANNEL;
2278     insufficient_credits_message.subject = "insufficient credits";
2279
2280     this->message_hub_ptr->sendMessage(insufficient_credits_message);
2281
2282     std::cout << "Insufficient credits message sent by " << this << std::endl;
2283
2284     return;
2285 } /* __sendInsufficientCreditsMessage() */
```

4.7.3.25 __sendTileSelectedMessage()

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

Helper method to format and send message on tile selection.

```
1801 {
1802     Message tile_selected_message;
1803
1804     tile_selected_message.channel = TILE_SELECTED_CHANNEL;
1805     tile_selected_message.subject = "tile selected";
1806
1807     this->message_hub_ptr->sendMessage(tile_selected_message);
1808
1809     return;
1810 } /* __sendTileSelectedMessage() */
```

4.7.3.26 __sendTileStateMessage()

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

Helper method to format and send tile state message.

```
2122 {
2123     Message tile_state_message;
2124
2125     tile_state_message.channel = TILE_STATE_CHANNEL;
2126     tile_state_message.subject = "tile state";
2127
2128     //          32 char x 17 line console "-----\n";
2129     std::string console_string = "      **** TILE INFO **** \n";
2130
2131     console_string
2132         += this->__getTileCoordsSubstring();
2133     console_string
2134         += " \n";
2135
2136     console_string
2137         += this->__getTileTypeSubstring();
2138     console_string
2139         += this->__getTileResourceSubstring();
2140     console_string
2141         += this->__getTileImprovementSubstring();
2142     console_string
2143         += " \n";
2144
2145     console_string
2146         += this->__getTileOptionsSubstring();
2147
2148     tile_state_message.string_payload["console string"] = console_string;
2149
2150     this->message_hub_ptr->sendMessage(tile_state_message);
2151
2152     std::cout << "Tile state message sent by " << this << std::endl;
2153     return;
2154 } /* __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.
-------------------	-------------------------

```
2216 {
2217     Message update_game_phase_message;
2218
2219     update_game_phase_message.channel = GAME_CHANNEL;
2220     update_game_phase_message.subject = "update game phase";
2221
2222     update_game_phase_message.string_payload["game phase"] = game_phase;
2223
2224     this->message_hub_ptr->sendMessage(update_game_phase_message);
2225
2226     std::cout << "Update game phase message sent by " << this << std::endl;
2227
2228     return;
2229 } /* __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(MONOCROME_TEXT_RED);
203
204                 break;
205             }
206
207             case (TileResource :: BELOW_AVERAGE): {
208                 this->resource_text.setString("-1");
209                 this->resource_text.setFillColor(MONOCROME_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     case (TileType :: LAKE): {
702         this->__setUpSolarPVBuildOption(true);
703         this->__setUpWindTurbineBuildOption(true);
704
705         break;
706     }
707
708     case (TileType :: MOUNTAINS): {
709         this->__setUpDieselGeneratorBuildOption();
710         this->__setUpSolarPVBuildOption();
711         this->__setUpWindTurbineBuildOption();
712         //this->__setUpEnergyStorageSystemBuildOption();
713
714         break;
715     }
716
717     case (TileType :: OCEAN): {
718         this->__setUpWindTurbineBuildOption(false, true);
719         this->__setUpTidalTurbineBuildOption();
720         this->__setUpWaveEnergyConverterBuildOption();
721
722         break;
723     }
724
725     case (TileType :: PLAINS): {
726         this->__setUpDieselGeneratorBuildOption();
727         this->__setUpSolarPVBuildOption();
728         this->__setUpWindTurbineBuildOption();
729         //this->__setUpEnergyStorageSystemBuildOption();
730
731         break;
732     }
733
734     default: {
735         // do nothing!
736
737         break;
738     }
739 }
740
741 return;
742 }
743
744 /* __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(MONOCROME_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     // -----
439     std::string diesel_generator_string = "DIESEL GENERATOR\n";
440     diesel_generator_string += " \n";
441     diesel_generator_string += "CAPACITY: 100 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 = " ENERGY STORAGE \n";
641     energy_storage_system_string += " \n";
642     energy_storage_system_string += "CAPCTY: 1 MWh\n";
643     energy_storage_system_string += "COST: ";
644     energy_storage_system_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
645     energy_storage_system_string += " K\n\n";
646     energy_storage_system_string += "BUILD: [E] \n";
647
648     // 3. call general method
649     this->__setUpBuildOption(texture_key, energy_storage_system_string);
650     */
651     return;
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(MONOCROME_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\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
318             this->explosion_sprite_reel.back().setOrigin(
319                 this->explosion_sprite_reel.back().getLocalBounds().width / 2,
320                 this->explosion_sprite_reel.back().getLocalBounds().height / 2
321             );
322
323             this->explosion_sprite_reel.back().setPosition(
324                 this->position_x,
325                 this->position_y
326             );
327         }
328     }
329
330     return;
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
99     this->tile_sprite.setPointCount(n_points);
100
101     for (int i = 0; i < n_points; i++) {
102         this->tile_sprite.setPoint(
103             i,
104             sf::Vector2f(
105                 this->position_x + this->major_radius * cos((30 + 60 * i) * (M_PI / 180)),
106                 this->position_y + this->major_radius * sin((30 + 60 * i) * (M_PI / 180))
107             )
108         );
109     }
110
111     this->tile_sprite.setOutlineThickness(1);
112     this->tile_sprite.setOutlineColor(sf::Color(175, 175, 175, 255));
113
114     return;
115 } /* __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.

```
2708 {
2709     this->resource_assessed = true;
2710     this->resource_assessment = true;
2711
2712     this->assets_manager_ptr->getSound("resource assessment")->play();
2713
2714     this->__setResourceText();
2715     this->__sendTileStateMessage();
2716
2717     return;
2718 } /* assess() */
```

4.7.3.45 decorateTile()

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

Method to decorate tile.

```
2586 {
2587     switch (this->tile_type) {
2588         case (TileType :: FOREST): {
2589             this->tile_decoration_sprite.setTexture(
2590                 *(this->assets_manager_ptr->getTexture("pine_tree_64x64_1"))
2591             );
2592
2593             break;
2594         }
2595
2596         case (TileType :: LAKE): {
2597             this->tile_decoration_sprite.setTexture(
2598                 *(this->assets_manager_ptr->getTexture("water_shimmer_64x64_1"))
2599             );
2600
2601             break;
2602         }
2603
2604         case (TileType :: MOUNTAINS): {
2605             this->tile_decoration_sprite.setTexture(
2606                 *(this->assets_manager_ptr->getTexture("mountain_64x64_1"))
2607             );
2608
2609             break;
2610         }
2611
2612         case (TileType :: OCEAN): {
2613             this->tile_decoration_sprite.setTexture(
2614                 *(this->assets_manager_ptr->getTexture("water_waves_64x64_1"))
2615             );
2616
2617             break;
2618         }
2619
2620         case (TileType :: PLAINS): {
2621             this->tile_decoration_sprite.setTexture(
2622                 *(this->assets_manager_ptr->getTexture("wheat_64x64_1"))
2623             );
2624
2625             break;
2626         }
2627
2628         default: {
2629             // do nothing!
2630
2631             break;
2632         }
2633     }
2634
2635     if (this->tile_type == TileType :: OCEAN or this->tile_type == TileType :: LAKE) {
```

```

2637         this->tile_decoration_sprite.setOrigin(
2638             this->tile_decoration_sprite.getLocalBounds().width / 2,
2639             this->tile_decoration_sprite.getLocalBounds().height / 2
2640         );
2641
2642         this->tile_decoration_sprite.setPosition(
2643             this->position_x,
2644             this->position_y
2645         );
2646
2647         if ((double)rand() / RAND_MAX > 0.5) {
2648             this->tile_decoration_sprite.setScale(sf::Vector2f(-1, 1));
2649         }
2650     }
2651
2652     else {
2653         this->tile_decoration_sprite.setOrigin(
2654             this->tile_decoration_sprite.getLocalBounds().width / 2,
2655             this->tile_decoration_sprite.getLocalBounds().height
2656         );
2657
2658         this->tile_decoration_sprite.setPosition(
2659             this->position_x,
2660             this->position_y + 12
2661         );
2662
2663         if ((double)rand() / RAND_MAX > 0.5) {
2664             this->tile_decoration_sprite.setScale(sf::Vector2f(-1, 1));
2665         }
2666     }
2667
2668     return;
2669 } /* 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.

```

2849 {
2850     // 1. draw hex
2851     this->render_window_ptr->draw(this->tile_sprite);
2852
2853     // 2. draw node
2854     if (this->show_node) {
2855         this->render_window_ptr->draw(this->node_sprite);
2856     }
2857
2858     // 3. draw tile decoration
2859     if (not this->decoration_cleared) {
2860         this->render_window_ptr->draw(this->tile_decoration_sprite);
2861     }
2862
2863     // 4. draw selection outline
2864     if (this->is_selected) {
2865         sf::Color outline_colour = this->select_outline_sprite.getOutlineColor();
2866
2867         outline_colour.a =
2868             255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2);
2869
2870         this->select_outline_sprite.setOutlineColor(outline_colour);
2871
2872         this->render_window_ptr->draw(this->select_outline_sprite);
2873     }
2874
2875     // 5. draw tile improvement
2876     if (this->has_improvement) {
2877         if (not this->tile_improvement_ptr->just_built) {
2878             this->tile_improvement_ptr->draw();
2879         }
2880     }
2881
2882     // 6. draw resource
2883     if (this->show_resource) {
2884         this->render_window_ptr->draw(this->resource_chip_sprite);
2885         this->render_window_ptr->draw(this->resource_text);
2886     }

```

```

2887
2888 // 7. draw resource assessment notification
2889 if (this->resource_assessment) {
2890     int alpha = this->magnifying_glass_sprite.getColor().a;
2891
2892     alpha -= 0.05 * FRAMES_PER_SECOND;
2893     if (alpha < 0) {
2894         alpha = 0;
2895         this->resource_assessment = false;
2896     }
2897
2898     this->magnifying_glass_sprite.setColor(
2899         sf::Color(255, 255, 255, alpha)
2900     );
2901
2902     this->render_window_ptr->draw(this->magnifying_glass_sprite);
2903 }
2904
2905 // 8. draw explosion, then settlement placement
2906 if (this->draw_explosion) {
2907     this->render_window_ptr->draw(this->explosion_sprite_reel[this->explosion_frame]);
2908
2909     if (this->frame % (FRAMES_PER_SECOND / 20) == 0) {
2910         this->explosion_frame++;
2911     }
2912
2913     if (this->explosion_frame >= this->explosion_sprite_reel.size()) {
2914         this->draw_explosion = false;
2915         this->explosion_frame = 0;
2916     }
2917 }
2918
2919 else if (this->has_improvement) {
2920     if (this->tile_improvement_ptr->just_built) {
2921         this->tile_improvement_ptr->draw();
2922     }
2923 }
2924
2925 // 9. build menu
2926 if (this->build_menu_open) {
2927     this->render_window_ptr->draw(this->build_menu_backing);
2928     this->render_window_ptr->draw(this->build_menu_backing_text);
2929
2930     for (size_t i = 0; i < this->build_menu_options_vec.size(); i++) {
2931         for (size_t j = 0; j < this->build_menu_options_vec[i].size(); j++) {
2932             this->render_window_ptr->draw(this->build_menu_options_vec[i][j]);
2933         }
2934         this->render_window_ptr->draw(this->build_menu_options_text_vec[i]);
2935     }
2936 }
2937
2938 this->frame++;
2939 return;
2940 } /* draw() */

```

4.7.3.47 processEvent()

```

void HexTile::processEvent (
    void )

```

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

```

2733 {
2734     // 1. process TileImprovement events
2735     if (
2736         this->is_selected and
2737         this->tile_improvement_ptr != NULL
2738     ) {
2739         this->tile_improvement_ptr->processEvent();
2740     }
2741
2742     // 2. process HexTile events
2743     if (this->event_ptr->type == sf::Event::KeyPressed) {
2744         this->__handleKeyPressEvents();
2745     }
2746
2747     if (this->event_ptr->type == sf::Event::KeyReleased) {
2748         this->__handleKeyReleaseEvents();
2749     }

```



```

2750
2751     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
2752         this->__handleMouseButtonEvents();
2753     }
2754
2755     return;
2756 } /* processEvent() */

```

4.7.3.48 processMessage()

```

void HexTile::processMessage (
    void )

```

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

```

2771 {
2772     // 1. process TileImprovement messages
2773     if (this->tile_improvement_ptr != NULL) {
2774         this->tile_improvement_ptr->processMessage();
2775     }
2776
2777     // 2. process HexTile messages
2778     if (this->is_selected) {
2779         if (not this->message_hub_ptr->isEmpty(TILE_STATE_CHANNEL)) {
2780             Message tile_state_message = this->message_hub_ptr->receiveMessage(
2781                 TILE_STATE_CHANNEL
2782             );
2783
2784             if (tile_state_message.subject == "state request") {
2785                 this->__sendTileStateMessage();
2786
2787                 std::cout << "Tile state request received by " << this << std::endl;
2788                 this->message_hub_ptr->popMessage(TILE_STATE_CHANNEL);
2789             }
2790         }
2791
2792         std::cout << "Current credits (HexTile): " << this->credits << " K" <<
2793             std::endl;
2794     }
2795
2796     if (not this->message_hub_ptr->isEmpty(GAME_STATE_CHANNEL)) {
2797         Message game_state_message = this->message_hub_ptr->receiveMessage(
2798             GAME_STATE_CHANNEL
2799         );
2800
2801         if (game_state_message.subject == "game state") {
2802             this->credits = game_state_message.int_payload["credits"];
2803             this->game_phase = game_state_message.string_payload["game phase"];
2804
2805             if (this->tile_improvement_ptr != NULL) {
2806                 this->tile_improvement_ptr->credits = this->credits;
2807                 this->tile_improvement_ptr->game_phase = this->game_phase;
2808
2809                 this->tile_improvement_ptr->month =
2810                     game_state_message.int_payload["month"];
2811
2812                 this->tile_improvement_ptr->demand_MWh =
2813                     game_state_message.int_payload["demand_MWh"];
2814
2815                 this->tile_improvement_ptr->demand_vec_MWh =
2816                     game_state_message.vector_payload["demand_vec_MWh"];
2817
2818                 this->tile_improvement_ptr->update();
2819             }
2820
2821             this->message_hub_ptr->incrementMessageRead(GAME_STATE_CHANNEL);
2822
2823             std::cout << "Game state message read and passed by " << this <<
2824                 " (credits: " << this->credits << " K)" << std::endl;
2825
2826             if (this->is_selected) {
2827                 this->__sendTileStateMessage();
2828             }
2829         }
2830     }
2831
2832     return;
2833 } /* 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].
--------------------	--

```
2535 {
2536     // 1. check input
2537     if (input_value < 0 or input_value > 1) {
2538         std::string error_str = "ERROR HexTile::setTitleResource() given input value is ";
2539         error_str += "not in the closed interval [0, 1]";
2540
2541         #ifdef _WIN32
2542             std::cout << error_str << std::endl;
2543         #endif /* _WIN32 */
2544
2545         throw std::runtime_error(error_str);
2546     }
2547
2548     // 2. convert input value to tile resource
2549     TileResource tile_resource;
2550
2551     if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[0]) {
2552         tile_resource = TileResource :: POOR;
2553     }
2554     else if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[1]) {
2555         tile_resource = TileResource :: BELOW_AVERAGE;
2556     }
2557     else if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[2]) {
2558         tile_resource = TileResource :: AVERAGE;
2559     }
2560     else if (input_value <= TILE_RESOURCE_CUMULATIVE_PROBABILITIES[3]) {
2561         tile_resource = TileResource :: ABOVE_AVERAGE;
2562     }
2563     else {
2564         tile_resource = TileResource :: GOOD;
2565     }
2566
2567     // 3. call alternate method
2568     this->setTitleResource(tile_resource);
2569
2570     return;
2571 } /* 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.
----------------------	---

```
2513 {
2514     this->tile_resource = tile_resource;
2515     this->__setResourceText();
2516
2517     return;
2518 } /* 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].
--------------------	--

```
2463 {
2464     // 1. check input
2465     if (input_value < 0 or input_value > 1) {
2466         std::string error_str = "ERROR HexTile::setTileType() given input value is ";
2467         error_str += "not in the closed interval [0, 1]";
2468
2469         #ifdef _WIN32
2470             std::cout << error_str << std::endl;
2471         #endif /* _WIN32 */
2472
2473         throw std::runtime_error(error_str);
2474     }
2475
2476     // 2. convert input value to tile type
2477     TileType tile_type;
2478
2479     if (input_value <= TILE_TYPE_CUMULATIVE_PROBABILITIES[0]) {
2480         tile_type = TileType :: LAKE;
2481     }
2482     else if (input_value <= TILE_TYPE_CUMULATIVE_PROBABILITIES[1]) {
2483         tile_type = TileType :: PLAINS;
2484     }
2485     else if (input_value <= TILE_TYPE_CUMULATIVE_PROBABILITIES[2]) {
2486         tile_type = TileType :: FOREST;
2487     }
2488     else {
2489         tile_type = TileType :: MOUNTAINS;
2490     }
2491
2492     // 3. call alternate method
2493     this->setTileType(tile_type);
2494
2495     return;
2496 } /* 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.
------------------	---

```
2402 {
2403     this->tile_type = tile_type;
2404
2405     switch (this->tile_type) {
2406         case (TileType :: FOREST): {
2407             this->tile_sprite.setFillColor(FOREST_GREEN);
2408
2409             break;
2410         }
2411
2412         case (TileType :: LAKE): {
```

```

2413         this->tile_sprite.setFillColor(LAKE_BLUE);
2414
2415         break;
2416     }
2417
2418     case (TileType :: MOUNTAINS): {
2419         this->tile_sprite.setFillColor(MOUNTAINS_GREY);
2420
2421         break;
2422     }
2423
2424     case (TileType :: OCEAN): {
2425         this->tile_sprite.setFillColor(OCEAN_BLUE);
2426
2427         break;
2428     }
2429
2430     case (TileType :: PLAINS): {
2431         this->tile_sprite.setFillColor(PLAINS_YELLOW);
2432
2433         break;
2434     }
2435
2436     default: {
2437         // do nothing!
2438
2439         break;
2440     }
2441 }
2442
2443 this->__setUpBuildMenu();
2444
2445 return;
2446 } /* setTileType(TileType) */

```

4.7.3.53 toggleResourceOverlay()

```

void HexTile::toggleResourceOverlay (
    void )

```

Method to toggle the tile resource overlay.

```

2684 {
2685     if (this->show_resource) {
2686         this->show_resource = false;
2687     }
2688     else {
2689         this->show_resource = true;
2690     }
2691
2692     return;
2693 } /* 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:

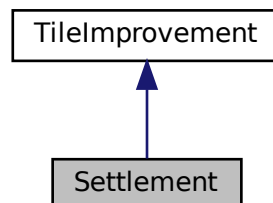
- header/ESC_core/[MessageHub.h](#)
- source/ESC_core/[MessageHub.cpp](#)

4.10 Settlement Class Reference

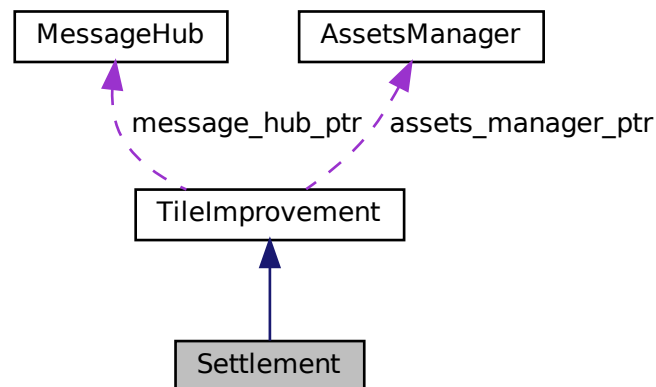
A settlement class (child class of [TileImprovement](#)).

```
#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:

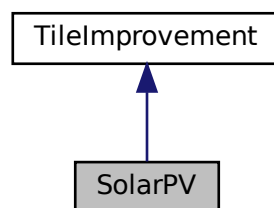
- header/[Settlement.h](#)
- source/[Settlement.cpp](#)

4.11 SolarPV Class Reference

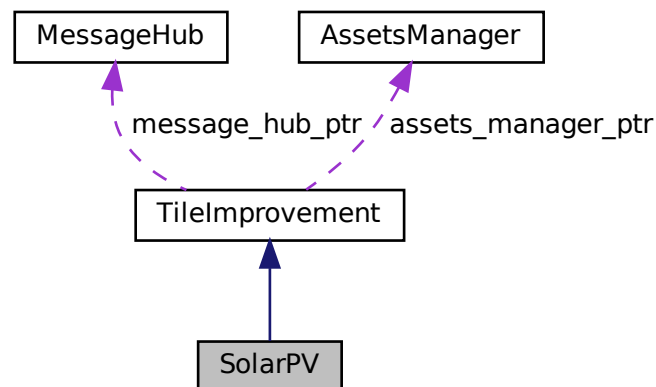
A settlement class (child class of [TileImprovement](#)).

```
#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.

```
745 :
746 TileImprovement (
747     position_x,
748     position_y,
749     tile_resource,
750     event_ptr,
751     render_window_ptr,
752     assets_manager_ptr,
753     message_hub_ptr
754 )
755 {
756     // 1. set attributes
757
758     // 1.1. private
759     //...
760
761     // 1.2. public
762     this->tile_improvement_type = TileImprovementType :: SOLAR_PV;
763
764     this->is_running = false;
765
766     this->health = 100;
767
768     this->capacity_kW = 100;
769     this->upgrade_level = 1;
770
771     this->storage_kWh = 0;
772     this->storage_level = 0;
773
774     this->production_MWh = 0;
775     this->dispatch_MWh = 0;
776     this->dispatchable_MWh = 0;
777
778     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
779
780     this->capacity_factor_vec.resize(30, 0);
781     this->production_vec_MWh.resize(30, 0);
```



```

782     this->dispatch_vec_MWh.resize(30, 0);
783
784     this->tile_improvement_string = "SOLAR PV ARRAY";
785
786     this->__setUpTileImprovementSpriteStatic();
787     this->__computeCapacityFactors();
788     this->update();
789
790     std::cout << "SolarPV constructed at " << this << std::endl;
791
792     return;
793 } /* SolarPV() */

```

4.11.2.2 ~SolarPV()

```

SolarPV::~~SolarPV (
    void ) [virtual]

```

Destructor for the [SolarPV](#) class.

```

1125 {
1126     std::cout << "SolarPV at " << this << " destroyed" << std::endl;
1127
1128     return;
1129 } /* ~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     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
292     std::default_random_engine generator(seed);
293
294     double mean =
295         this->tile_resource_scalar * MEAN_DAILY_SOLAR_CAPACITY_FACTORS[this->month - 1];
296
297     double stdev = STDEV_DAILY_SOLAR_CAPACITY_FACTORS[this->month - 1];
298
299     if (this->tile_resource_scalar > 1) {
300         stdev /= this->tile_resource_scalar;
301     }
302
303     std::normal_distribution<double> normal_dist(mean, stdev);
304
305     double capacity_factor = 0;
306
307     for (int i = 0; i < 30; i++) {
308         capacity_factor = normal_dist(generator);
309
310         if (capacity_factor < 0) {
311             capacity_factor = 0;
312         }
313
314         this->capacity_factor_vec[i] = capacity_factor;
315     }
316
317     return;
318 } /* __computeCapacityFactors() */
```

4.11.3.3 __computeDispatch()

```
void SolarPV::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
361 {
362     double stored_energy_MWh = 0;
363     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
364
365     double demand_MWh = 0;
366     double production_MWh = 0;
367     double dispatchable_MWh = 0;
368     double difference_MWh = 0;
369
370     double room_MWh = 0;
371
372     for (int i = 0; i < 30; i++) {
373         demand_MWh = this->demand_vec_MWh[i];
374         production_MWh = this->production_vec_MWh[i];
375
376         if (production_MWh <= demand_MWh) {
377             this->dispatch_vec_MWh[i] = production_MWh;
378             dispatchable_MWh += this->dispatch_vec_MWh[i];
379
380             difference_MWh = demand_MWh - production_MWh;
381
382             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
383                 if (difference_MWh > stored_energy_MWh) {
384                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
385                     dispatchable_MWh += stored_energy_MWh;
386                     stored_energy_MWh = 0;
387                 }
388
389                 else {
390                     this->dispatch_vec_MWh[i] += difference_MWh;
391                     dispatchable_MWh += difference_MWh;
392                     stored_energy_MWh -= difference_MWh;
393                 }
394             }
395         }
396     }
397 }
```

```

394     }
395 }
396
397 else {
398     this->dispatch_vec_MWh[i] = demand_MWh;
399     dispatchable_MWh += this->dispatch_vec_MWh[i];
400
401     difference_MWh = production_MWh - demand_MWh;
402
403     if (
404         (storage_capacity_MWh > 0) and
405         (stored_energy_MWh < storage_capacity_MWh)
406     ) {
407         room_MWh = storage_capacity_MWh - stored_energy_MWh;
408
409         if (difference_MWh > room_MWh) {
410             stored_energy_MWh += room_MWh;
411         }
412
413         else {
414             stored_energy_MWh += difference_MWh;
415         }
416     }
417 }
418 }
419
420 this->dispatchable_MWh = round(dispatchable_MWh);
421
422 if (this->dispatch_MWh != this->dispatchable_MWh) {
423     this->dispatch_MWh = this->dispatchable_MWh;
424 }
425
426 return;
427 } /* __computeDispatch() */

```

4.11.3.4 __computeProduction()

```

void SolarPV::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

333 {
334     double production_MWh = 0;
335
336     for (int i = 0; i < 30; i++) {
337         this->production_vec_MWh[i] =
338             this->max_daily_production_MWh * this->capacity_factor_vec[i];
339
340         production_MWh += this->production_vec_MWh[i];
341     }
342
343     this->production_MWh = round(production_MWh);
344
345     return;
346 } /* __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(MONOCHROME_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.

```
568 {
569     // 1. draw power capacity upgrade sprite
570     sf::Vector2f initial_position = this->tile_improvement_sprite_static.getPosition();
571     this->tile_improvement_sprite_static.setPosition(400 - 100, 400 - 32);
572
573     sf::Color initial_colour = this->tile_improvement_sprite_static.getColor();
574     this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
575
576     sf::Vector2f initial_scale = this->tile_improvement_sprite_static.getScale();
577     this->tile_improvement_sprite_static.setScale(sf::Vector2f(1, 1));
578
579     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
580
581     this->tile_improvement_sprite_static.setPosition(initial_position);
582     this->tile_improvement_sprite_static.setColor(initial_colour);
```

```

583     this->tile_improvement_sprite_static.setScale(initial_scale);
584
585     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
586
587
588     // 2. draw power capacity upgrade text
589     //      16 char line = "          \n"
590     std::string power_upgrade_string = "POWER CAPACITY \n";
591     power_upgrade_string += "          \n";
592
593     power_upgrade_string += "CAPACITY: ";
594     power_upgrade_string += std::to_string(this->capacity_kW);
595     power_upgrade_string += " kW\n";
596
597     power_upgrade_string += "LEVEL: ";
598     power_upgrade_string += std::to_string(this->upgrade_level);
599     power_upgrade_string += "\n\n";
600
601     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
602         power_upgrade_string += "[W]: + 100 kW (";
603         power_upgrade_string += std::to_string(SOLAR_PV_BUILD_COST);
604         power_upgrade_string += " K)\n";
605     }
606
607     else {
608         power_upgrade_string += " * MAX LEVEL * \n";
609     }
610
611     sf::Text power_upgrade_text = sf::Text(
612         power_upgrade_string,
613         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
614         16
615     );
616
617     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
618     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
619     power_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
620
621     this->render_window_ptr->draw(power_upgrade_text);
622
623
624     // 3. draw energy capacity (storage) upgrade sprite
625     this->render_window_ptr->draw(this->storage_upgrade_sprite);
626     this->render_window_ptr->draw(this->upgrade_plus_sprite);
627
628
629     // 4. draw energy capacity (storage) upgrade text
630     //      16 char line = "          \n"
631     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
632     energy_upgrade_string += "          \n";
633
634     energy_upgrade_string += "CAPACITY: ";
635     energy_upgrade_string += std::to_string(this->storage_level * 200);
636     energy_upgrade_string += " kWh\n";
637
638     energy_upgrade_string += "LEVEL: ";
639     energy_upgrade_string += std::to_string(this->storage_level);
640     energy_upgrade_string += "\n\n";
641
642     if (this->storage_level < MAX_STORAGE_LEVELS) {
643         energy_upgrade_string += "[D]: + 200 kWh (";
644         energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
645         energy_upgrade_string += " K)\n";
646     }
647
648     else {
649         energy_upgrade_string += " * MAX LEVEL * \n";
650     }
651
652     sf::Text energy_upgrade_text = sf::Text(
653         energy_upgrade_string,
654         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
655         16
656     );
657
658     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
659     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
660     energy_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
661
662     this->render_window_ptr->draw(energy_upgrade_text);
663
664     return;
665 } /* __drawUpgradeOptions() */

```

4.11.3.8 __handleKeyPressEvents()

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

Helper method to handle key press events.

```
442 {
443     if (this->just_built) {
444         return;
445     }
446
447     switch (this->event_ptr->key.code) {
448         case (sf::Keyboard::U): {
449             this->__openUpgradeMenu();
450
451             break;
452         }
453
454
455         case (sf::Keyboard::W): {
456             if (this->production_menu_open) {
457                 this->dispatch_MWh++;
458
459                 if (this->dispatch_MWh > this->dispatchable_MWh) {
460                     this->dispatch_MWh = 0;
461                 }
462
463                 this->__computeProductionCosts();
464                 this->assets_manager_ptr->getSound("interface click")->play();
465             }
466
467             else if (this->upgrade_menu_open) {
468                 this->__upgradePowerCapacity();
469             }
470
471             break;
472         }
473
474
475         case (sf::Keyboard::S): {
476             if (this->production_menu_open) {
477                 this->dispatch_MWh--;
478
479                 if (this->dispatch_MWh < 0) {
480                     this->dispatch_MWh = this->dispatchable_MWh;
481                 }
482
483                 this->__computeProductionCosts();
484                 this->assets_manager_ptr->getSound("interface click")->play();
485             }
486
487             break;
488         }
489
490
491         case (sf::Keyboard::D): {
492             if (this->upgrade_menu_open) {
493                 this->__upgradeStorageCapacity();
494                 this->__computeProduction();
495                 this->__computeDispatch();
496             }
497
498             break;
499         }
500
501
502         default: {
503             // do nothing!
504
505             break;
506         }
507     }
508
509     return;
510 } /* __handleKeyPressEvents() */
```

4.11.3.9 __handleMouseButtonEvents()

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

Helper method to handle mouse button events.

```

525 {
526     if (this->just_built) {
527         return;
528     }
529
530     switch (this->event_ptr->mouseButton.button) {
531         case (sf::Mouse::Left): {
532             //...
533
534             break;
535         }
536
537         case (sf::Mouse::Right): {
538             //...
539
540             break;
541         }
542
543         default: {
544             // do nothing!
545
546             break;
547         }
548     }
549 }
550
551 return;
552 }
553 /* __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.

```

680 {
681     Message improvement_state_message;
682

```

```

683     improvement_state_message.channel = GAME_CHANNEL;
684     improvement_state_message.subject = "improvement state";
685
686     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
687     improvement_state_message.int_payload["operation_maintenance_cost"] =
688         this->operation_maintenance_cost;
689
690     this->message_hub_ptr->sendMessage(improvement_state_message);
691
692     std::cout << "Improvement state message sent by " << this << std::endl;
693
694     return;
695 } /* __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](#).

```

898 {
899     // 1. send improvement state message
900     this->__sendImprovementStateMessage();
901
902     // 2. update
903     this->__computeCapacityFactors();
904     this->update();
905
906     // 3. handle start/stop
907     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
908         this->is_running = true;
909     }
910
911     else if (this->is_running and (this->dispatch_MWh <= 0)) {
912         this->is_running = false;
913     }
914
915     // 4. handle equipment health
916     if (this->is_running) {
917         this->health--;
918
919         if (this->health <= 0) {
920             this->__breakdown();
921         }
922     }
923
924     // 5. send tile state request (if selected)
925     if (this->is_selected) {
926         this->__sendTileStateRequest();
927     }
928
929     return;
930 } /* 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](#).

```

1019 {
1020     // 1. if just built, call base method and return
1021     if (this->just_built) {
1022         TileImprovement::draw();

```

```

1023
1024     return;
1025 }
1026
1027 // 2. handle upgrade effects
1028 if (this->just_upgraded) {
1029     this->tile_improvement_sprite_static.setColor(
1030         sf::Color(
1031             255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1032             255,
1033             255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1034             255
1035         )
1036     );
1037
1038     this->tile_improvement_sprite_static.setScale(
1039         sf::Vector2f(
1040             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1041             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1042         )
1043     );
1044
1045     this->upgrade_frame++;
1046 }
1047
1048 if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1049     this->tile_improvement_sprite_static.setColor(
1050         sf::Color(255,255,255,255)
1051     );
1052
1053     this->tile_improvement_sprite_static.setScale(sf::Vector2f(1,1));
1054
1055     this->just_upgraded = false;
1056     this->upgrade_frame = 0;
1057 }
1058
1059 // 3. draw static sprite
1060 this->render_window_ptr->draw(this->tile_improvement_sprite_static);
1061
1062 // 4. draw storage upgrades
1063 for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1064     this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1065 }
1066
1067 // 5. handle dispatch illustration
1068 if (this->dispatch_MWh > 0) {
1069     this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1070     this->__drawDispatch();
1071 }
1072
1073 // 6. draw production menu
1074 if (this->production_menu_open) {
1075     this->render_window_ptr->draw(this->production_menu_backing);
1076     this->render_window_ptr->draw(this->production_menu_backing_text);
1077
1078     this->__drawProductionMenu();
1079 }
1080
1081 // 7. draw upgrade menu
1082 if (this->upgrade_menu_open) {
1083     this->render_window_ptr->draw(this->upgrade_menu_backing);
1084     this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1085
1086     this->__drawUpgradeOptions();
1087 }
1088
1089 // 10. handle broken effects
1090 if (this->is_broken) {
1091     this->tile_improvement_sprite_static.setColor(
1092         sf::Color(
1093             255,
1094             255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1095             255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1096             255
1097         )
1098     );
1099 }
1100
1101 this->frame++;
1102 return;

```

```
1110 }    /* 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](#).

```
810 {
811     //          32 char x 17 line console "-----\n";
812     std::string options_substring = "CAPACITY: ";
813     options_substring += std::to_string(this->capacity_kW);
814     options_substring += " kW (level ";
815     options_substring += std::to_string(this->upgrade_level);
816     options_substring += ")\n";
817
818     options_substring += "PRODUCTION: ";
819     options_substring += std::to_string(this->production_MWh);
820     options_substring += " MWh\n";
821
822     options_substring += "DISPATCHABLE: ";
823     options_substring += std::to_string(this->dispatchable_MWh);
824     options_substring += " MWh\n";
825
826     options_substring += "HEALTH: ";
827     options_substring += std::to_string(this->health);
828     options_substring += "/100";
829
830     if (this->health <= 0) {
831         options_substring += " ** BROKEN! **\n";
832     }
833
834     else {
835         options_substring += "\n";
836     }
837
838     options_substring += "
839     options_substring += "      **** SOLAR PV OPTIONS ****
840     options_substring += "
841
842     if (this->is_broken) {
843         options_substring += "      [R]: REPAIR (";
844         options_substring += std::to_string(SOLAR_PV_BUILD_COST);
845         options_substring += " K)\n";
846     }
847
848     else {
849         options_substring += "      [E]: OPEN PRODUCTION MENU \n";
850     }
851
852     options_substring += "      [U]: OPEN UPGRADE MENU \n";
853     options_substring += "HOLD [P]: SCRAP (";
854     options_substring += std::to_string(SCRAP_COST);
855     options_substring += " K)";
856
857     return options_substring;
858 } /* getTileOptionsSubstring() */
```

4.11.3.17 processEvent()

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

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

Reimplemented from [TileImprovement](#).

```
970 {
971     TileImprovement :: processEvent();
972
973     if (this->event_ptr->type == sf::Event::KeyPressed) {
974         this->__handleKeyPressEvents();
975     }
976
977     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
978         this->__handleMouseButtonEvents();
979     }
980
981     return;
982 } /* processEvent() */
```

4.11.3.18 processMessage()

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

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

Reimplemented from [TileImprovement](#).

```
997 {
998     TileImprovement :: processMessage();
999
1000     //...
1001
1002     return;
1003 } /* 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](#).

```
875 {
876     TileImprovement :: setIsSelected(is_selected);
877
878     if (this->is_running and this->is_selected) {
879         this->assets_manager_ptr->getSound("solar hum")->play();
880     }
881 }
```

```
882     return;  
883 } /* setIsSelected() */
```

4.11.3.20 update()

```
void SolarPV::update (  
    void ) [virtual]
```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
945 {  
946     this->__computeProduction();  
947     this->__computeProductionCosts();  
948     this->__computeDispatch();  
949  
950     if (this->is_selected) {  
951         this->__sendTileStateRequest();  
952     }  
953  
954     return;  
955 } /* 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:

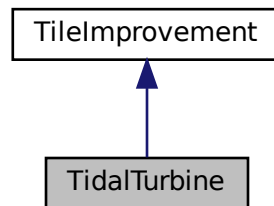
- header/[SolarPV.h](#)
- source/[SolarPV.cpp](#)

4.12 TidalTurbine Class Reference

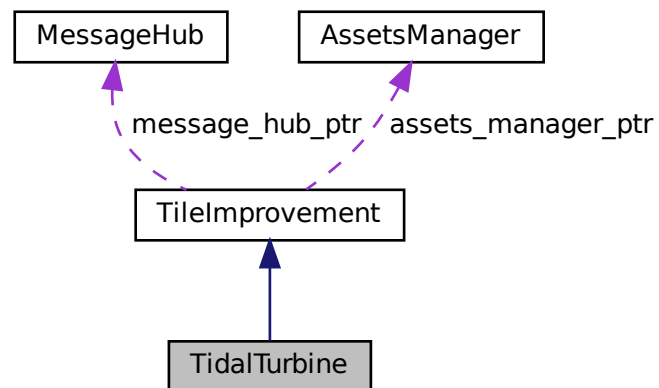
A settlement class (child class of [TileImprovement](#)).

```
#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.

```

747 :
748 TileImprovement (
749     position_x,
750     position_y,
751     tile_resource,
752     event_ptr,
753     render_window_ptr,
754     assets_manager_ptr,
755     message_hub_ptr
756 )
757 {
758     // 1. set attributes
759
760     // 1.1. private
761     //...
762
763     // 1.2. public
764     this->tile_improvement_type = TileImprovementType :: TIDAL_TURBINE;
765
766     this->is_running = false;
767
768     this->health = 100;
769
770     this->capacity_kW = 100;
771     this->upgrade_level = 1;
772
773     this->storage_kWh = 0;
774     this->storage_level = 0;
775
776     this->production_MWh = 0;
777     this->dispatch_MWh = 0;
778     this->dispatchable_MWh = 0;
779
780     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
781
782     this->rotor_drotation = 64 * SECONDS_PER_FRAME;
783     this->bobbing_y = 4;
784
785     this->capacity_factor_vec.resize(30, 0);
786     this->production_vec_MWh.resize(30, 0);
787     this->dispatch_vec_MWh.resize(30, 0);
788
789     this->tile_improvement_string = "TIDAL TURBINE";
790
791     this->__setUpTileImprovementSpriteAnimated();
792     this->__computeCapacityFactors();
793     this->update();
794
795     std::cout << "TidalTurbine constructed at " << this << std::endl;
796
797     return;
798 } /* TidalTurbine() */

```

4.12.2.2 ~TidalTurbine()

```

TidalTurbine::~TidalTurbine (
    void ) [virtual]

```

Destructor for the [TidalTurbine](#) class.

```

1156 {
1157     std::cout << "TidalTurbine at " << this << " destroyed" << std::endl;
1158
1159     return;
1160 } /* ~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     for (int i = 0; i < 30; i++) {
309         this->capacity_factor_vec[i] =
310             this->tile_resource_scalar * DAILY_TIDAL_CAPACITY_FACTOR;
311     }
312
313     return;
314 } /* __computeCapacityFactors() */
```

4.12.3.3 __computeDispatch()

```
void TidalTurbine::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
357 {
358     double stored_energy_MWh = 0;
359     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
360
361     double demand_MWh = 0;
362     double production_MWh = 0;
363     double dispatchable_MWh = 0;
364     double difference_MWh = 0;
365
366     double room_MWh = 0;
367
368     for (int i = 0; i < 30; i++) {
369         demand_MWh = this->demand_vec_MWh[i];
370         production_MWh = this->production_vec_MWh[i];
371
372         if (production_MWh <= demand_MWh) {
373             this->dispatch_vec_MWh[i] = production_MWh;
374             dispatchable_MWh += this->dispatch_vec_MWh[i];
375
376             difference_MWh = demand_MWh - production_MWh;
377
378             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
379                 if (difference_MWh > stored_energy_MWh) {
380                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
381                     dispatchable_MWh += stored_energy_MWh;
382                     stored_energy_MWh = 0;
383                 }
384             }
385         }
386     }
387 }
```

```

385         else {
386             this->dispatch_vec_MWh[i] += difference_MWh;
387             dispatchable_MWh += difference_MWh;
388             stored_energy_MWh -= difference_MWh;
389         }
390     }
391 }
392
393 else {
394     this->dispatch_vec_MWh[i] = demand_MWh;
395     dispatchable_MWh += this->dispatch_vec_MWh[i];
396
397     difference_MWh = production_MWh - demand_MWh;
398
399     if (
400         (storage_capacity_MWh > 0) and
401         (stored_energy_MWh < storage_capacity_MWh)
402     ) {
403         room_MWh = storage_capacity_MWh - stored_energy_MWh;
404
405         if (difference_MWh > room_MWh) {
406             stored_energy_MWh += room_MWh;
407         }
408
409         else {
410             stored_energy_MWh += difference_MWh;
411         }
412     }
413 }
414 }
415
416 this->dispatchable_MWh = round(dispatchable_MWh);
417
418 if (this->dispatch_MWh != this->dispatchable_MWh) {
419     this->dispatch_MWh = this->dispatchable_MWh;
420 }
421
422 return;
423 } /* __computeDispatch() */

```

4.12.3.4 __computeProduction()

```

void TidalTurbine::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

329 {
330     double production_MWh = 0;
331
332     for (int i = 0; i < 30; i++) {
333         this->production_vec_MWh[i] =
334             this->max_daily_production_MWh * this->capacity_factor_vec[i];
335
336         production_MWh += this->production_vec_MWh[i];
337     }
338
339     this->production_MWh = round(production_MWh);
340
341     return;
342 } /* __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.setFillColor(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.

```
564 {
565     // 1. draw power capacity upgrade sprite
566     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
567         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
568         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 32 - 8);
569
570         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
571         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
572     }
```

```

573         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
574         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
575
576         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
577         this->tile_improvement_sprite_animated[i].setRotation(0);
578
579         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
580
581         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
582         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
583         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
584         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
585     }
586
587     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
588
589
590     // 2. draw power capacity upgrade text
591     //      16 char line = "
592     std::string power_upgrade_string = "POWER CAPACITY \n";
593     power_upgrade_string += "
594
595     power_upgrade_string += "CAPACITY: ";
596     power_upgrade_string += std::to_string(this->capacity_kW);
597     power_upgrade_string += " kW\n";
598
599     power_upgrade_string += "LEVEL: ";
600     power_upgrade_string += std::to_string(this->upgrade_level);
601     power_upgrade_string += "\n\n";
602
603     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
604         power_upgrade_string += "[W]: + 100 kW (";
605         power_upgrade_string += std::to_string(TIDAL_TURBINE_BUILD_COST);
606         power_upgrade_string += " K)\n";
607     }
608
609     else {
610         power_upgrade_string += " * MAX LEVEL * \n";
611     }
612
613     sf::Text power_upgrade_text = sf::Text(
614         power_upgrade_string,
615         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
616         16
617     );
618
619     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
620     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
621     power_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
622
623     this->render_window_ptr->draw(power_upgrade_text);
624
625
626     // 3. draw energy capacity (storage) upgrade sprite
627     this->render_window_ptr->draw(this->storage_upgrade_sprite);
628     this->render_window_ptr->draw(this->upgrade_plus_sprite);
629
630
631     // 4. draw energy capacity (storage) upgrade text
632     //      16 char line = "
633     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
634     energy_upgrade_string += "
635
636     energy_upgrade_string += "CAPACITY: ";
637     energy_upgrade_string += std::to_string(this->storage_level * 200);
638     energy_upgrade_string += " kWh\n";
639
640     energy_upgrade_string += "LEVEL: ";
641     energy_upgrade_string += std::to_string(this->storage_level);
642     energy_upgrade_string += "\n\n";
643
644     if (this->storage_level < MAX_STORAGE_LEVELS) {
645         energy_upgrade_string += "[D]: + 200 kWh (";
646         energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
647         energy_upgrade_string += " K)\n";
648     }
649
650     else {
651         energy_upgrade_string += " * MAX LEVEL * \n";
652     }
653
654     sf::Text energy_upgrade_text = sf::Text(
655         energy_upgrade_string,
656         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
657         16
658     );
659

```

```

660     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
661     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
662     energy_upgrade_text.setFillColor(MONOCHROME_TEXT_GREEN);
663
664     this->render_window_ptr->draw(energy_upgrade_text);
665
666     return;
667 } /* __drawUpgradeOptions() */

```

4.12.3.8 __handleKeyPressEvents()

```

void TidalTurbine::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

438 {
439     if (this->just_built) {
440         return;
441     }
442
443     switch (this->event_ptr->key.code) {
444         case (sf::Keyboard::U): {
445             this->__openUpgradeMenu();
446
447             break;
448         }
449
450
451         case (sf::Keyboard::W): {
452             if (this->production_menu_open) {
453                 this->dispatch_MWh++;
454
455                 if (this->dispatch_MWh > this->dispatchable_MWh) {
456                     this->dispatch_MWh = 0;
457                 }
458
459                 this->__computeProductionCosts();
460                 this->assets_manager_ptr->getSound("interface click")->play();
461             }
462
463             else if (this->upgrade_menu_open) {
464                 this->__upgradePowerCapacity();
465             }
466
467             break;
468         }
469
470
471         case (sf::Keyboard::S): {
472             if (this->production_menu_open) {
473                 this->dispatch_MWh--;
474
475                 if (this->dispatch_MWh < 0) {
476                     this->dispatch_MWh = this->dispatchable_MWh;
477                 }
478
479                 this->__computeProductionCosts();
480                 this->assets_manager_ptr->getSound("interface click")->play();
481             }
482
483             break;
484         }
485
486
487         case (sf::Keyboard::D): {
488             if (this->upgrade_menu_open) {
489                 this->__upgradeStorageCapacity();
490                 this->__computeProduction();
491                 this->__computeDispatch();
492             }
493
494             break;
495         }
496
497
498         default: {
499             // do nothing!
500

```

```

501         break;
502     }
503 }
504
505 return;
506 } /* __handleKeyPressEvents() */

```

4.12.3.9 __handleMouseButtonEvents()

```

void TidalTurbine::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

521 {
522     if (this->just_built) {
523         return;
524     }
525
526     switch (this->event_ptr->mouseButton.button) {
527         case (sf::Mouse::Left): {
528             //...
529
530             break;
531         }
532
533         case (sf::Mouse::Right): {
534             //...
535
536             break;
537         }
538     }
539
540     default: {
541         // do nothing!
542
543         break;
544     }
545 }
546
547 return;
548 } /* __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.

```
682 {
683     Message improvement_state_message;
684
685     improvement_state_message.channel = GAME_CHANNEL;
686     improvement_state_message.subject = "improvement state";
687
688     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
689     improvement_state_message.int_payload["operation_maintenance_cost"] =
690         this->operation_maintenance_cost;
691
692     this->message_hub_ptr->sendMessage(improvement_state_message);
693
694     std::cout << "Improvement state message sent by " << this << std::endl;
695
696     return;
697 } /* __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](#).

```
904 {
905     // 1. send improvement state message
906     this->__sendImprovementStateMessage();
907
908     // 2. update
909     this->__computeCapacityFactors();
910     this->update();
911
912     // 3. handle start/stop
913     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
914         this->is_running = true;
915     }
916
917     else if (this->is_running and (this->dispatch_MWh <= 0)) {
918         this->is_running = false;
919     }
920
921     // 4. handle equipment health
922     if (this->is_running) {
923         this->health--;
924
925         if (this->health <= 0) {
926             this->__breakdown();
927         }
928     }
929 }
```

```

930 // 5. send tile state request (if selected)
931 if (this->is_selected) {
932     this->__sendTileStateRequest();
933 }
934
935 return;
936 } /* 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](#).

```

1025 {
1026 // 1. if just built, call base method and return
1027 if (this->just_built) {
1028     TileImprovement :: draw();
1029
1030     return;
1031 }
1032
1033 // 2. handle upgrade effects
1034 if (this->just_upgraded) {
1035     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1036         this->tile_improvement_sprite_animated[i].setColor(
1037             sf::Color(
1038                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1039                 255,
1040                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1041                 255
1042             )
1043         );
1044
1045         this->tile_improvement_sprite_animated[i].setScale(
1046             sf::Vector2f(
1047                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1048                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1049             )
1050         );
1051     }
1052 }
1053
1054 this->upgrade_frame++;
1055 }
1056
1057 if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1058     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1059         this->tile_improvement_sprite_animated[i].setColor(
1060             sf::Color(255,255,255,255)
1061         );
1062
1063         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1064     }
1065
1066     this->just_upgraded = false;
1067     this->upgrade_frame = 0;
1068 }
1069
1070 // 3. handle bobbing
1071 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1072     this->tile_improvement_sprite_animated[i].setPosition(
1073         this->position_x,
1074         this->position_y + this->bobbing_y * cos(
1075             (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1076         )
1077     );
1078 }
1079 }
1080
1081 // 4. draw first element of animated sprite
1082 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1083
1084
1085

```

```

1086 // 5. draw second element of animated sprite
1087 if (this->is_running) {
1088     this->tile_improvement_sprite_animated[1].rotate(this->rotor_drotation);
1089 }
1090
1091 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1092
1093
1094 // 6. draw storage upgrades
1095 for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1096     this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1097 }
1098
1099
1100 // 7. handle dispatch illustration
1101 if (this->dispatch_MWh > 0) {
1102     this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1103     this->__drawDispatch();
1104 }
1105
1106
1107 // 8. draw production menu
1108 if (this->production_menu_open) {
1109     this->render_window_ptr->draw(this->production_menu_backing);
1110     this->render_window_ptr->draw(this->production_menu_backing_text);
1111
1112     this->__drawProductionMenu();
1113 }
1114
1115
1116 // 9. draw upgrade menu
1117 if (this->upgrade_menu_open) {
1118     this->render_window_ptr->draw(this->upgrade_menu_backing);
1119     this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1120
1121     this->__drawUpgradeOptions();
1122 }
1123
1124
1125 // 10. handle broken effects
1126 if (this->is_broken) {
1127     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1128         this->tile_improvement_sprite_animated[i].setColor(
1129             sf::Color(
1130                 255,
1131                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1132                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1133                 255
1134             )
1135         );
1136     }
1137 }
1138
1139 this->frame++;
1140 return;
1141 } /* 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](#).

```

815 {
816     //          32 char x 17 line console "-----\n";
817     std::string options_substring = "CAPACITY: ";
818     options_substring += std::to_string(this->capacity_kW);
819     options_substring += " kW (level ";

```

```

820     options_substring          += std::to_string(this->upgrade_level);
821     options_substring          += ") \n";
822
823     options_substring          += "PRODUCTION:      ";
824     options_substring          += std::to_string(this->production_MWh);
825     options_substring          += " MWh \n";
826
827     options_substring          += "DISPATCHABLE:  ";
828     options_substring          += std::to_string(this->dispatchable_MWh);
829     options_substring          += " MWh \n";
830
831     options_substring          += "HEALTH:        ";
832     options_substring          += std::to_string(this->health);
833     options_substring          += "/100";
834
835     if (this->health <= 0) {
836         options_substring
837     }
838
839     else {
840         options_substring
841     }
842
843     options_substring          += "
844     options_substring          += "**** TIDAL TURBINE OPTIONS **** \n";
845     options_substring          += "
846
847     if (this->is_broken) {
848         options_substring
849         options_substring
850         options_substring
851     }
852
853     else {
854         options_substring
855     }
856
857     options_substring          += "
858     options_substring          += "HOLD [P]:  SCRAP (";
859     options_substring          += std::to_string(SCRAP_COST);
860     options_substring          += " K) \n";
861
862     return options_substring;
863 } /* getTileOptionsSubstring() */

```

4.12.3.17 processEvent()

```

void TidalTurbine::processEvent (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

976 {
977     TileImprovement :: processEvent ();
978
979     if (this->event_ptr->type == sf::Event::KeyPressed) {
980         this->__handleKeyPressEvents();
981     }
982
983     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
984         this->__handleMouseButtonEvents();
985     }
986
987     return;
988 } /* processEvent() */

```

4.12.3.18 processMessage()

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

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

Reimplemented from [TileImprovement](#).

```
1003 {
1004     TileImprovement :: processMessage();
1005
1006     //...
1007
1008     return;
1009 } /* 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](#).

```
880 {
881     TileImprovement :: setIsSelected(is_selected);
882
883     if (this->is_running and this->is_selected) {
884         this->assets_manager_ptr->getSound("water flow")->play();
885     }
886
887     return;
888 } /* setIsSelected() */
```

4.12.3.20 update()

```
void TidalTurbine::update (
    void ) [virtual]
```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
951 {
952     this->__computeProduction();
953     this->__computeProductionCosts();
954     this->__computeDispatch();
955
956     if (this->is_selected) {
957         this->__sendTileStateRequest();
958     }
959
960     return;
961 } /* 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:

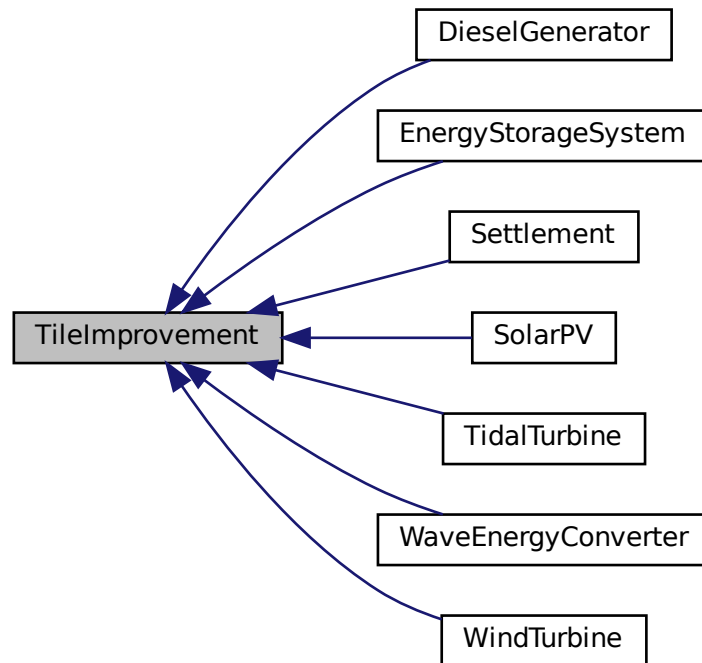
- header/[TidalTurbine.h](#)
- source/[TidalTurbine.cpp](#)

4.13 TileImprovement Class Reference

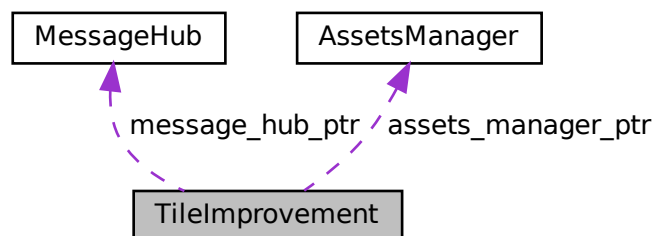
A base class for the tile improvement hierarchy.

```
#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.

```
726 {
727     // 1. set attributes
728
729     // 1.1. protected
730     this->event_ptr = event_ptr;
731     this->render_window_ptr = render_window_ptr;
732
733     this->assets_manager_ptr = assets_manager_ptr;
734     this->message_hub_ptr = message_hub_ptr;
735
736     // 1.2. public
737     this->is_selected = true;
738     this->just_built = true;
739     this->production_menu_open = false;
740     this->upgrade_menu_open = false;
741     this->is_broken = false;
742
743     this->just_upgraded = false;
744     this->upgrade_frame = 0;
745
746     this->frame = 0;
747     this->credits = 0;
748     this->month = 1;
749     this->demand_MWh = 0;
750
751     this->demand_vec_MWh.resize(30, 0);
752 }
```

```

753     this->operation_maintenance_cost = 0;
754
755     this->tile_resource = tile_resource;
756
757     switch (this->tile_resource) {
758     case (0): {
759         this->tile_resource_scalar = 0.85;
760
761         break;
762     }
763
764
765     case (1): {
766         this->tile_resource_scalar = 0.925;
767
768         break;
769     }
770
771
772     case (2): {
773         this->tile_resource_scalar = 1;
774
775         break;
776     }
777
778
779     case (3): {
780         this->tile_resource_scalar = 1.075;
781
782         break;
783     }
784
785
786     case (4): {
787         this->tile_resource_scalar = 1.15;
788
789         break;
790     }
791
792
793     default: {
794         this->tile_resource_scalar = 1;
795     }
796 }
797
798 this->position_x = position_x;
799 this->position_y = position_y;
800
801 this->game_phase = "build settlement";
802
803 this->__setUpProductionMenu();
804 this->__setUpUpgradeMenu();
805 this->__setUpDispatchIllustration();
806
807 std::cout << "TileImprovement constructed at " << this << std::endl;
808
809 return;
810 } /* TileImprovement() */

```

4.13.2.2 ~TileImprovement()

```

TileImprovement::~TileImprovement (
    void ) [virtual]

```

Destructor for the [TileImprovement](#) class.

```

1043 {
1044     std::cout << "TileImprovement at " << this << " destroyed" << std::endl;
1045
1046     return;
1047 } /* ~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->assets_manager_ptr->getSound("breakdown")->play();
435
436     return;
437 } /* __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.

```
516 {
517     if (not this->upgrade_menu_open) {
518         return;
519     }
520
521     this->upgrade_menu_open = false;
522     this->assets_manager_ptr->getSound("build menu close")->play();
523
524     return;
525 } /* __closeUpgradeMenu() */
```

4.13.3.4 __drawDispatch()

```
void TileImprovement::__drawDispatch (
    void ) [protected]
```

Helper method to draw dispatch illustration.

```
647 {
648     double alpha = 255 * pow(cos((0.5 * M_PI * this->frame) / FRAMES_PER_SECOND), 2);
649
650
651     // 1. dispatch backing
652     sf::Color backing_colour = this->dispatch_backing.getFillColor();
653     backing_colour.a = alpha;
654
655     this->dispatch_backing.setFillColor(backing_colour);
656     this->dispatch_backing.setOutlineColor(sf::Color(0, 0, 0, alpha));
657
658     this->render_window_ptr->draw(this->dispatch_backing);
659
660
661     // 2. dispatch text
662     this->dispatch_text.setOrigin(
663         this->dispatch_text.getLocalBounds().width / 2,
664         this->dispatch_text.getLocalBounds().height / 2
665     );
666
667     sf::Color text_colour = this->dispatch_text.getFillColor();
668     text_colour.a = alpha;
669
670     this->dispatch_text.setFillColor(text_colour);
671
672     this->render_window_ptr->draw(this->dispatch_text);
673
674     return;
675 } /* __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.

```
488 {
489     if (this->upgrade_menu_open) {
490         return;
491     }
492     if (this->production_menu_open) {
493         this->__closeProductionMenu();
494     }
495     this->upgrade_menu_open = true;
496     this->assets_manager_ptr->getSound("build menu open")->play();
497     return;
498 }
499
500 /* __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](#).

```
452 {
453     this->health = 100;
454     if (this->is_broken) {
455         this->is_broken = false;
456         this->assets_manager_ptr->getSound("positive notification")->play();
457     }
458     if (this->tile_improvement_sprite_static.getTexture() != NULL) {
459         this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
460     }
461     else {
462         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
463             this->tile_improvement_sprite_animated[i].setColor(
464                 sf::Color(255, 255, 255, 255)
465             );
466         }
467     }
468     return;
469 }
470
471 /* __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.
----------------------	--

```

593 {
594     Message credits_spent_message;
595
596     credits_spent_message.channel = GAME_CHANNEL;
597     credits_spent_message.subject = "credits spent";
598
599     credits_spent_message.int_payload["credits spent"] = credits_spent;
600
601     this->message_hub_ptr->sendMessage(credits_spent_message);
602
603     std::cout << "Credits spent (" << credits_spent << ") message sent by " << this
604               << std::endl;
605     return;
606 } /* __sendCreditsSpentMessage() */

```

4.13.3.11 __sendGameStateRequest()

```

void TileImprovement::__sendGameStateRequest (
    void ) [protected]

```

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

```

566 {
567     Message game_state_request;
568
569     game_state_request.channel = GAME_CHANNEL;
570     game_state_request.subject = "state request";
571
572     this->message_hub_ptr->sendMessage(game_state_request);
573
574     std::cout << "Game state request message sent by " << this << std::endl;
575     return;
576 } /* __sendGameStateRequest() */

```

4.13.3.12 __sendInsufficientCreditsMessage()

```

void TileImprovement::__sendInsufficientCreditsMessage (
    void ) [protected]

```

Helper method to format and send an insufficient credits message.

```

621 {
622     Message insufficient_credits_message;
623
624     insufficient_credits_message.channel = GAME_CHANNEL;
625     insufficient_credits_message.subject = "insufficient credits";
626
627     this->message_hub_ptr->sendMessage(insufficient_credits_message);
628
629     std::cout << "Insufficient credits message sent by " << this << std::endl;
630
631     return;
632 } /* __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.

```

541 {
542     Message tile_state_request;
543
544     tile_state_request.channel = TILE_STATE_CHANNEL;
545     tile_state_request.subject = "state request";
546
547     this->message_hub_ptr->sendMessage(tile_state_request);
548
549     std::cout << "Tile state request sent by " << this << std::endl;
550     return;
551 } /* __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
162     return;
163 } /* __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](#).

```

914 {
915     if (this->tile_improvement_sprite_static.getTexture() != NULL) {
916         int alpha = this->tile_improvement_sprite_static.getColor().a;
917
918         alpha += 0.08 * FRAMES_PER_SECOND;
919
920         this->tile_improvement_sprite_static.setColor(
921             sf::Color(255, 255, 255, alpha)
922         );
923
924         this->tile_improvement_sprite_static.move(0, 50 * SECONDS_PER_FRAME);

```

```

925
926     if (
927         (alpha >= 255) or
928         (this->tile_improvement_sprite_static.getPosition().y >= this->position_y + 12)
929     ) {
930         this->tile_improvement_sprite_static.setColor(
931             sf::Color(255, 255, 255, 255)
932         );
933
934         this->tile_improvement_sprite_static.setPosition(
935             this->position_x,
936             this->position_y + 12
937         );
938
939         this->just_built = false;
940         this->assets_manager_ptr->getSound("place improvement")->play();
941     }
942
943     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
944 }
945
946
947 else {
948     int alpha = 0;
949
950     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
951         alpha = this->tile_improvement_sprite_animated[i].getColor().a;
952
953         alpha += 0.08 * FRAMES_PER_SECOND;
954
955         this->tile_improvement_sprite_animated[i].setColor(
956             sf::Color(255, 255, 255, alpha)
957         );
958
959         this->tile_improvement_sprite_animated[i].move(0, 50 * SECONDS_PER_FRAME);
960
961         if (
962             (alpha >= 255) or
963             (this->tile_improvement_sprite_animated[i].getPosition().y >= this->position_y + 12)
964         ) {
965             this->tile_improvement_sprite_animated[i].setColor(
966                 sf::Color(255, 255, 255, 255)
967             );
968
969             this->tile_improvement_sprite_animated[i].setPosition(
970                 this->position_x,
971                 this->position_y + 12
972             );
973         }
974
975         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
976     }
977
978     if (
979         (alpha >= 255) or
980         (this->tile_improvement_sprite_animated[0].getPosition().y >= this->position_y + 12)
981     ) {
982         this->just_built = false;
983         this->assets_manager_ptr->getSound("place improvement")->play();
984
985         switch (this->tile_improvement_type) {
986             case (TileImprovementType :: WIND_TURBINE): {
987                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
988                     this->tile_improvement_sprite_animated[i].setOrigin(32, 32);
989                     this->tile_improvement_sprite_animated[i].move(0, -32);
990                 }
991
992                 break;
993             }
994
995             case (TileImprovementType :: TIDAL_TURBINE): {
996                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
997                     this->tile_improvement_sprite_animated[i].setOrigin(32, 45);
998                     this->tile_improvement_sprite_animated[i].move(0, -19);
999                 }
1000
1001                 break;
1002             }
1003
1004             case (TileImprovementType :: WAVE_ENERGY_CONVERTER): {
1005                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1006                     this->tile_improvement_sprite_animated[i].setOrigin(32, 32);
1007                     this->tile_improvement_sprite_animated[i].move(0, -32);
1008                 }
1009             }
1010         }
1011

```

```

1012             break;
1013         }
1014
1015
1016         default: {
1017             // do nothing!
1018
1019             break;
1020         }
1021     }
1022 }
1023 }
1024
1025
1026     this->frame++;
1027     return;
1028 } /* 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](#).

```

854 {
855     if (this->event_ptr->type == sf::Event::KeyPressed) {
856         this->__handleKeyPressEvents();
857     }
858
859     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
860         this->__handleMouseButtonEvents();
861     }
862
863     return;
864 } /* 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](#).

```
879 {
880     if (not this->message_hub_ptr->isEmpty(GAME_STATE_CHANNEL)) {
881         Message game_state_message = this->message_hub_ptr->receiveMessage(
882             GAME_STATE_CHANNEL
883         );
884
885         if (game_state_message.subject == "turn advance") {
886             this->credits = game_state_message.int_payload["credits"];
887             this->month = game_state_message.int_payload["month"];
888             this->demand_MWh = game_state_message.int_payload["demand_MWh"];
889
890             this->advanceTurn();
891
892             this->message_hub_ptr->incrementMessageRead(GAME_STATE_CHANNEL);
893             std::cout << "Turn advance message read and passed by " << this << std::endl;
894         }
895     }
896
897     return;
898 } /* 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](#).

```
827 {
828     this->is_selected = is_selected;
829
830     if ((not is_selected) and this->production_menu_open) {
831         this->__closeProductionMenu();
832     }
833
834     if ((not is_selected) and this->upgrade_menu_open) {
835         this->__closeUpgradeMenu();
836     }
837
838     return;
839 } /* 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:

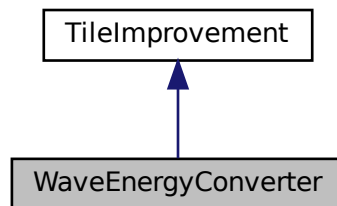
- header/[TileImprovement.h](#)
- source/[TileImprovement.cpp](#)

4.14 WaveEnergyConverter Class Reference

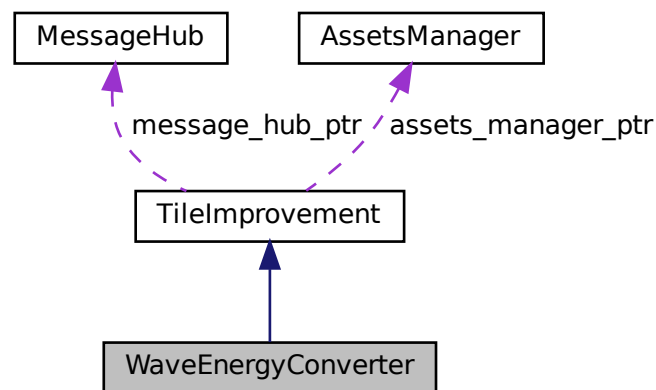
A settlement class (child class of [TileImprovement](#)).

```
#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.

```

763 :
764 TileImprovement (
765     position_x,
766     position_y,
767     tile_resource,
768     event_ptr,
769     render_window_ptr,
770     assets_manager_ptr,
771     message_hub_ptr
772 )
773 {
774     // 1. set attributes
775
776     // 1.1. private
777     //...
778
779     // 1.2. public
780     this->tile_improvement_type = TileImprovementType :: WAVE_ENERGY_CONVERTER;
781
782     this->is_running = false;
783
784     this->health = 100;
785
786     this->capacity_kW = 100;
787     this->upgrade_level = 1;
788
789     this->storage_kWh = 0;
790     this->storage_level = 0;
791
792     this->production_MWh = 0;
793     this->dispatch_MWh = 0;
794     this->dispatchable_MWh = 0;
795
796     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
797
798     this->bobbing_y = 4;
799
800     this->capacity_factor_vec.resize(30, 0);
801     this->production_vec_MWh.resize(30, 0);
802     this->dispatch_vec_MWh.resize(30, 0);
803
804     this->tile_improvement_string = "WAVE ENERGY";
805
806     this->__setUpTileImprovementSpriteAnimated();
807     this->__computeCapacityFactors();
808     this->update();
809
810     std::cout << "WaveEnergyConverter constructed at " << this << std::endl;
811
812     return;
813 } /* WaveEnergyConverter() */

```

4.14.2.2 ~WaveEnergyConverter()

```

WaveEnergyConverter::~WaveEnergyConverter (
    void ) [virtual]

```

Destructor for the [WaveEnergyConverter](#) class.

```

1182 {
1183     std::cout << "WaveEnergyConverter at " << this << " destroyed" << std::endl;
1184
1185     return;
1186 } /* ~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     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
309     std::default_random_engine generator(seed);
310
311     double mean =
312         this->tile_resource_scalar * MEAN_DAILY_WAVE_CAPACITY_FACTORS[this->month - 1];
313
314     double stdev = STDEV_DAILY_WAVE_CAPACITY_FACTORS[this->month - 1];
315
316     if (this->tile_resource_scalar > 1) {
317         stdev /= this->tile_resource_scalar;
318     }
319
320     std::normal_distribution<double> normal_dist(mean, stdev);
321
322     double capacity_factor = 0;
323
324     for (int i = 0; i < 30; i++) {
325         capacity_factor = normal_dist(generator);
326
327         if (capacity_factor < 0) {
328             capacity_factor = 0;
329         }
330
331         this->capacity_factor_vec[i] = capacity_factor;
332     }
333
334     return;
335 } /* __computeCapacityFactors() */
```

4.14.3.3 __computeDispatch()

```
void WaveEnergyConverter::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
378 {
379     double stored_energy_MWh = 0;
380     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
381
382     double demand_MWh = 0;
383     double production_MWh = 0;
384     double dispatchable_MWh = 0;
```

```

385     double difference_MWh = 0;
386
387     double room_MWh = 0;
388
389     for (int i = 0; i < 30; i++) {
390         demand_MWh = this->demand_vec_MWh[i];
391         production_MWh = this->production_vec_MWh[i];
392
393         if (production_MWh <= demand_MWh) {
394             this->dispatch_vec_MWh[i] = production_MWh;
395             dispatchable_MWh += this->dispatch_vec_MWh[i];
396
397             difference_MWh = demand_MWh - production_MWh;
398
399             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
400                 if (difference_MWh > stored_energy_MWh) {
401                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
402                     dispatchable_MWh += stored_energy_MWh;
403                     stored_energy_MWh = 0;
404                 }
405
406                 else {
407                     this->dispatch_vec_MWh[i] += difference_MWh;
408                     dispatchable_MWh += difference_MWh;
409                     stored_energy_MWh -= difference_MWh;
410                 }
411             }
412         }
413
414         else {
415             this->dispatch_vec_MWh[i] = demand_MWh;
416             dispatchable_MWh += this->dispatch_vec_MWh[i];
417
418             difference_MWh = production_MWh - demand_MWh;
419
420             if (
421                 (storage_capacity_MWh > 0) and
422                 (stored_energy_MWh < storage_capacity_MWh)
423             ) {
424                 room_MWh = storage_capacity_MWh - stored_energy_MWh;
425
426                 if (difference_MWh > room_MWh) {
427                     stored_energy_MWh += room_MWh;
428                 }
429
430                 else {
431                     stored_energy_MWh += difference_MWh;
432                 }
433             }
434         }
435     }
436
437     this->dispatchable_MWh = round(dispatchable_MWh);
438
439     if (this->dispatch_MWh != this->dispatchable_MWh) {
440         this->dispatch_MWh = this->dispatchable_MWh;
441     }
442
443     return;
444 } /* __computeDispatch() */

```

4.14.3.4 __computeProduction()

```

void WaveEnergyConverter::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

350 {
351     double production_MWh = 0;
352
353     for (int i = 0; i < 30; i++) {
354         this->production_vec_MWh[i] =
355             this->max_daily_production_MWh * this->capacity_factor_vec[i];
356
357         production_MWh += this->production_vec_MWh[i];
358     }
359
360     this->production_MWh = round(production_MWh);

```

```

361
362     return;
363 } /* __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.setFillColor(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() */

```

4.14.3.7 __drawUpgradeOptions()

```

void WaveEnergyConverter::__drawUpgradeOptions (
    void ) [private]

```

Helper method to set up and draw upgrade options.

```

584 {
585     // 1. draw power capacity upgrade sprite
586     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
587         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
588         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 32 - 20);
589
590         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
591         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
592
593         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
594         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
595
596         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
597
598         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
599         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
600         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
601     }
602
603     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
604
605
606     // 2. draw power capacity upgrade text
607     // 16 char line = "\n"
608     std::string power_upgrade_string = "POWER CAPACITY \n";
609     power_upgrade_string += "\n";
610
611     power_upgrade_string += "CAPACITY: ";
612     power_upgrade_string += std::to_string(this->capacity_kW);
613     power_upgrade_string += " kW\n";
614
615     power_upgrade_string += "LEVEL: ";
616     power_upgrade_string += std::to_string(this->upgrade_level);
617     power_upgrade_string += "\n\n";
618
619     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
620         power_upgrade_string += "[W]: + 100 kW (";
621         power_upgrade_string += std::to_string(WAVE_ENERGY_CONVERTER_BUILD_COST);
622         power_upgrade_string += " K)\n";
623     }
624
625     else {
626         power_upgrade_string += " * MAX LEVEL * \n";
627     }
628
629     sf::Text power_upgrade_text = sf::Text(
630         power_upgrade_string,
631         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
632         16
633     );
634
635     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
636     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
637     power_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
638
639     this->render_window_ptr->draw(power_upgrade_text);
640
641
642     // 3. draw energy capacity (storage) upgrade sprite
643     this->render_window_ptr->draw(this->storage_upgrade_sprite);
644     this->render_window_ptr->draw(this->upgrade_plus_sprite);
645
646

```



```

647 // 4. draw energy capacity (storage) upgrade text
648 // 16 char line = " \n"
649 std::string energy_upgrade_string = "ENERGY CAPACITY \n";
650 energy_upgrade_string += " \n";
651
652 energy_upgrade_string += "CAPACITY: ";
653 energy_upgrade_string += std::to_string(this->storage_level * 200);
654 energy_upgrade_string += " kWh\n";
655
656 energy_upgrade_string += "LEVEL: ";
657 energy_upgrade_string += std::to_string(this->storage_level);
658 energy_upgrade_string += "\n\n";
659
660 if (this->storage_level < MAX_STORAGE_LEVELS) {
661     energy_upgrade_string += "[D]: + 200 kWh (";
662     energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
663     energy_upgrade_string += " K)\n";
664 }
665
666 else {
667     energy_upgrade_string += " * MAX LEVEL * \n";
668 }
669
670 sf::Text energy_upgrade_text = sf::Text(
671     energy_upgrade_string,
672     *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
673     16
674 );
675
676 energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
677 energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
678 energy_upgrade_text.setFillColor(MONOCHROME_TEXT_GREEN);
679
680 this->render_window_ptr->draw(energy_upgrade_text);
681
682 return;
683 } /* __drawUpgradeOptions() */

```

4.14.3.8 __handleKeyPressEvents()

```

void WaveEnergyConverter::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

459 {
460     if (this->just_built) {
461         return;
462     }
463
464     switch (this->event_ptr->key.code) {
465         case (sf::Keyboard::U): {
466             this->__openUpgradeMenu();
467
468             break;
469         }
470
471         case (sf::Keyboard::W): {
472             if (this->production_menu_open) {
473                 this->dispatch_MWh++;
474
475                 if (this->dispatch_MWh > this->dispatchable_MWh) {
476                     this->dispatch_MWh = 0;
477                 }
478
479                 this->__computeProductionCosts();
480                 this->assets_manager_ptr->getSound("interface click")->play();
481             }
482
483             else if (this->upgrade_menu_open) {
484                 this->__upgradePowerCapacity();
485             }
486
487             break;
488         }
489
490         case (sf::Keyboard::S): {

```

```

493         if (this->production_menu_open) {
494             this->dispatch_MWh--;
495
496             if (this->dispatch_MWh < 0) {
497                 this->dispatch_MWh = this->dispatchable_MWh;
498             }
499
500             this->__computeProductionCosts();
501             this->assets_manager_ptr->getSound("interface click")->play();
502         }
503
504         break;
505     }
506
507
508     case (sf::Keyboard::D): {
509         if (this->upgrade_menu_open) {
510             this->__upgradeStorageCapacity();
511             this->__computeProduction();
512             this->__computeDispatch();
513         }
514
515         break;
516     }
517
518
519     default: {
520         // do nothing!
521
522         break;
523     }
524 }
525
526 return;
527 } /* __handleKeyPressEvents() */

```

4.14.3.9 __handleMouseButtonEvents()

```

void WaveEnergyConverter::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

542 {
543     if (this->just_built) {
544         return;
545     }
546     switch (this->event_ptr->mouseButton.button) {
547         case (sf::Mouse::Left): {
548             //...
549
550             break;
551         }
552
553
554         case (sf::Mouse::Right): {
555             //...
556
557             break;
558         }
559
560
561         default: {
562             // do nothing!
563
564             break;
565         }
566     }
567
568     return;
569 } /* __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.

```
698 {
699     Message improvement_state_message;
700
701     improvement_state_message.channel = GAME_CHANNEL;
702     improvement_state_message.subject = "improvement state";
703
704     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
705     improvement_state_message.int_payload["operation_maintenance_cost"] =
706         this->operation_maintenance_cost;
707
708     this->message_hub_ptr->sendMessage(improvement_state_message);
709
710     std::cout << "Improvement state message sent by " << this << std::endl;
711
712     return;
713 } /* __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](#).

```

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
936     if (this->is_running) {
937         this->health--;
938
939         if (this->health <= 0) {
940             this->__breakdown();
941         }
942     }
943
944     // 5. send tile state request (if selected)
945     if (this->is_selected) {
946         this->__sendTileStateRequest();
947     }
948
949     return;
950 } /* 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](#).

```

1039 {
1040     // 1. if just built, call base method and return
1041     if (this->just_built) {
1042         TileImprovement :: draw();
1043
1044         return;
1045     }
1046
1047
1048     // 2. handle upgrade effects
1049     if (this->just_upgraded) {
1050         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1051             this->tile_improvement_sprite_animated[i].setColor(
1052                 sf::Color(
1053                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1054                     255,
1055                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1056                     255
1057                 )
1058             );
1059
1060             this->tile_improvement_sprite_animated[i].setScale(
1061                 sf::Vector2f(
1062                     1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1063                     1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1064                 )
1065             );
1066         }
1067
1068         this->upgrade_frame++;
1069     }

```

```

1070
1071 if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
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(255,255,255,255)
1075         );
1076         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1077     }
1078
1079     this->just_upgraded = false;
1080     this->upgrade_frame = 0;
1081 }
1082
1083
1084
1085 // 3. draw first element of animated sprite
1086 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1087
1088
1089 // 4. draw second element of animated sprite
1090 if (this->is_running) {
1091     this->tile_improvement_sprite_animated[0].setPosition(
1092         this->position_x,
1093         this->position_y + this->bobbing_y * cos(
1094             (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1095         )
1096     );
1097
1098     this->tile_improvement_sprite_animated[1].setPosition(
1099         this->position_x,
1100         this->position_y + 1.25 * this->bobbing_y * sin(
1101             (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1102         )
1103     );
1104 }
1105
1106 else {
1107     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1108         this->tile_improvement_sprite_animated[i].setPosition(
1109             this->position_x,
1110             this->position_y + this->bobbing_y * cos(
1111                 (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1112             )
1113         );
1114     }
1115 }
1116
1117 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1118
1119
1120 // 5. draw storage upgrades
1121 for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1122     this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1123 }
1124
1125
1126 // 6. handle dispatch illustration
1127 if (this->dispatch_MWh > 0) {
1128     this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1129     this->__drawDispatch();
1130 }
1131
1132
1133 // 7. draw production menu
1134 if (this->production_menu_open) {
1135     this->render_window_ptr->draw(this->production_menu_backing);
1136     this->render_window_ptr->draw(this->production_menu_backing_text);
1137
1138     this->__drawProductionMenu();
1139 }
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
1151 // 9. handle broken effects
1152 if (this->is_broken) {
1153     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1154         this->tile_improvement_sprite_animated[i].setColor(
1155             sf::Color(
1156                 255,

```

```

1157             255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1158             255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1159             255
1160         )
1161     );
1162 }
1163 }
1164
1165     this->frame++;
1166     return;
1167 } /* 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](#).

```

830 {
831     // 32 char x 17 line console "-----\n";
832     std::string options_substring = "CAPACITY: ";
833     options_substring += std::to_string(this->capacity_kW);
834     options_substring += " kW (level ";
835     options_substring += std::to_string(this->upgrade_level);
836     options_substring += ")\n";
837
838     options_substring += "PRODUCTION: ";
839     options_substring += std::to_string(this->production_MWh);
840     options_substring += " MWh\n";
841
842     options_substring += "DISPATCHABLE: ";
843     options_substring += std::to_string(this->dispatchable_MWh);
844     options_substring += " MWh\n";
845
846     options_substring += "HEALTH: ";
847     options_substring += std::to_string(this->health);
848     options_substring += "/100";
849
850     if (this->health <= 0) {
851         options_substring += " ** BROKEN! **\n";
852     }
853
854     else {
855         options_substring += "\n";
856     }
857
858     options_substring += "
859     options_substring += " **** WAVE ENERGY OPTIONS ****
860     options_substring += "
861
862     if (this->is_broken) {
863         options_substring += " [R]: REPAIR ";
864         options_substring += std::to_string(WAVE_ENERGY_CONVERTER_BUILD_COST);
865         options_substring += " K)\n";
866     }
867
868     else {
869         options_substring += " [E]: OPEN PRODUCTION MENU \n";
870     }
871
872     options_substring += " [U]: OPEN UPGRADE MENU \n";
873     options_substring += "HOLD [P]: SCRAP ";
874     options_substring += std::to_string(SCRAP_COST);
875     options_substring += " K)";
876
877     return options_substring;
878 } /* getTileOptionsSubstring() */

```

4.14.3.17 processEvent()

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

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

Reimplemented from [TileImprovement](#).

```
990 {
991     TileImprovement :: processEvent();
992
993     if (this->event_ptr->type == sf::Event::KeyPressed) {
994         this->__handleKeyPressEvents();
995     }
996
997     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
998         this->__handleMouseButtonEvents();
999     }
1000
1001     return;
1002 } /* processEvent() */
```

4.14.3.18 processMessage()

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

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

Reimplemented from [TileImprovement](#).

```
1017 {
1018     TileImprovement :: processMessage();
1019
1020     //...
1021
1022     return;
1023 } /* 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](#).

```
895 {
896     TileImprovement :: setIsSelected(is_selected);
897
898     if (this->is_running and this->is_selected) {
899         this->assets_manager_ptr->getSound("ocean waves")->play();
900     }
901 }
```



```
902     return;  
903 } /* setIsSelected() */
```

4.14.3.20 update()

```
void WaveEnergyConverter::update (  
    void ) [virtual]
```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
965 {  
966     this->__computeProduction();  
967     this->__computeProductionCosts();  
968     this->__computeDispatch();  
969  
970     if (this->is_selected) {  
971         this->__sendTileStateRequest();  
972     }  
973  
974     return;  
975 } /* 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:

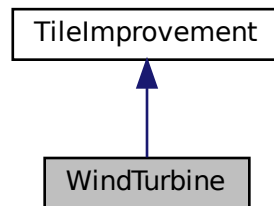
- header/[WaveEnergyConverter.h](#)
- source/[WaveEnergyConverter.cpp](#)

4.15 WindTurbine Class Reference

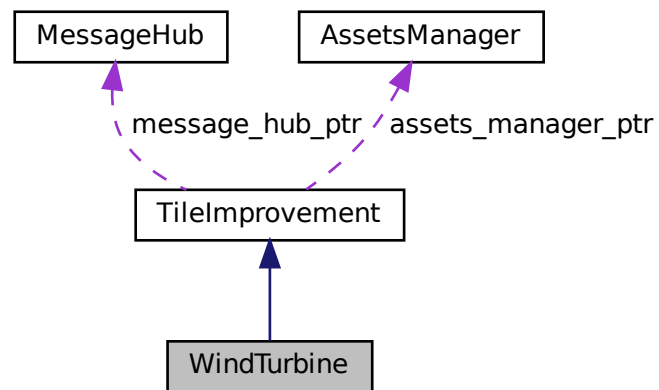
A settlement class (child class of [TileImprovement](#)).

```
#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.

```

770 :
771 TileImprovement (
772     position_x,
773     position_y,
774     tile_resource,
775     event_ptr,
776     render_window_ptr,
777     assets_manager_ptr,
778     message_hub_ptr
779 )
780 {
781     // 1. set attributes
782
783     // 1.1. private
784     //...
785
786     // 1.2. public
787     this->tile_improvement_type = TileImprovementType :: WIND_TURBINE;
788
789     this->is_running = false;
790
791     this->health = 100;
792
793     this->capacity_kW = 100;
794     this->upgrade_level = 1;
795
796     this->storage_kWh = 0;
797     this->storage_level = 0;
798
799     this->production_MWh = 0;
800     this->dispatch_MWh = 0;
801     this->dispatchable_MWh = 0;
802
803     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
804
805     this->rotor_drotation = 256 * SECONDS_PER_FRAME;
806
807     this->capacity_factor_vec.resize(30, 0);
808     this->production_vec_MWh.resize(30, 0);
809     this->dispatch_vec_MWh.resize(30, 0);
810
811     this->tile_improvement_string = "WIND TURBINE";
812
813     this->__setUpTileImprovementSpriteAnimated();
814     this->__computeCapacityFactors();
815     this->update();
816
817     std::cout << "WindTurbine constructed at " << this << std::endl;
818
819     return;
820 } /* WindTurbine() */

```

4.15.2.2 ~WindTurbine()

```

WindTurbine::~~WindTurbine (
    void ) [virtual]

```

Destructor for the [WindTurbine](#) class.

```

1168 {
1169     std::cout << "WindTurbine at " << this << " destroyed" << std::endl;
1170
1171     return;
1172 } /* ~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     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
309     std::default_random_engine generator(seed);
310
311     double mean =
312         this->tile_resource_scalar * MEAN_DAILY_WIND_CAPACITY_FACTORS[this->month - 1];
313
314     double stdev = STDEV_DAILY_WIND_CAPACITY_FACTORS[this->month - 1];
315
316     if (this->tile_resource_scalar > 1) {
317         stdev /= this->tile_resource_scalar;
318     }
319
320     std::normal_distribution<double> normal_dist(mean, stdev);
321
322     double capacity_factor = 0;
323
324     for (int i = 0; i < 30; i++) {
325         capacity_factor = normal_dist(generator);
326
327         if (capacity_factor < 0) {
328             capacity_factor = 0;
329         }
330
331         this->capacity_factor_vec[i] = capacity_factor;
332     }
333
334     return;
335 } /* __computeCapacityFactors() */
```

4.15.3.3 __computeDispatch()

```
void WindTurbine::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
378 {
379     std::cout << "WindTurbine :: __computeDispatch()" << std::endl;
380
381     double stored_energy_MWh = 0;
382     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
383
384     double demand_MWh = 0;
```

```

385     double production_MWh = 0;
386     double dispatchable_MWh = 0;
387     double difference_MWh = 0;
388
389     double room_MWh = 0;
390
391     for (int i = 0; i < 30; i++) {
392         demand_MWh = this->demand_vec_MWh[i];
393         production_MWh = this->production_vec_MWh[i];
394
395         if (production_MWh <= demand_MWh) {
396             this->dispatch_vec_MWh[i] = production_MWh;
397             dispatchable_MWh += this->dispatch_vec_MWh[i];
398
399             difference_MWh = demand_MWh - production_MWh;
400
401             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
402                 if (difference_MWh > stored_energy_MWh) {
403                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
404                     dispatchable_MWh += stored_energy_MWh;
405                     stored_energy_MWh = 0;
406                 }
407
408                 else {
409                     this->dispatch_vec_MWh[i] += difference_MWh;
410                     dispatchable_MWh += difference_MWh;
411                     stored_energy_MWh -= difference_MWh;
412                 }
413             }
414         }
415
416         else {
417             this->dispatch_vec_MWh[i] = demand_MWh;
418             dispatchable_MWh += this->dispatch_vec_MWh[i];
419
420             difference_MWh = production_MWh - demand_MWh;
421
422             if (
423                 (storage_capacity_MWh > 0) and
424                 (stored_energy_MWh < storage_capacity_MWh)
425             ) {
426                 room_MWh = storage_capacity_MWh - stored_energy_MWh;
427
428                 if (difference_MWh > room_MWh) {
429                     stored_energy_MWh += room_MWh;
430                 }
431
432                 else {
433                     stored_energy_MWh += difference_MWh;
434                 }
435             }
436         }
437     }
438
439     this->dispatchable_MWh = round(dispatchable_MWh);
440
441     if (this->dispatch_MWh != this->dispatchable_MWh) {
442         this->dispatch_MWh = this->dispatchable_MWh;
443     }
444
445     return;
446 } /* __computeDispatch() */

```

4.15.3.4 __computeProduction()

```

void WindTurbine::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

350 {
351     double production_MWh = 0;
352
353     for (int i = 0; i < 30; i++) {
354         this->production_vec_MWh[i] =
355             this->max_daily_production_MWh * this->capacity_factor_vec[i];
356
357         production_MWh += this->production_vec_MWh[i];
358     }

```



```

359
360     this->production_MWh = round(production_MWh);
361
362     return;
363 } /* __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         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(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.

```

587 {
588     // 1. draw power capacity upgrade sprite
589     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
590         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
591         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 56);
592
593         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
594         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
595
596         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
597         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
598
599         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
600         this->tile_improvement_sprite_animated[i].setRotation(0);
601
602         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
603
604         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
605         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
606         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
607         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
608     }
609
610     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
611
612
613     // 2. draw power capacity upgrade text
614     // 16 char line = "
615     std::string power_upgrade_string = "POWER CAPACITY \n";
616     power_upgrade_string += " \n";
617
618     power_upgrade_string += "CAPACITY: ";
619     power_upgrade_string += std::to_string(this->capacity_kW);
620     power_upgrade_string += " kW\n";
621
622     power_upgrade_string += "LEVEL: ";
623     power_upgrade_string += std::to_string(this->upgrade_level);
624     power_upgrade_string += "\n\n";
625
626     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
627         power_upgrade_string += "[W]: + 100 kW (";
628         power_upgrade_string += std::to_string(WIND_TURBINE_BUILD_COST);
629         power_upgrade_string += " K)\n";
630     }
631
632     else {
633         power_upgrade_string += " * MAX LEVEL * \n";
634     }
635
636     sf::Text power_upgrade_text = sf::Text(
637         power_upgrade_string,
638         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
639         16
640     );
641
642     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
643     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
644     power_upgrade_text.setFillColour(MONOCHROME_TEXT_GREEN);
645
646     this->render_window_ptr->draw(power_upgrade_text);
647

```

```

648
649 // 3. draw energy capacity (storage) upgrade sprite
650 this->render_window_ptr->draw(this->storage_upgrade_sprite);
651 this->render_window_ptr->draw(this->upgrade_plus_sprite);
652
653
654 // 4. draw energy capacity (storage) upgrade text
655 // 16 char line = " \n"
656 std::string energy_upgrade_string = "ENERGY CAPACITY \n";
657 energy_upgrade_string += " \n";
658
659 energy_upgrade_string += "CAPACITY: ";
660 energy_upgrade_string += std::to_string(this->storage_level * 200);
661 energy_upgrade_string += " kWh\n";
662
663 energy_upgrade_string += "LEVEL: ";
664 energy_upgrade_string += std::to_string(this->storage_level);
665 energy_upgrade_string += "\n\n";
666
667 if (this->storage_level < MAX_STORAGE_LEVELS) {
668     energy_upgrade_string += "[D]: + 200 kWh (";
669     energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
670     energy_upgrade_string += " K)\n";
671 }
672
673 else {
674     energy_upgrade_string += " * MAX LEVEL * \n";
675 }
676
677 sf::Text energy_upgrade_text = sf::Text(
678     energy_upgrade_string,
679     *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
680     16
681 );
682
683 energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
684 energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
685 energy_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
686
687 this->render_window_ptr->draw(energy_upgrade_text);
688
689 return;
690 } /* __drawUpgradeOptions() */

```

4.15.3.8 __handleKeyPressEvents()

```

void WindTurbine::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

461 {
462     if (this->just_built) {
463         return;
464     }
465
466     switch (this->event_ptr->key.code) {
467         case (sf::Keyboard::U): {
468             this->__openUpgradeMenu();
469
470             break;
471         }
472
473         case (sf::Keyboard::W): {
474             if (this->production_menu_open) {
475                 this->dispatch_MWh++;
476
477                 if (this->dispatch_MWh > this->dispatchable_MWh) {
478                     this->dispatch_MWh = 0;
479                 }
480
481                 this->__computeProductionCosts();
482                 this->assets_manager_ptr->getSound("interface click")->play();
483             }
484
485             else if (this->upgrade_menu_open) {
486                 this->__upgradePowerCapacity();
487             }
488         }

```

```

489         break;
490     }
491 }
492
493 case (sf::Keyboard::S): {
494     if (this->production_menu_open) {
495         this->dispatch_MWh--;
496
497         if (this->dispatch_MWh < 0) {
498             this->dispatch_MWh = this->dispatchable_MWh;
499         }
500
501         this->__computeProductionCosts();
502         this->assets_manager_ptr->getSound("interface click")->play();
503     }
504     break;
505 }
506
507 case (sf::Keyboard::D): {
508     if (this->upgrade_menu_open) {
509         this->__upgradeStorageCapacity();
510         this->__computeProduction();
511         this->__computeDispatch();
512     }
513     break;
514 }
515
516 default: {
517     // do nothing!
518     break;
519 }
520
521 return;
522 } /* __handleKeyPressEvents() */

```

4.15.3.9 __handleMouseButtonEvents()

```

void WindTurbine::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

544 {
545     if (this->just_built) {
546         return;
547     }
548
549     switch (this->event_ptr->mouseButton.button) {
550         case (sf::Mouse::Left): {
551             //...
552
553             break;
554         }
555
556         case (sf::Mouse::Right): {
557             //...
558
559             break;
560         }
561
562         default: {
563             // do nothing!
564             break;
565         }
566     }
567
568     return;
569 } /* __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.

```
705 {
706     Message improvement_state_message;
707
708     improvement_state_message.channel = GAME_CHANNEL;
709     improvement_state_message.subject = "improvement state";
710
711     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
712     improvement_state_message.int_payload["operation_maintenance_cost"] =
713         this->operation_maintenance_cost;
714
715     this->message_hub_ptr->sendMessage(improvement_state_message);
716
717     std::cout << "Improvement state message sent by " << this << std::endl;
718
719     return;
720 } /* __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](#).

```

925 {
926     // 1. send improvement state message
927     this->__sendImprovementStateMessage();
928
929     // 2. update
930     this->__computeCapacityFactors();
931     this->update();
932
933     // 3. handle start/stop
934     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
935         this->is_running = true;
936     }
937
938     else if (this->is_running and (this->dispatch_MWh <= 0)) {
939         this->is_running = false;
940     }
941
942     // 4. handle equipment health
943     if (this->is_running) {
944         this->health--;
945
946         if (this->health <= 0) {
947             this->__breakdown();
948         }
949     }
950
951     // 5. send tile state request (if selected)
952     if (this->is_selected) {
953         this->__sendTileStateRequest();
954     }
955
956     return;
957 } /* 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](#).

```

1048 {
1049     // 1. if just built, call base method and return
1050     if (this->just_built) {
1051         TileImprovement :: draw();
1052
1053         return;
1054     }
1055
1056     // 2. handle upgrade effects
1057     if (this->just_upgraded) {
1058         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1059             this->tile_improvement_sprite_animated[i].setColor(
1060                 sf::Color(
1061                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1062                     255,
1063                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1064                     255
1065                 )
1066             );
1067
1068             this->tile_improvement_sprite_animated[i].setScale(
1069                 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
1080     if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1081         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1082             this->tile_improvement_sprite_animated[i].setColor(
1083                 sf::Color(255,255,255,255)
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
1094 // 3. draw first element of animated sprite
1095 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1096
1097
1098 // 4. draw second element of animated sprite
1099 if (this->is_running) {
1100     this->tile_improvement_sprite_animated[1].rotate(this->rotor_drotation);
1101 }
1102
1103 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1104
1105
1106 // 5. draw storage upgrades
1107 for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1108     this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1109 }
1110
1111
1112 // 6. handle dispatch illustration
1113 if (this->dispatch_MWh > 0) {
1114     this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1115     this->__drawDispatch();
1116 }
1117
1118
1119 // 7. draw production menu
1120 if (this->production_menu_open) {
1121     this->render_window_ptr->draw(this->production_menu_backing);
1122     this->render_window_ptr->draw(this->production_menu_backing_text);
1123
1124     this->__drawProductionMenu();
1125 }
1126
1127
1128 // 8. draw upgrade menu
1129 if (this->upgrade_menu_open) {
1130     this->render_window_ptr->draw(this->upgrade_menu_backing);
1131     this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1132
1133     this->__drawUpgradeOptions();
1134 }
1135
1136
1137 // 9. handle broken effects
1138 if (this->is_broken) {
1139     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1140         this->tile_improvement_sprite_animated[i].setColor(
1141             sf::Color(
1142                 255,
1143                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1144                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1145                 255
1146             )
1147         );
1148     }
1149 }
1150
1151 this->frame++;
1152 return;
1153 } /* 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](#).

```

837 {
838     //          32 char x 17 line console "-----\n";
839     std::string options_substring
840         = "CAPACITY: ";
841     options_substring
842         += std::to_string(this->capacity_kW);
843     options_substring
844         += " kW (level ";
845     options_substring
846         += std::to_string(this->upgrade_level);
847     options_substring
848         += ") \n";
849     options_substring
850         += "PRODUCTION: ";
851     options_substring
852         += std::to_string(this->production_MWh);
853     options_substring
854         += " MWh\n";
855     options_substring
856         += "DISPATCHABLE: ";
857     options_substring
858         += std::to_string(this->dispatchable_MWh);
859     options_substring
860         += " MWh\n";
861     options_substring
862         += "HEALTH: ";
863     options_substring
864         += std::to_string(this->health);
865     options_substring
866         += "/100";
867     if (this->health <= 0) {
868         options_substring
869             += " ** BROKEN! **\n";
870     }
871     else {
872         options_substring
873             += "\n";
874     }
875     options_substring
876         += "
877         **** WIND TURBINE OPTIONS ****
878         \n";
879     if (this->is_broken) {
880         options_substring
881             += " [R]: REPAIR (";
882         options_substring
883             += std::to_string(WIND_TURBINE_BUILD_COST);
884         options_substring
885             += " K)\n";
886     }
887     else {
888         options_substring
889             += " [E]: OPEN PRODUCTION MENU \n";
890     }
891     options_substring
892         += " [U]: OPEN UPGRADE MENU \n";
893     options_substring
894         += "HOLD [P]: SCRAP (";
895     options_substring
896         += std::to_string(SCRAP_COST);
897     options_substring
898         += " K)";
899     return options_substring;
900 } /* getTileOptionsSubstring() */

```

4.15.3.17 processEvent()

```

void WindTurbine::processEvent (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

999 {
1000     TileImprovement :: processEvent();
1001
1002     if (this->event_ptr->type == sf::Event::KeyPressed) {
1003         this->__handleKeyPressEvents();
1004     }
1005
1006     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1007         this->__handleMouseButtonEvents();
1008     }
1009
1010     return;
1011 } /* processEvent() */

```

4.15.3.18 processMessage()

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

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

Reimplemented from [TileImprovement](#).

```
1026 {
1027     TileImprovement :: processMessage();
1028
1029     //...
1030
1031     return;
1032 } /* 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](#).

```
902 {
903     TileImprovement :: setIsSelected(is_selected);
904
905     if (this->is_running and this->is_selected) {
906         this->assets_manager_ptr->getSound("wind turbine running")->play();
907     }
908
909     return;
910 } /* setIsSelected() */
```

4.15.3.20 update()

```
void WindTurbine::update (
    void ) [virtual]
```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
972 {
973     std::cout << "WindTurbine :: update()" << std::endl;
974
975     this->__computeProduction();
976     this->__computeProductionCosts();
977     this->__computeDispatch();
978
979     if (this->is_selected) {
980         this->__sendTileStateRequest();
981     }
982
983     return;
984 } /* 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

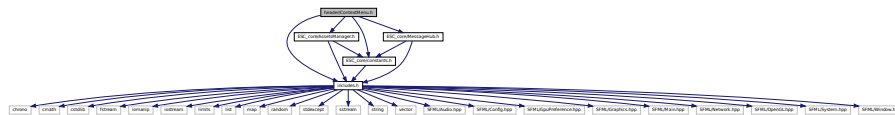
File Documentation

5.1 header/ContextMenu.h File Reference

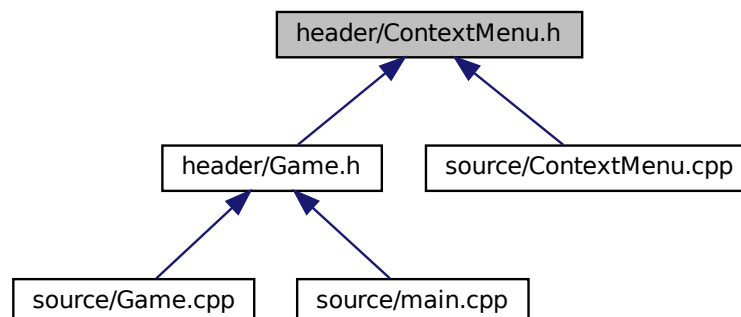
Header file for the [ContextMenu](#) class.

```
#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

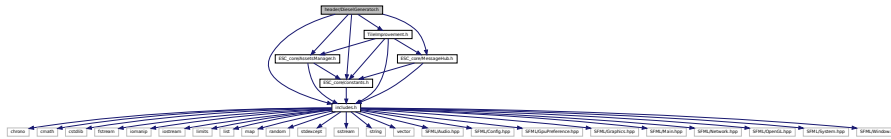
Header file for the [DieselGenerator](#) class.

```

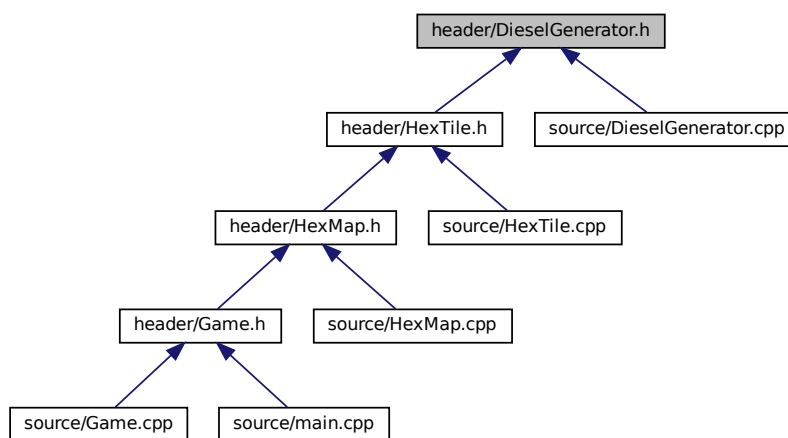
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"

```

```
#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

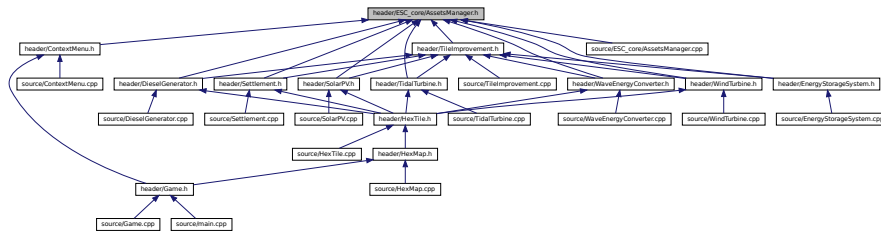
Header file for the [DieselGenerator](#) class.

5.3 header/EnergyStorageSystem.h File Reference

Header file for the [EnergyStorageSystem](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
```


This graph shows which files directly or indirectly include this file:



Classes

- class [AssetsManager](#)
A class which manages visual and sound assets.

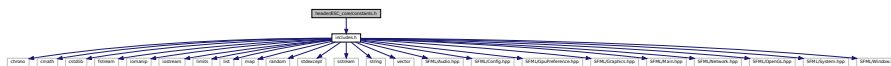
5.4.1 Detailed Description

Header file for the [AssetsManager](#) class.

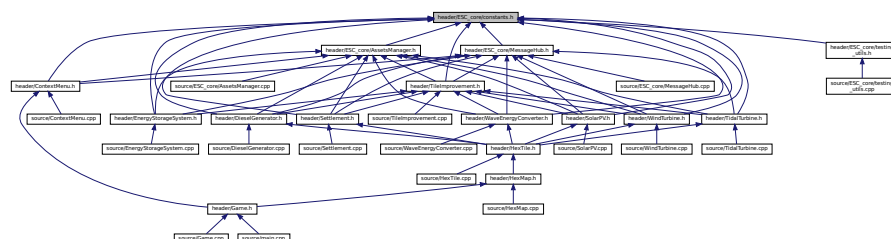
5.5 header/ESC_core/constants.h File Reference

Header file for various constants.

```
#include "includes.h"
Include dependency graph for constants.h:
```



This graph shows which files directly or indirectly include this file:



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` = 100
- The cost of building (or upgrading) a diesel generator in 100 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 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` = 0.0475

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.

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 BUILD_SETTLEMENT_COST

```
const int BUILD_SETTLEMENT_COST = 250
```

The cost of building a settlement.

5.5.3.2 CLEAR_FOREST_COST

```
const int CLEAR_FOREST_COST = 160
```

The cost of clearing a forest tile.

5.5.3.3 CLEAR_MOUNTAINS_COST

```
const int CLEAR_MOUNTAINS_COST = 500
```

The cost of clearing a mountains tile.

5.5.3.4 CLEAR_PLAINS_COST

```
const int CLEAR_PLAINS_COST = 80
```

The cost of clearing a plains tile.

5.5.3.5 COST_PER_LITRE_DIESEL

```
const double COST_PER_LITRE_DIESEL = 1.75
```

The cost of a litre of diesel.

5.5.3.6 CREDITS_PER_MWH_SERVED

```
const double CREDITS_PER_MWH_SERVED = 1.125
```

The number of credits (x1000) earned.

5.5.3.7 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 $(24)(\text{power capacity [kW]}) / 1000$. The tides are not a random process (usually semi-diurnal, mostly driven by orbits of moon and sun).

5.5.3.8 DIESEL_GENERATOR_BUILD_COST

```
const int DIESEL_GENERATOR_BUILD_COST = 100
```

The cost of building (or upgrading) a diesel generator in 100 kW increments.

5.5.3.9 DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION

```
const double DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenace cost of running a diesel generator (assumed 0.05 credits per kWh produced).

5.5.3.10 EMISSIONS_LIFETIME_LIMIT_TONNES

```
const int EMISSIONS_LIFETIME_LIMIT_TONNES = 2000
```

The lifetime limit on CO2-equivalent emissions (1 tonne CO2e \sim 667 L diesel).

5.5.3.11 ENERGY_STORAGE_SYSTEM_BUILD_COST

```
const int ENERGY_STORAGE_SYSTEM_BUILD_COST = 160
```

The cost of adding energy storage in 200 kWh increments.

5.5.3.12 FLOAT_TOLERANCE

```
const double FLOAT_TOLERANCE = 1e-6
```

Tolerance for floating point equality tests.

5.5.3.13 FRAMES_PER_SECOND

```
const int FRAMES_PER_SECOND = 60
```

Target frames per second.

5.5.3.14 GAME_CHANNEL

```
const std::string GAME_CHANNEL = "GAME CHANNEL"
```

A message channel for game messages.

5.5.3.15 GAME_HEIGHT

```
const int GAME_HEIGHT = 800
```

Height of the game space.

5.5.3.16 GAME_STATE_CHANNEL

```
const std::string GAME_STATE_CHANNEL = "GAME STATE CHANNEL"
```

A message channel for game state messages.

5.5.3.17 GAME_WIDTH

```
const int GAME_WIDTH = 1200
```

Width of the game space.

5.5.3.18 HEX_MAP_CHANNEL

```
const std::string HEX_MAP_CHANNEL = "HEX MAP CHANNEL"
```

A message channel for hex map messages.

5.5.3.19 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.

5.5.3.20 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).

5.5.3.21 MAX_STORAGE_LEVELS

```
const int MAX_STORAGE_LEVELS = 5
```

The maximum storage level of any tile improvement.

5.5.3.22 MAX_UPGRADE_LEVELS

```
const int MAX_UPGRADE_LEVELS = 5
```

The maximum upgrade level of any tile improvement.

5.5.3.23 MAXIMUM_DAILY_DEMAND_PER_CAPITA

```
const double MAXIMUM_DAILY_DEMAND_PER_CAPITA = 0.0475
```

The maximum daily demand [MWh] (at any point in the year) per capita.

5.5.3.24 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)(max load [kW]) / 1000.

5.5.3.25 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.

5.5.3.26 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.

5.5.3.27 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.

5.5.3.28 MEAN_POPULATION_GROWTH_RATE

```
const double MEAN_POPULATION_GROWTH_RATE = 0.020
```

The mean monthly population growth rate.

5.5.3.29 NO_TILE_SELECTED_CHANNEL

```
const std::string NO_TILE_SELECTED_CHANNEL = "NO TILE SELECTED CHANNEL"
```

A message channel for no tile selected messages.

5.5.3.30 RESOURCE_ASSESSMENT_COST

```
const int RESOURCE_ASSESSMENT_COST = 20
```

The cost of doing a resource assessment.

5.5.3.31 SCRAP_COST

```
const int SCRAP_COST = 50
```

The cost of scrapping a tile improvement (other than settlement).

5.5.3.32 SECONDS_PER_FRAME

```
const double SECONDS_PER_FRAME = 1.0 / 60
```

Target seconds per frame (just reciprocal of target frames per second).

5.5.3.33 SECONDS_PER_MONTH

```
const unsigned long long int SECONDS_PER_MONTH = 2628164
```

5.5.3.34 SECONDS_PER_YEAR

```
const unsigned long long int SECONDS_PER_YEAR = 31537970
```

5.5.3.35 SETTLEMENT_CHANNEL

```
const std::string SETTLEMENT_CHANNEL = "SETTLEMENT CHANNEL"
```

A message channel for the settlement.

5.5.3.36 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).

5.5.3.37 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.

5.5.3.38 SOLAR_PV_WATER_BUILD_MULTIPLIER

```
const double SOLAR_PV_WATER_BUILD_MULTIPLIER = 1.285714
```

The additional cost of building on water.

5.5.3.39 STARTING_CREDITS

```
const int STARTING_CREDITS = 800
```

The starting balance of credits.

5.5.3.40 STARTING_POPULATION

```
const int STARTING_POPULATION = 100
```

The starting population of a settlement.

5.5.3.41 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.

5.5.3.42 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.

5.5.3.43 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.

5.5.3.44 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.

5.5.3.45 STDEV_POPULATION_GROWTH_RATE

```
const double STDEV_POPULATION_GROWTH_RATE = 0.005
```

The standard deviation in monthly population growth rate.

5.5.3.46 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).

5.5.3.47 TIDAL_TURBINE_BUILD_COST

```
const int TIDAL_TURBINE_BUILD_COST = 550
```

The cost of building (or upgrading) a tidal turbine in 100 kW increments.

5.5.3.48 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).

5.5.3.49 TILE_SELECTED_CHANNEL

```
const std::string TILE_SELECTED_CHANNEL = "TILE SELECTED CHANNEL"
```

A message channel for tile selection messages.

5.5.3.50 TILE_STATE_CHANNEL

```
const std::string TILE_STATE_CHANNEL = "TILE STATE CHANNEL"
```

A message channel for tile state messages.

5.5.3.51 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).

5.5.3.52 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.

5.5.3.53 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).

5.5.3.54 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).

5.5.3.55 WIND_TURBINE_BUILD_COST

```
const int WIND_TURBINE_BUILD_COST = 450
```

The cost of building (or upgrading) a wind turbine in 100 kW increments.

5.5.3.56 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

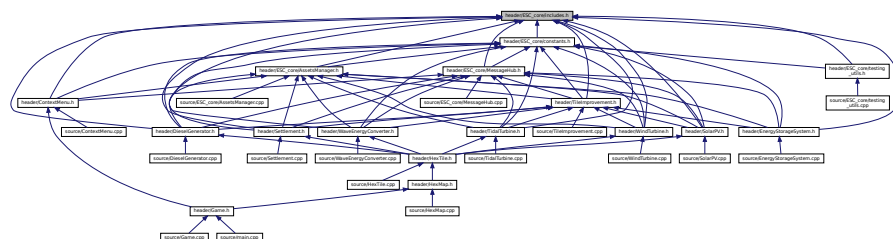
Header file for various includes.

```
#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

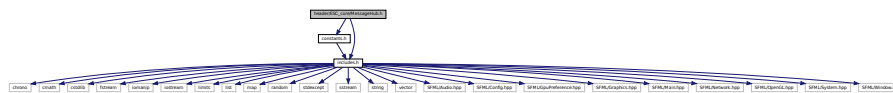
Header file for various includes.

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

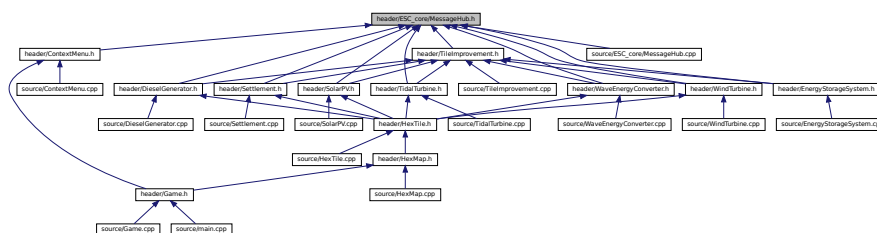
5.8 header/ESC_core/MessageHub.h File Reference

Header file for the [MessageHub](#) class.

```
#include "constants.h"
#include "includes.h"
Include dependency graph for MessageHub.h:
```



This graph shows which files directly or indirectly include this file:



Classes

- struct [Message](#)
A structure which defines a standard message format.
- class [MessageHub](#)
A class which acts as a central hub for inter-object message traffic.

5.8.1 Detailed Description

Header file for the [MessageHub](#) class.

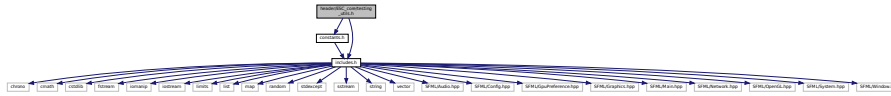
5.9 header/ESC_core/testing_utils.h File Reference

Header file for various testing utilities.

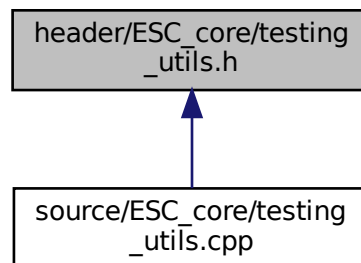
```
#include "constants.h"
```

```
#include "includes.h"
```

Include dependency graph for testing_utils.h:



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 " <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() */

```

5.9.2.6 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.
<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() */

```

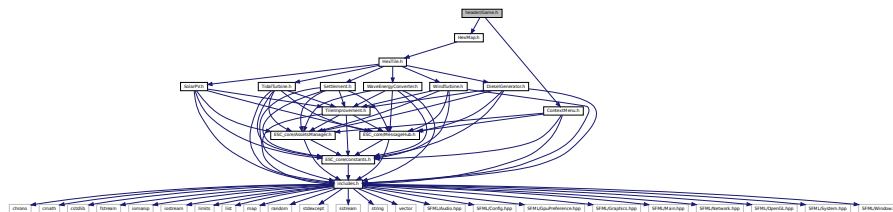
5.10 header/Game.h File Reference

```

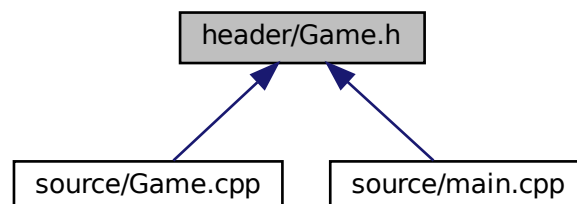
#include "HexMap.h"
#include "ContextMenu.h"

```

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.

Enumerations

- enum [GamePhase](#) {
[BUILD_SETTLEMENT](#) , [SYSTEM_MANAGEMENT](#) , [LOSS_EMISSIONS](#) , [LOSS_DEMAND](#) ,
[LOSS_CREDITS](#) , [VICTORY](#) , [N_GAME_PHASES](#) }

An enumeration of the various game phases.

5.10.1 Enumeration Type Documentation

5.10.1.1 GamePhase

enum [GamePhase](#)

An enumeration of the various game phases.

Enumerator

BUILD_SETTLEMENT	The settlement building phase.
SYSTEM_MANAGEMENT	The system management phase (main phase of play).
LOSS_EMISSIONS	A loss due to excessive emissions.
LOSS_DEMAND	A loss due to failing to meet the demand.
LOSS_CREDITS	A loss due to running out of credits.
VICTORY	A victory (12 consecutive months of zero emissions).
N_GAME_PHASES	A simple hack to get the number of elements in GamePhase.

```

66         {
67     BUILD_SETTLEMENT,
68     SYSTEM_MANAGEMENT,
69     LOSS_EMISSIONS,
70     LOSS_DEMAND,
71     LOSS_CREDITS,
72     VICTORY,
73     N_GAME_PHASES
74 };  /* GamePhase */

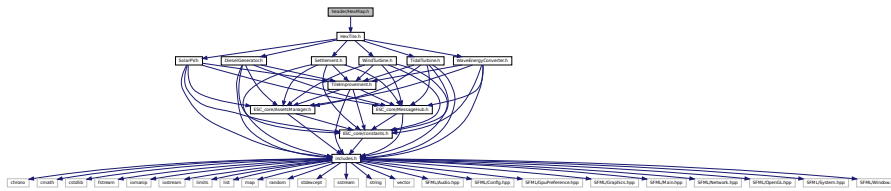
```

5.11 header/HexMap.h File Reference

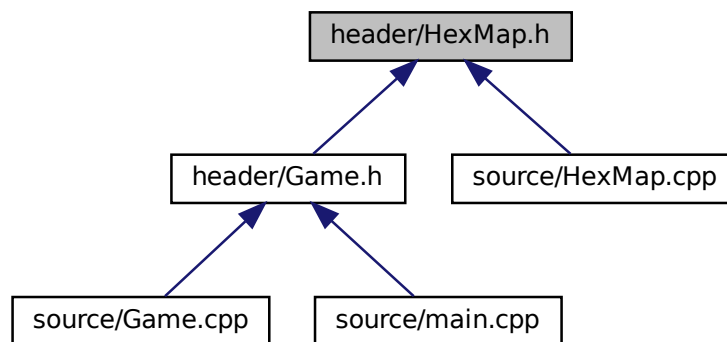
Header file for the [HexMap](#) class.

```
#include "HexTile.h"
```

Include dependency graph for HexMap.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [HexMap](#)

A class which defines a hex map of hex tiles.

5.11.1 Detailed Description

Header file for the [HexMap](#) class.

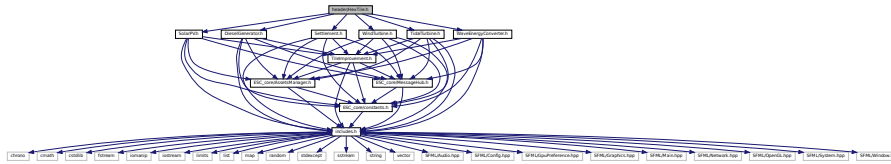
5.12 header/HexTile.h File Reference

Header file for the [Game](#) class.

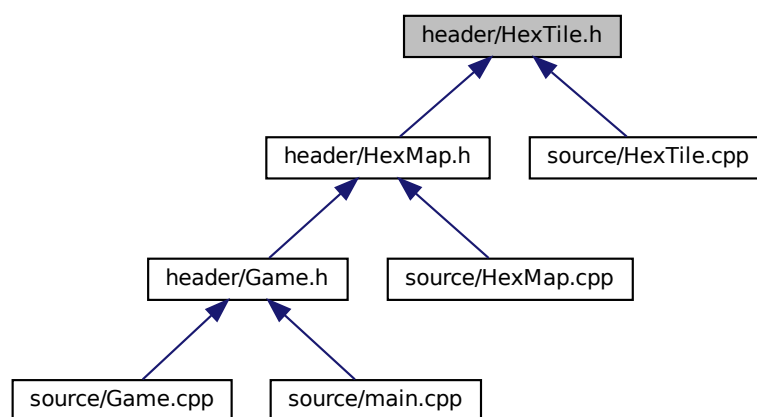
```
#include "DieselGenerator.h"
#include "Settlement.h"
#include "SolarPV.h"
#include "TidalTurbine.h"
#include "WaveEnergyConverter.h"
```

```
#include "WindTurbine.h"
```

Include dependency graph for HexTile.h:



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 */

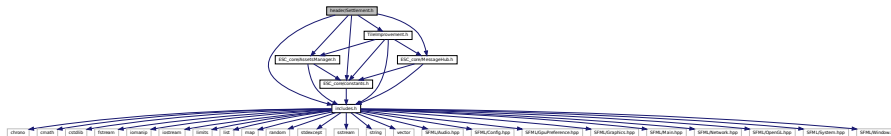
```

5.13 header/Settlement.h File Reference

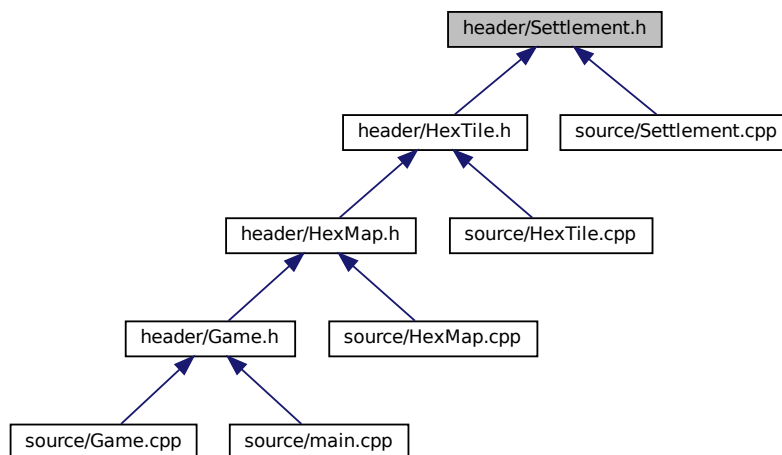
Header file for the [Settlement](#) class.

```
#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

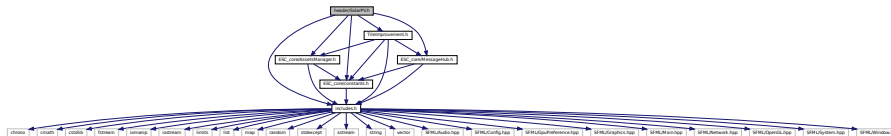
Header file for the [Settlement](#) class.

5.14 header/SolarPV.h File Reference

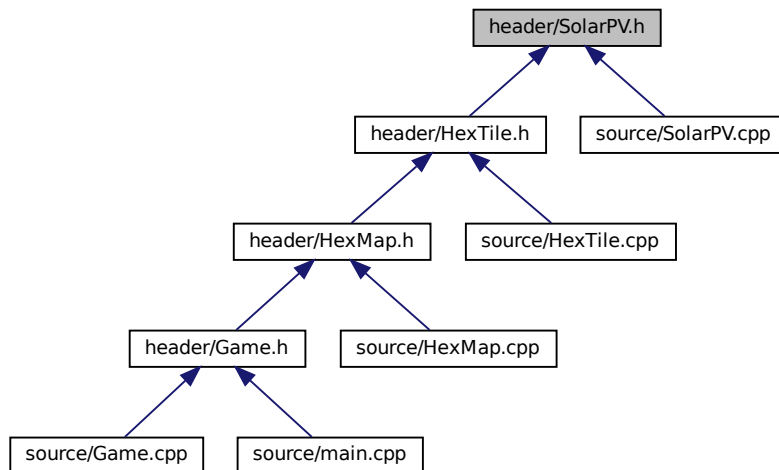
Header file for the [SolarPV](#) class.

```
#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

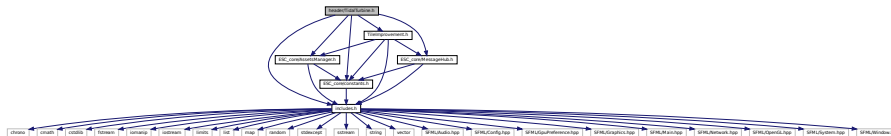
Header file for the [SolarPV](#) class.

5.15 header/TidalTurbine.h File Reference

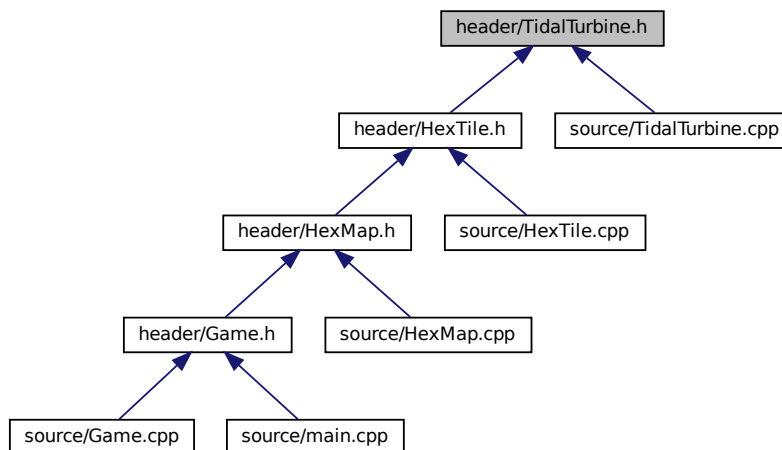
Header file for the [TidalTurbine](#) class.

```
#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](#)).

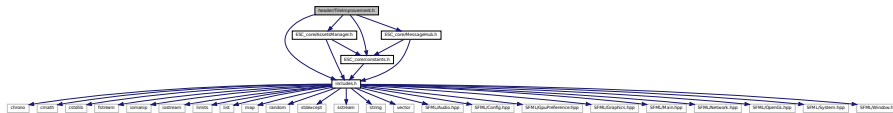
5.15.1 Detailed Description

Header file for the [TidalTurbine](#) class.

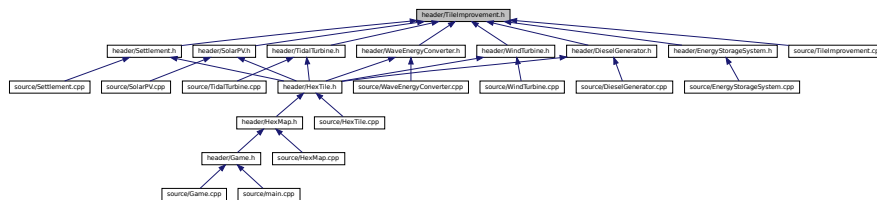
5.16 header/TileImprovement.h File Reference

Header file for the [TileImprovement](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.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

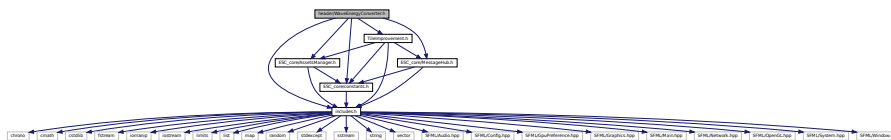
Header file for the [WaveEnergyConverter](#) class.

```

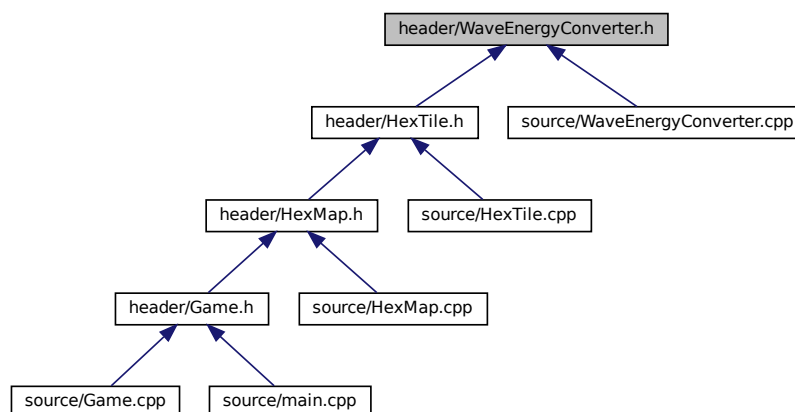
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"

```

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

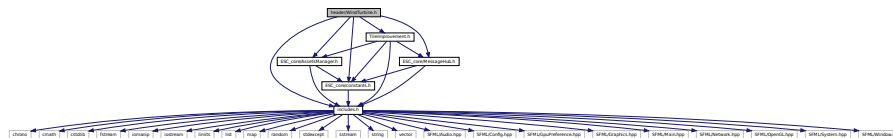
Header file for the [WaveEnergyConverter](#) class.

5.18 header/WindTurbine.h File Reference

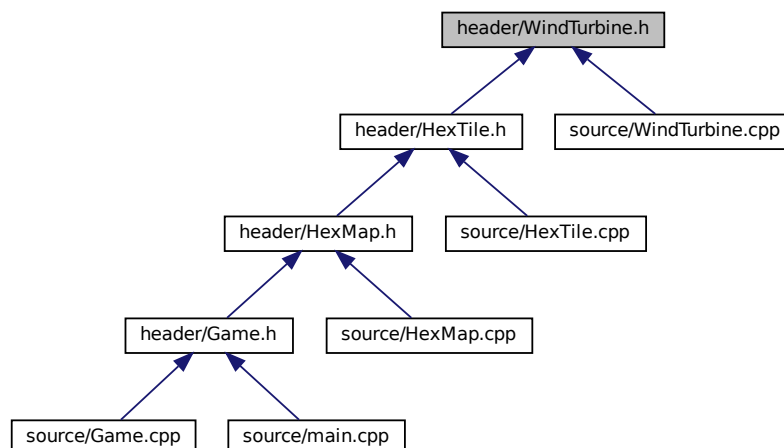
Header file for the [WindTurbine](#) class.

```
#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](#)).

5.23.1 Detailed Description

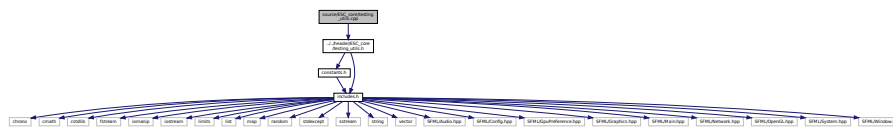
Implementation file for the `MessageHub` class.

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

5.24 source/ESC_core/testing_utils.cpp File Reference

Implementation file for various testing utilities.

```
#include "../..header/ESC_core/testing_utils.h"
Include dependency graph for testing_utils.cpp:
```



Functions

- void `printGreen` (std::string input_str)
A function that sends green text to std::cout.
- void `printGold` (std::string input_str)
A function that sends gold text to std::cout.
- void `printRed` (std::string input_str)
A function that sends red text to std::cout.
- 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`).
- void `testGreaterThan` (double x, double y, std::string file, int line)
Tests if $x > y$.
- void `testGreaterThanOrEqualTo` (double x, double y, std::string file, int line)
Tests if $x \geq y$.
- void `testLessThan` (double x, double y, std::string file, int line)
Tests if $x < y$.
- void `testLessThanOrEqualTo` (double x, double y, std::string file, int line)
Tests if $x \leq y$.
- void `testTruth` (bool statement, std::string file, int line)
Tests if the given statement is true.
- 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.

5.24.1 Detailed Description

Implementation file for various testing utilities.

This is a library of utility functions used throughout the various test suites.

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 << "\x1B[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 << "\x1B[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__").

```

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\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() */

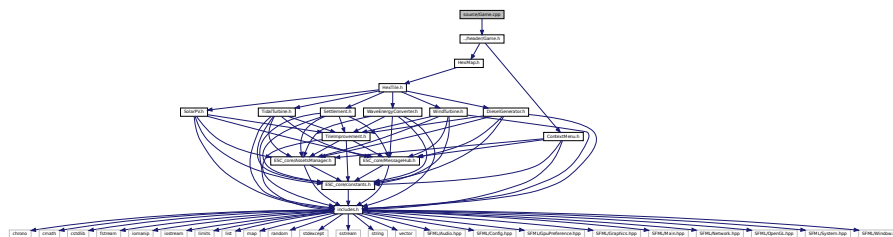
```

5.25 source/Game.cpp File Reference

Implementation file for the `Game` class.

```
#include "../header/Game.h"
```

Include dependency graph for Game.cpp:



5.25.1 Detailed Description

Implementation file for the `Game` class.

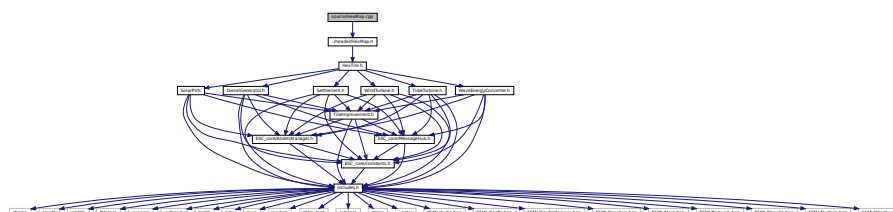
A class which defines a tile of a hex map.

5.26 source/HexMap.cpp File Reference

Implementation file for the [HexMap](#) class.

```
#include "../header/HexMap.h"
```

Include dependency graph for HexMap.cpp:



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.

```
339 {
340     sf::RenderWindow* render_window_ptr = new sf::RenderWindow(
341         sf::VideoMode(GAME_WIDTH, GAME_HEIGHT),
342         "Road To Zero"
343     );
344
345     return render_window_ptr;
346 } /* 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     // 2. load tile sheets
72     assets_manager_ptr->loadTexture(
73         "assets/tile_sheets/pine_tree_64x64_1_CC-BY.png",
74         "pine_tree_64x64_1"
75     );
76
77     assets_manager_ptr->loadTexture(
78         "assets/tile_sheets/wheat_64x64_1_CC-BY.png",
79         "wheat_64x64_1"
80     );
81
82     assets_manager_ptr->loadTexture(
83         "assets/tile_sheets/mountain_64x64_1_CC-BY.png",
84         "mountain_64x64_1"
```

```

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
306     // 4. load tracks
307     assets_manager_ptr->loadTrack(
308         "assets/audio/tracks/TreeStarMoon_Dobranoc_CC0.ogg",
309         "Tree Star Moon - Dobranoc"
310     );
311
312     assets_manager_ptr->loadTrack(
313         "assets/audio/tracks/TreeStarMoon_Lighthouse_CC0.ogg",
314         "Tree Star Moon - Lighthouse"
315     );
316
317     assets_manager_ptr->loadTrack(
318         "assets/audio/tracks/TreeStarMoon_SkyFarm_CC0.ogg",
319         "Tree Star Moon - Sky Farm"
320     );
321
322     return;
323 } /* 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();

```

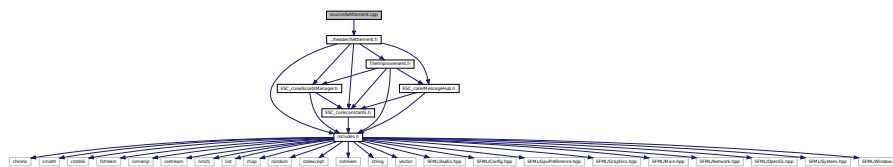
```
362
363 // 3. start game loop
364 bool quit_game = false;
365 assets_manager.playTrack();
366
367 while (not quit_game) {
368     Game game(render_window_ptr, &assets_manager);
369     quit_game = game.run();
370 }
371
372 // 4. clean up
373 render_window_ptr->close();
374 delete render_window_ptr;
375
376 return 0;
377 } /* main() */
```

5.29 source/Settlement.cpp File Reference

Implementation file for the **Settlement** class.

```
#include "../header/Settlement.h"
```

Include dependency graph for Settlement.cpp:



5.29.1 Detailed Description

Implementation file for the **Settlement** class.

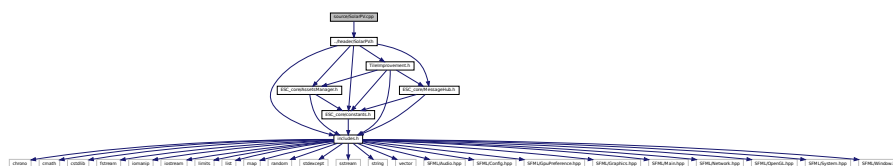
A base class for the tile improvement hierarchy.

5.30 source/SolarPV.cpp File Reference

Implementation file for the **SolarPV** class.

```
#include "../header/SolarPV.h"
```

Include dependency graph for SolarPV.cpp:



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Index

- __advanceTurn
 - Game, [65](#)
- __assembleHexMap
 - HexMap, [96](#)
- __assessNeighbours
 - HexMap, [96](#)
- __breakdown
 - DieselGenerator, [41](#)
 - SolarPV, [187](#)
 - TidalTurbine, [204](#)
 - TileImprovement, [224](#)
 - WaveEnergyConverter, [246](#)
 - WindTurbine, [264](#)
- __buildDieselGenerator
 - HexTile, [124](#)
- __buildDrawOrderVector
 - HexMap, [97](#)
- __buildEnergyStorage
 - HexTile, [125](#)
- __buildSettlement
 - HexTile, [126](#)
- __buildSolarPV
 - HexTile, [126](#)
- __buildTidalTurbine
 - HexTile, [127](#)
- __buildWaveEnergyConverter
 - HexTile, [127](#)
- __buildWindTurbine
 - HexTile, [128](#)
- __checkTerminatingConditions
 - Game, [66](#)
- __clearDecoration
 - HexTile, [129](#)
- __closeBuildMenu
 - HexTile, [129](#)
- __closeProductionMenu
 - TileImprovement, [225](#)
- __closeUpgradeMenu
 - TileImprovement, [225](#)
- __computeCapacityFactors
 - SolarPV, [187](#)
 - TidalTurbine, [205](#)
 - WaveEnergyConverter, [247](#)
 - WindTurbine, [265](#)
- __computeCurrentDemand
 - Game, [66](#)
- __computeDispatch
 - SolarPV, [188](#)
 - TidalTurbine, [205](#)
 - WaveEnergyConverter, [247](#)
 - WindTurbine, [265](#)
- __computeProduction
 - SolarPV, [189](#)
 - TidalTurbine, [206](#)
 - WaveEnergyConverter, [248](#)
 - WindTurbine, [266](#)
- __computeProductionCosts
 - DieselGenerator, [41](#)
 - SolarPV, [189](#)
 - TidalTurbine, [206](#)
 - WaveEnergyConverter, [249](#)
 - WindTurbine, [267](#)
- __draw
 - Game, [67](#)
- __drawConsoleScreenFrame
 - ContextMenu, [22](#)
- __drawConsoleText
 - ContextMenu, [23](#)
- __drawDispatch
 - TileImprovement, [225](#)
- __drawFrameClockOverlay
 - Game, [68](#)
- __drawHUD
 - Game, [68](#)
- __drawLossCredits
 - Game, [70](#)
- __drawLossDemand
 - Game, [71](#)
- __drawLossEmissions
 - Game, [71](#)
- __drawProductionMenu
 - DieselGenerator, [41](#)
 - SolarPV, [189](#)
 - TidalTurbine, [206](#)
 - WaveEnergyConverter, [249](#)
 - WindTurbine, [267](#)
- __drawTotalDispatch
 - HexMap, [97](#)
- __drawTurnAdvanceBanner
 - Game, [72](#)
- __drawTurnSummary
 - Game, [73](#)
- __drawUpgradeOptions
 - SolarPV, [190](#)
 - TidalTurbine, [207](#)
 - WaveEnergyConverter, [250](#)
 - WindTurbine, [268](#)
- __drawVictory

- Game, 74
- __drawVisualScreenFrame
 - ContextMenu, 24
- __enforceOceanContinuity
 - HexMap, 99
- __getMajorityTileType
 - HexMap, 100
- __getNeighboursVector
 - HexMap, 101
- __getNoise
 - HexMap, 101
- __getSelectedTile
 - HexMap, 103
- __getTileCoordsSubstring
 - HexTile, 130
- __getTileImprovementSubstring
 - HexTile, 130
- __getTileOptionsSubstring
 - HexTile, 130
- __getTileResourceSubstring
 - HexTile, 132
- __getTileTypeSubstring
 - HexTile, 133
- __getValidMapIndexPositions
 - HexMap, 103
- __handleImprovementStateMessage
 - Game, 74
- __handleKeyPressEvents
 - ContextMenu, 24
 - DieselGenerator, 42
 - EnergyStorageSystem, 55
 - Game, 75
 - HexMap, 104
 - HexTile, 133
 - Settlement, 177
 - SolarPV, 191
 - TidalTurbine, 209
 - TileImprovement, 226
 - WaveEnergyConverter, 251
 - WindTurbine, 269
- __handleKeyReleaseEvents
 - HexTile, 137
- __handleMouseButtonEvents
 - ContextMenu, 25
 - DieselGenerator, 43
 - EnergyStorageSystem, 55
 - Game, 75
 - HexMap, 105
 - HexTile, 138
 - Settlement, 178
 - SolarPV, 192
 - TidalTurbine, 210
 - TileImprovement, 227
 - WaveEnergyConverter, 252
 - WindTurbine, 270
- __insufficientCreditsAlarm
 - Game, 76
- __isClicked
 - HexTile, 139
- __isLakeTouchingOcean
 - HexMap, 105
- __layTiles
 - HexMap, 106
- __loadSoundBuffer
 - AssetsManager, 9
- __logSettlementPosition
 - HexMap, 108
- __openBuildMenu
 - HexTile, 139
- __openProductionMenu
 - TileImprovement, 227
- __openUpgradeMenu
 - TileImprovement, 227
- __procedurallyGenerateTileResources
 - HexMap, 108
- __procedurallyGenerateTileTypes
 - HexMap, 109
- __processEvent
 - Game, 77
- __processMessage
 - Game, 77
- __repair
 - DieselGenerator, 44
 - SolarPV, 193
 - TidalTurbine, 210
 - TileImprovement, 228
 - WaveEnergyConverter, 252
 - WindTurbine, 270
- __scrapImprovement
 - HexTile, 139
- __sendAssessNeighboursMessage
 - HexTile, 140
- __sendCreditsEarnedMessage
 - Game, 79
- __sendCreditsSpentMessage
 - HexTile, 141
 - TileImprovement, 228
- __sendGameStateMessage
 - Game, 79
- __sendGameStateRequest
 - HexTile, 141
 - TileImprovement, 229
- __sendImprovementStateMessage
 - DieselGenerator, 44
 - SolarPV, 193
 - TidalTurbine, 210
 - WaveEnergyConverter, 253
 - WindTurbine, 271
- __sendInsufficientCreditsMessage
 - HexTile, 141
 - TileImprovement, 229
- __sendNoTileSelectedMessage
 - HexMap, 110
- __sendQuitGameMessage
 - ContextMenu, 25
- __sendRestartGameMessage

- ContextMenu, 25
- __sendTileSelectedMessage
 - HexTile, 142
- __sendTileStateMessage
 - HexTile, 142
- __sendTileStateRequest
 - TileImprovement, 229
- __sendTurnAdvanceMessage
 - Game, 80
- __sendUpdateGamePhaseMessage
 - HexTile, 142
- __setConsoleState
 - ContextMenu, 26
- __setConsoleString
 - ContextMenu, 26
- __setIsSelected
 - HexTile, 143
- __setResourceText
 - HexTile, 143
- __setUpBuildMenu
 - HexTile, 144
- __setUpBuildOption
 - HexTile, 145
- __setUpCoinSprite
 - Settlement, 178
- __setUpConsoleScreen
 - ContextMenu, 27
- __setUpConsoleScreenFrame
 - ContextMenu, 27
- __setUpDieselGeneratorBuildOption
 - HexTile, 146
- __setUpDispatchIllustration
 - TileImprovement, 229
- __setUpEnergyStorageSystemBuildOption
 - HexTile, 147
- __setUpGlassScreen
 - HexMap, 110
- __setUpMagnifyingGlassSprite
 - HexTile, 147
- __setUpMenuFrame
 - ContextMenu, 29
- __setUpNodeSprite
 - HexTile, 147
- __setUpProductionMenu
 - EnergyStorageSystem, 56
 - TileImprovement, 230
- __setUpResourceChipSprite
 - HexTile, 148
- __setUpSelectOutlineSprite
 - HexTile, 148
- __setUpSolarPVBuildOption
 - HexTile, 148
- __setUpTidalTurbineBuildOption
 - HexTile, 149
- __setUpTileExplosionReel
 - HexTile, 149
- __setUpTileImprovementSpriteAnimated
 - DieselGenerator, 44
- TidalTurbine, 211
- WaveEnergyConverter, 253
- WindTurbine, 271
- __setUpTileImprovementSpriteStatic
 - EnergyStorageSystem, 56
 - Settlement, 178
 - SolarPV, 194
- __setUpTileSprite
 - HexTile, 150
- __setUpUpgradeMenu
 - TileImprovement, 230
- __setUpVisualScreen
 - ContextMenu, 30
- __setUpVisualScreenFrame
 - ContextMenu, 30
- __setUpWaveEnergyConverterBuildOption
 - HexTile, 150
- __setUpWindTurbineBuildOption
 - HexTile, 151
- __smoothTileTypes
 - HexMap, 110
- __summarizeTurn
 - Game, 81
- __toggleFrameClockOverlay
 - Game, 82
- __updatePopulation
 - Game, 82
- __upgrade
 - DieselGenerator, 45
 - EnergyStorageSystem, 56
- __upgradePowerCapacity
 - SolarPV, 194
 - TidalTurbine, 211
 - WaveEnergyConverter, 254
 - WindTurbine, 272
- __upgradeStorageCapacity
 - TileImprovement, 231
- ~AssetsManager
 - AssetsManager, 8
- ~ContextMenu
 - ContextMenu, 22
- ~DieselGenerator
 - DieselGenerator, 41
- ~EnergyStorageSystem
 - EnergyStorageSystem, 54
- ~Game
 - Game, 65
- ~HexMap
 - HexMap, 95
- ~HexTile
 - HexTile, 124
- ~MessageHub
 - MessageHub, 168
- ~Settlement
 - Settlement, 177
- ~SolarPV
 - SolarPV, 187
- ~TidalTurbine

- TidalTurbine, 204
- ~TileImprovement
 - TileImprovement, 224
- ~WaveEnergyConverter
 - WaveEnergyConverter, 246
- ~WindTurbine
 - WindTurbine, 264
- ABOVE_AVERAGE
 - HexTile.h, 312
- addChannel
 - MessageHub, 168
- advanceTurn
 - DieselGenerator, 45
 - SolarPV, 195
 - TidalTurbine, 212
 - TileImprovement, 232
 - WaveEnergyConverter, 254
 - WindTurbine, 272
- assess
 - HexMap, 111
 - HexTile, 151
- assets_manager_ptr
 - ContextMenu, 33
 - Game, 84
 - HexMap, 115
 - HexTile, 158
 - TileImprovement, 236
- 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, 312
- BELOW_AVERAGE
 - HexTile.h, 312
- bobbing_y
 - TidalTurbine, 217
 - WaveEnergyConverter, 259
- bool_payload
 - Message, 165
- border_tiles_vec
 - HexMap, 115
- build_menu_backing
 - HexTile, 158
- build_menu_backing_text
 - HexTile, 159
- build_menu_open
 - HexTile, 159
- build_menu_options_text_vec
 - HexTile, 159
- build_menu_options_vec
 - HexTile, 159
- BUILD_SETTLEMENT
 - Game.h, 309
- BUILD_SETTLEMENT_COST
 - constants.h, 289
- capacity_factor_vec
 - SolarPV, 199
 - TidalTurbine, 217
 - WaveEnergyConverter, 259
 - WindTurbine, 277
- capacity_kW
 - DieselGenerator, 50
 - SolarPV, 199
 - TidalTurbine, 217
 - WaveEnergyConverter, 259
 - WindTurbine, 277
- capacity_MWh
 - EnergyStorageSystem, 59
- channel
 - Message, 165
- charge_MWh
 - EnergyStorageSystem, 59
- check_terminating_conditions
 - Game, 84
- clear
 - AssetsManager, 10
 - HexMap, 111
 - MessageHub, 169
- CLEAR_FOREST_COST
 - constants.h, 289
- CLEAR_MOUNTAINS_COST
 - constants.h, 289
- CLEAR_PLAINS_COST
 - constants.h, 290
- clearMessages
 - MessageHub, 169
- clock
 - Game, 85
- coin_sprite
 - Settlement, 182
- consecutive_zero_emissions_months
 - Game, 85

- 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, [280](#)
- constants.h
 - BUILD_SETTLEMENT_COST, [289](#)
 - CLEAR_FOREST_COST, [289](#)
 - CLEAR_MOUNTAINS_COST, [289](#)
 - CLEAR_PLAINS_COST, [290](#)
 - COST_PER_LITRE_DIESEL, [290](#)
 - CREDITS_PER_MWH_SERVED, [290](#)
 - DAILY_TIDAL_CAPACITY_FACTOR, [290](#)
 - DIESEL_GENERATOR_BUILD_COST, [290](#)
 - DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION, [290](#)
 - EMISSIONS_LIFETIME_LIMIT_TONNES, [291](#)
 - ENERGY_STORAGE_SYSTEM_BUILD_COST, [291](#)
 - FLOAT_TOLERANCE, [291](#)
 - FOREST_GREEN, [287](#)
 - FRAMES_PER_SECOND, [291](#)
 - GAME_CHANNEL, [291](#)
 - GAME_HEIGHT, [291](#)
 - GAME_STATE_CHANNEL, [292](#)
 - GAME_WIDTH, [292](#)
 - HEX_MAP_CHANNEL, [292](#)
 - KG_CO2E_PER_LITRE_DIESEL, [292](#)
 - LAKE_BLUE, [287](#)
 - LITRES_DIESEL_PER_MWH_PRODUCTION, [292](#)
 - MAX_STORAGE_LEVELS, [292](#)
 - MAX_UPGRADE_LEVELS, [293](#)
 - MAXIMUM_DAILY_DEMAND_PER_CAPITA, [293](#)
 - MEAN_DAILY_DEMAND_RATIOS, [293](#)
 - MEAN_DAILY_SOLAR_CAPACITY_FACTORS, [293](#)
 - MEAN_DAILY_WAVE_CAPACITY_FACTORS, [293](#)
 - MEAN_DAILY_WIND_CAPACITY_FACTORS, [294](#)
 - MEAN_POPULATION_GROWTH_RATE, [294](#)
 - MENU_FRAME_GREY, [287](#)
 - MONOCHROME_SCREEN_BACKGROUND, [287](#)
 - MONOCHROME_TEXT_AMBER, [287](#)
 - MONOCHROME_TEXT_GREEN, [288](#)
 - MONOCHROME_TEXT_RED, [288](#)
 - MOUNTAINS_GREY, [288](#)
 - NO_TILE_SELECTED_CHANNEL, [294](#)
 - OCEAN_BLUE, [288](#)
 - PLAINS_YELLOW, [288](#)
 - RESOURCE_ASSESSMENT_COST, [294](#)
 - RESOURCE_CHIP_GREY, [289](#)
 - SCRAP_COST, [294](#)
 - SECONDS_PER_FRAME, [295](#)
 - SECONDS_PER_MONTH, [295](#)
 - SECONDS_PER_YEAR, [295](#)
 - SETTLEMENT_CHANNEL, [295](#)
 - SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION, [295](#)
 - SOLAR_PV_BUILD_COST, [295](#)
 - SOLAR_PV_WATER_BUILD_MULTIPLIER, [296](#)
 - STARTING_CREDITS, [296](#)
 - STARTING_POPULATION, [296](#)
 - STDEV_DAILY_DEMAND_RATIOS, [296](#)
 - STDEV_DAILY_SOLAR_CAPACITY_FACTORS, [296](#)
 - STDEV_DAILY_WAVE_CAPACITY_FACTORS, [297](#)
 - STDEV_DAILY_WIND_CAPACITY_FACTORS, [297](#)
 - STDEV_POPULATION_GROWTH_RATE, [297](#)
 - TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION, [297](#)
 - TIDAL_TURBINE_BUILD_COST, [298](#)
 - TILE_RESOURCE_CUMULATIVE_PROBABILITIES, [298](#)
 - TILE_SELECTED_CHANNEL, [298](#)
 - TILE_STATE_CHANNEL, [298](#)
 - TILE_TYPE_CUMULATIVE_PROBABILITIES, [298](#)
 - VISUAL_SCREEN_FRAME_GREY, [289](#)
 - WAVE_ENERGY_CONVERTER_BUILD_COST, [299](#)
 - WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION, [299](#)
 - WIND_OP_MAINT_COST_PER_MWH_PRODUCTION, [299](#)
 - WIND_TURBINE_BUILD_COST, [299](#)
 - WIND_TURBINE_WATER_BUILD_MULTIPLIER, [299](#)
- constructRenderWindow
 - main.cpp, [329](#)
- context_menu_ptr
 - Game, [85](#)
- 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, 280
 - MENU, 280
 - N_CONSOLE_STATES, 280
 - NONE_STATE, 280
 - READY, 280
 - TILE, 280
- COST_PER_LITRE_DIESEL
 - constants.h, 290
- credits
 - Game, 85
 - HexTile, 159
 - TileImprovement, 236
- CREDITS_PER_MWH_SERVED
 - constants.h, 290
- cumulative_emissions_tonnes
 - Game, 85
- current_track
 - AssetsManager, 18
- DAILY_TIDAL_CAPACITY_FACTOR
 - constants.h, 290
- decorateTile
 - HexTile, 152
- decoration_cleared
 - HexTile, 159
- demand_MWh
 - Game, 85
 - HexMap, 115
 - TileImprovement, 236
- demand_remaining_MWh
 - Game, 86
- demand_served_MWh
 - Game, 86
- demand_vec_MWh
 - Game, 86
 - TileImprovement, 236
- DIESEL_GENERATOR
 - TileImprovement.h, 317
- DIESEL_GENERATOR_BUILD_COST
 - constants.h, 290
- DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION
 - constants.h, 290
- 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, 50
 - processEvent, 49
 - processMessage, 49
 - production_MWh, 51
 - setIsSelected, 49
 - smoke_da, 51
 - smoke_dx, 51
 - smoke_dy, 51
 - smoke_prob, 51
 - smoke_sprite_list, 51
- dispatch_backing
 - TileImprovement, 236
- dispatch_income
 - Game, 86
- dispatch_MWh
 - SolarPV, 199
 - TidalTurbine, 217
 - WaveEnergyConverter, 259
 - WindTurbine, 277
- dispatch_text
 - TileImprovement, 236
- dispatch_vec_MWh

- SolarPV, 199
- TidalTurbine, 217
- WaveEnergyConverter, 260
- WindTurbine, 277
- dispatchable_MWh
 - SolarPV, 200
 - TidalTurbine, 217
 - WaveEnergyConverter, 260
 - WindTurbine, 277
- double_payload
 - Message, 165
- draw
 - ContextMenu, 31
 - DieselGenerator, 46
 - EnergyStorageSystem, 57
 - HexMap, 112
 - HexTile, 153
 - Settlement, 179
 - SolarPV, 195
 - TidalTurbine, 213
 - TileImprovement, 232
 - WaveEnergyConverter, 255
 - WindTurbine, 273
- draw_coin
 - Settlement, 182
- draw_explosion
 - HexTile, 160
- draw_turn_advance_banner
 - Game, 86
- EMISSIONS_LIFETIME_LIMIT_TONNES
 - constants.h, 291
- emissions_tonnes_CO2e
 - DieselGenerator, 50
- ENERGY_STORAGE_SYSTEM_BUILD_COST
 - constants.h, 291
- EnergyStorageSystem, 52
 - __handleKeyPressEvents, 55
 - __handleMouseButtonEvents, 55
 - __setUpProductionMenu, 56
 - __setUpTileImprovementSpriteStatic, 56
 - __upgrade, 56
 - ~EnergyStorageSystem, 54
 - capacity_MWh, 59
 - charge_MWh, 59
 - draw, 57
 - EnergyStorageSystem, 53
 - getTileOptionsSubstring, 57
 - processEvent, 58
 - processMessage, 58
 - setIsSelected, 59
- event
 - Game, 86
- event_ptr
 - ContextMenu, 35
 - HexMap, 115
 - HexTile, 160
 - TileImprovement, 237
- expectedErrorNotDetected
 - testing_utils.cpp, 322
 - testing_utils.h, 303
- explosion_frame
 - HexTile, 160
- explosion_sprite_reel
 - HexTile, 160
- FLOAT_TOLERANCE
 - constants.h, 291
- font_map
 - AssetsManager, 18
- FOREST
 - HexTile.h, 312
- FOREST_GREEN
 - constants.h, 287
- frame
 - ContextMenu, 35
 - Game, 87
 - HexMap, 115
 - HexTile, 160
 - TileImprovement, 237
- FRAMES_PER_SECOND
 - constants.h, 291
- fuel_cost
 - DieselGenerator, 50
- Game, 60
 - __advanceTurn, 65
 - __checkTerminatingConditions, 66
 - __computeCurrentDemand, 66
 - __draw, 67
 - __drawFrameClockOverlay, 68
 - __drawHUD, 68
 - __drawLossCredits, 70
 - __drawLossDemand, 71
 - __drawLossEmissions, 71
 - __drawTurnAdvanceBanner, 72
 - __drawTurnSummary, 73
 - __drawVictory, 74
 - __handleImprovementStateMessage, 74
 - __handleKeyPressEvents, 75
 - __handleMouseButtonEvents, 75
 - __insufficientCreditsAlarm, 76
 - __processEvent, 77
 - __processMessage, 77
 - __sendCreditsEarnedMessage, 79
 - __sendGameStateMessage, 79
 - __sendTurnAdvanceMessage, 80
 - __summarizeTurn, 81
 - __toggleFrameClockOverlay, 82
 - __updatePopulation, 82
 - ~Game, 65
 - assets_manager_ptr, 84
 - check_terminating_conditions, 84
 - clock, 85
 - consecutive_zero_emissions_months, 85
 - context_menu_ptr, 85
 - credits, 85
 - cumulative_emissions_tonnes, 85

- demand_MWh, 85
- demand_remaining_MWh, 86
- demand_served_MWh, 86
- demand_vec_MWh, 86
- dispatch_income, 86
- draw_turn_advance_banner, 86
- event, 86
- frame, 87
- Game, 64
- game_loop_broken, 87
- game_phase, 87
- hex_map_ptr, 87
- increase_turn_advance_alpha, 87
- message_deadlock, 87
- message_deadlock_frame, 88
- message_hub, 88
- month, 88
- net_credit_flow, 88
- overproduction_MWh, 88
- overproduction_penalty, 88
- past_demand_MWh, 89
- population, 89
- quit_game, 89
- render_window_ptr, 89
- run, 83
- show_frame_clock_overlay, 89
- show_tutorial, 89
- substring_idx, 90
- time_since_start_s, 90
- turn, 90
- turn_advance_alpha, 90
- turn_emissions_tonnes, 90
- turn_end, 90
- turn_fuel_cost, 91
- turn_operation_maintenance_cost, 91
- turn_summary_string, 91
- turn_summary_text, 91
- year, 91
- Game.h
 - BUILD_SETTLEMENT, 309
 - GamePhase, 309
 - LOSS_CREDITS, 309
 - LOSS_DEMAND, 309
 - LOSS_EMISSIONS, 309
 - N_GAME_PHASES, 309
 - SYSTEM_MANAGEMENT, 309
 - VICTORY, 309
- GAME_CHANNEL
 - constants.h, 291
- GAME_HEIGHT
 - constants.h, 291
- game_loop_broken
 - Game, 87
- game_menu_up
 - ContextMenu, 35
- game_phase
 - Game, 87
 - HexTile, 160
 - TileImprovement, 237
- GAME_STATE_CHANNEL
 - constants.h, 292
- GAME_WIDTH
 - constants.h, 292
- GamePhase
 - Game.h, 309
- getCurrentTrackKey
 - AssetsManager, 11
- getFont
 - AssetsManager, 11
- getSound
 - AssetsManager, 12
- getSoundBuffer
 - AssetsManager, 12
- getTexture
 - AssetsManager, 13
- getTileOptionsSubstring
 - DieselGenerator, 48
 - EnergyStorageSystem, 57
 - Settlement, 180
 - SolarPV, 197
 - TidalTurbine, 214
 - TileImprovement, 234
 - WaveEnergyConverter, 257
 - WindTurbine, 274
- getTrackStatus
 - AssetsManager, 13
- glass_screen
 - HexMap, 116
- GOOD
 - HexTile.h, 312
- has_improvement
 - HexTile, 161
- hasTraffic
 - MessageHub, 169
- header/ContextMenu.h, 279
- header/DieselGenerator.h, 280
- header/EnergyStorageSystem.h, 281
- header/ESC_core/AssetsManager.h, 282
- header/ESC_core/constants.h, 283
- header/ESC_core/doxygen_cite.h, 300
- header/ESC_core/includes.h, 300
- header/ESC_core/MessageHub.h, 301
- header/ESC_core/testing_utils.h, 302
- header/Game.h, 308
- header/HexMap.h, 309
- header/HexTile.h, 310
- header/Settlement.h, 313
- header/SolarPV.h, 314
- header/TidalTurbine.h, 315
- header/TileImprovement.h, 316
- header/WaveEnergyConverter.h, 317
- header/WindTurbine.h, 318
- health
 - TileImprovement, 237
- hex_draw_order_vec
 - HexMap, 116

hex_map
 HexMap, 116
HEX_MAP_CHANNEL
 constants.h, 292
hex_map_ptr
 Game, 87
HexMap, 92
 __assembleHexMap, 96
 __assessNeighbours, 96
 __buildDrawOrderVector, 97
 __drawTotalDispatch, 97
 __enforceOceanContinuity, 99
 __getMajorityTileType, 100
 __getNeighboursVector, 101
 __getNoise, 101
 __getSelectedTile, 103
 __getValidMapIndexPositions, 103
 __handleKeyPressEvents, 104
 __handleMouseButtonEvents, 105
 __isLakeTouchingOcean, 105
 __layTiles, 106
 __logSettlementPosition, 108
 __procedurallyGenerateTileResources, 108
 __procedurallyGenerateTileTypes, 109
 __sendNoTileSelectedMessage, 110
 __setUpGlassScreen, 110
 __smoothTileTypes, 110
 ~HexMap, 95
 assess, 111
 assets_manager_ptr, 115
 border_tiles_vec, 115
 clear, 111
 demand_MWh, 115
 draw, 112
 event_ptr, 115
 frame, 115
 glass_screen, 116
 hex_draw_order_vec, 116
 hex_map, 116
 HexMap, 95
 message_hub_ptr, 116
 n_layers, 116
 n_tiles, 116
 position_x, 117
 position_y, 117
 processEvent, 113
 processMessage, 113
 render_window_ptr, 117
 reroll, 114
 settlement_position_logged, 117
 settlement_position_x, 117
 settlement_position_y, 117
 show_resource, 118
 tile_position_x_vec, 118
 tile_position_y_vec, 118
 tile_selected, 118
 toggleResourceOverlay, 114
HexTile, 119
 __buildDieselGenerator, 124
 __buildEnergyStorage, 125
 __buildSettlement, 126
 __buildSolarPV, 126
 __buildTidalTurbine, 127
 __buildWaveEnergyConverter, 127
 __buildWindTurbine, 128
 __clearDecoration, 129
 __closeBuildMenu, 129
 __getTileCoordsSubstring, 130
 __getTileImprovementSubstring, 130
 __getTileOptionsSubstring, 130
 __getTileResourceSubstring, 132
 __getTileTypeSubstring, 133
 __handleKeyPressEvents, 133
 __handleKeyReleaseEvents, 137
 __handleMouseButtonEvents, 138
 __isClicked, 139
 __openBuildMenu, 139
 __scrapImprovement, 139
 __sendAssessNeighboursMessage, 140
 __sendCreditsSpentMessage, 141
 __sendGameStateRequest, 141
 __sendInsufficientCreditsMessage, 141
 __sendTileSelectedMessage, 142
 __sendTileStateMessage, 142
 __sendUpdateGamePhaseMessage, 142
 __setIsSelected, 143
 __setResourceText, 143
 __setUpBuildMenu, 144
 __setUpBuildOption, 145
 __setUpDieselGeneratorBuildOption, 146
 __setUpEnergyStorageSystemBuildOption, 147
 __setUpMagnifyingGlassSprite, 147
 __setUpNodeSprite, 147
 __setUpResourceChipSprite, 148
 __setUpSelectOutlineSprite, 148
 __setUpSolarPVBuildOption, 148
 __setUpTidalTurbineBuildOption, 149
 __setUpTileExplosionReel, 149
 __setUpTileSprite, 150
 __setUpWaveEnergyConverterBuildOption, 150
 __setUpWindTurbineBuildOption, 151
 ~HexTile, 124
 assess, 151
 assets_manager_ptr, 158
 build_menu_backing, 158
 build_menu_backing_text, 159
 build_menu_open, 159
 build_menu_options_text_vec, 159
 build_menu_options_vec, 159
 credits, 159
 decorateTile, 152
 decoration_cleared, 159
 draw, 153
 draw_explosion, 160
 event_ptr, 160
 explosion_frame, 160

- explosion_sprite_reel, 160
- frame, 160
- game_phase, 160
- has_improvement, 161
- HexTile, 123
- is_selected, 161
- magnifying_glass_sprite, 161
- major_radius, 161
- message_hub_ptr, 161
- minor_radius, 161
- node_sprite, 162
- position_x, 162
- position_y, 162
- processEvent, 154
- processMessage, 155
- render_window_ptr, 162
- resource_assessed, 162
- resource_assessment, 162
- resource_chip_sprite, 163
- resource_text, 163
- scrap_improvement_frame, 163
- select_outline_sprite, 163
- setTileResource, 155, 156
- setTileType, 156, 157
- show_node, 163
- show_resource, 163
- tile_decoration_sprite, 164
- tile_improvement_ptr, 164
- tile_resource, 164
- tile_sprite, 164
- tile_type, 164
- toggleResourceOverlay, 158
- HexTile.h
 - ABOVE_AVERAGE, 312
 - AVERAGE, 312
 - BELOW_AVERAGE, 312
 - FOREST, 312
 - GOOD, 312
 - LAKE, 312
 - MOUNTAINS, 312
 - N_TILE_RESOURCES, 312
 - N_TILE_TYPES, 312
 - NONE_TYPE, 312
 - OCEAN, 312
 - PLAINS, 312
 - POOR, 312
 - TileResource, 312
 - TileType, 312
- increase_turn_advance_alpha
 - Game, 87
- incrementMessageRead
 - MessageHub, 169
- int_payload
 - Message, 166
- is_broken
 - TileImprovement, 237
- is_running
 - TileImprovement, 237
- is_selected
 - HexTile, 161
 - TileImprovement, 238
- isEmpty
 - MessageHub, 170
- just_built
 - TileImprovement, 238
- just_upgraded
 - TileImprovement, 238
- KG_CO2E_PER_LITRE_DIESEL
 - constants.h, 292
- LAKE
 - HexTile.h, 312
- LAKE_BLUE
 - constants.h, 287
- LITRES_DIESEL_PER_MWH_PRODUCTION
 - constants.h, 292
- loadAssets
 - main.cpp, 329
- loadFont
 - AssetsManager, 14
- loadSound
 - AssetsManager, 14
- loadTexture
 - AssetsManager, 15
- loadTrack
 - AssetsManager, 16
- LOSS_CREDITS
 - Game.h, 309
- LOSS_DEMAND
 - Game.h, 309
- LOSS_EMISSIONS
 - Game.h, 309
- magnifying_glass_sprite
 - HexTile, 161
- main
 - main.cpp, 332
- main.cpp
 - constructRenderWindow, 329
 - loadAssets, 329
 - main, 332
- major_radius
 - HexTile, 161
- max_daily_production_MWh
 - SolarPV, 200
 - TidalTurbine, 218
 - WaveEnergyConverter, 260
 - WindTurbine, 277
- max_production_MWh
 - DieselGenerator, 50
- MAX_STORAGE_LEVELS
 - constants.h, 292
- MAX_UPGRADE_LEVELS
 - constants.h, 293
- MAXIMUM_DAILY_DEMAND_PER_CAPITA

- constants.h, [293](#)
- MEAN_DAILY_DEMAND_RATIOS
 - constants.h, [293](#)
- MEAN_DAILY_SOLAR_CAPACITY_FACTORS
 - constants.h, [293](#)
- MEAN_DAILY_WAVE_CAPACITY_FACTORS
 - constants.h, [293](#)
- MEAN_DAILY_WIND_CAPACITY_FACTORS
 - constants.h, [294](#)
- MEAN_POPULATION_GROWTH_RATE
 - constants.h, [294](#)
- MENU
 - ContextMenu.h, [280](#)
- menu_frame
 - ContextMenu, [35](#)
- MENU_FRAME_GREY
 - constants.h, [287](#)
- Message, [165](#)
 - bool_payload, [165](#)
 - channel, [165](#)
 - double_payload, [165](#)
 - int_payload, [166](#)
 - number_of_reads, [166](#)
 - string_payload, [166](#)
 - subject, [166](#)
 - vector_payload, [166](#)
- message_deadlock
 - Game, [87](#)
- message_deadlock_frame
 - Game, [88](#)
- message_hub
 - Game, [88](#)
- message_hub_ptr
 - ContextMenu, [35](#)
 - HexMap, [116](#)
 - HexTile, [161](#)
 - TileImprovement, [238](#)
- message_map
 - MessageHub, [174](#)
- MessageHub, [167](#)
 - ~MessageHub, [168](#)
 - addChannel, [168](#)
 - clear, [169](#)
 - clearMessages, [169](#)
 - hasTraffic, [169](#)
 - incrementMessageRead, [169](#)
 - isEmpty, [170](#)
 - message_map, [174](#)
 - MessageHub, [168](#)
 - popMessage, [171](#)
 - printState, [171](#)
 - receiveMessage, [172](#)
 - removeChannel, [173](#)
 - sendMessage, [173](#)
- minor_radius
 - HexTile, [161](#)
- MONOCHROME_SCREEN_BACKGROUND
 - constants.h, [287](#)
- MONOCHROME_TEXT_AMBER
 - constants.h, [287](#)
- MONOCHROME_TEXT_GREEN
 - constants.h, [288](#)
- MONOCHROME_TEXT_RED
 - constants.h, [288](#)
- month
 - Game, [88](#)
 - TileImprovement, [238](#)
- MOUNTAINS
 - HexTile.h, [312](#)
- MOUNTAINS_GREY
 - constants.h, [288](#)
- N_CONSOLE_STATES
 - ContextMenu.h, [280](#)
- N_GAME_PHASES
 - Game.h, [309](#)
- n_layers
 - HexMap, [116](#)
- N_TILE_IMPROVEMENT_TYPES
 - TileImprovement.h, [317](#)
- N_TILE_RESOURCES
 - HexTile.h, [312](#)
- N_TILE_TYPES
 - HexTile.h, [312](#)
- n_tiles
 - HexMap, [116](#)
- net_credit_flow
 - Game, [88](#)
- nextTrack
 - AssetsManager, [16](#)
- NO_TILE_SELECTED_CHANNEL
 - constants.h, [294](#)
- node_sprite
 - HexTile, [162](#)
- NONE_STATE
 - ContextMenu.h, [280](#)
- NONE_TYPE
 - HexTile.h, [312](#)
- number_of_reads
 - Message, [166](#)
- OCEAN
 - HexTile.h, [312](#)
- OCEAN_BLUE
 - constants.h, [288](#)
- operation_maintenance_cost
 - TileImprovement, [238](#)
- overproduction_MWh
 - Game, [88](#)
- overproduction_penalty
 - Game, [88](#)
- past_demand_MWh
 - Game, [89](#)
- pauseTrack
 - AssetsManager, [17](#)
- PLAINS

- HexTile.h, 312
- PLAINS_YELLOW
 - constants.h, 288
- playTrack
 - AssetsManager, 17
- POOR
 - HexTile.h, 312
- popMessage
 - MessageHub, 171
- population
 - Game, 89
- position_x
 - ContextMenu, 36
 - HexMap, 117
 - HexTile, 162
 - TileImprovement, 239
- position_y
 - ContextMenu, 36
 - HexMap, 117
 - HexTile, 162
 - TileImprovement, 239
- previousTrack
 - AssetsManager, 17
- printGold
 - testing_utils.cpp, 322
 - testing_utils.h, 303
- printGreen
 - testing_utils.cpp, 322
 - testing_utils.h, 303
- printRed
 - testing_utils.cpp, 323
 - testing_utils.h, 304
- printState
 - MessageHub, 171
- processEvent
 - ContextMenu, 32
 - DieselGenerator, 49
 - EnergyStorageSystem, 58
 - HexMap, 113
 - HexTile, 154
 - Settlement, 180
 - SolarPV, 197
 - TidalTurbine, 215
 - TileImprovement, 234
 - WaveEnergyConverter, 257
 - WindTurbine, 275
- processMessage
 - ContextMenu, 32
 - DieselGenerator, 49
 - EnergyStorageSystem, 58
 - HexMap, 113
 - HexTile, 155
 - Settlement, 181
 - SolarPV, 198
 - TidalTurbine, 215
 - TileImprovement, 234
 - WaveEnergyConverter, 258
 - WindTurbine, 275
- production_menu_backing
 - TileImprovement, 239
- production_menu_backing_text
 - TileImprovement, 239
- production_menu_open
 - TileImprovement, 239
- production_MWh
 - DieselGenerator, 51
 - SolarPV, 200
 - TidalTurbine, 218
 - WaveEnergyConverter, 260
 - WindTurbine, 278
- production_vec_MWh
 - SolarPV, 200
 - TidalTurbine, 218
 - WaveEnergyConverter, 260
 - WindTurbine, 278
- quit_game
 - Game, 89
- READY
 - ContextMenu.h, 280
- receiveMessage
 - MessageHub, 172
- removeChannel
 - MessageHub, 173
- render_window_ptr
 - ContextMenu, 36
 - Game, 89
 - HexMap, 117
 - HexTile, 162
 - TileImprovement, 239
- reroll
 - HexMap, 114
- resource_assessed
 - HexTile, 162
- resource_assessment
 - HexTile, 162
- RESOURCE_ASSESSMENT_COST
 - constants.h, 294
- RESOURCE_CHIP_GREY
 - constants.h, 289
- resource_chip_sprite
 - HexTile, 163
- resource_text
 - HexTile, 163
- rotor_drotation
 - TidalTurbine, 218
 - WindTurbine, 278
- run
 - Game, 83
- SCRAP_COST
 - constants.h, 294
- scrap_improvement_frame
 - HexTile, 163
- SECONDS_PER_FRAME
 - constants.h, 295

- SECONDS_PER_MONTH
 - constants.h, 295
- SECONDS_PER_YEAR
 - constants.h, 295
- select_outline_sprite
 - HexTile, 163
- sendMessage
 - MessageHub, 173
- setIsSelected
 - DieselGenerator, 49
 - EnergyStorageSystem, 59
 - Settlement, 181
 - SolarPV, 198
 - TidalTurbine, 216
 - TileImprovement, 235
 - WaveEnergyConverter, 258
 - WindTurbine, 276
- setTileResource
 - HexTile, 155, 156
- setTileType
 - HexTile, 156, 157
- SETTLEMENT
 - TileImprovement.h, 317
- Settlement, 174
 - __handleKeyPressEvents, 177
 - __handleMouseButtonEvents, 178
 - __setUpCoinSprite, 178
 - __setUpTileImprovementSpriteStatic, 178
 - ~Settlement, 177
 - coin_sprite, 182
 - draw, 179
 - draw_coin, 182
 - getTileOptionsSubstring, 180
 - processEvent, 180
 - processMessage, 181
 - setIsSelected, 181
 - Settlement, 176
 - smoke_da, 182
 - smoke_dx, 182
 - smoke_dy, 182
 - smoke_prob, 182
 - smoke_sprite_list, 183
- SETTLEMENT_CHANNEL
 - constants.h, 295
- settlement_position_logged
 - HexMap, 117
- settlement_position_x
 - HexMap, 117
- settlement_position_y
 - HexMap, 117
- show_frame_clock_overlay
 - Game, 89
- show_node
 - HexTile, 163
- show_resource
 - HexMap, 118
 - HexTile, 163
- show_tutorial
 - Game, 89
- smoke_da
 - DieselGenerator, 51
 - Settlement, 182
- smoke_dx
 - DieselGenerator, 51
 - Settlement, 182
- smoke_dy
 - DieselGenerator, 51
 - Settlement, 182
- smoke_prob
 - DieselGenerator, 51
 - Settlement, 182
- smoke_sprite_list
 - DieselGenerator, 51
 - Settlement, 183
- SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION
 - constants.h, 295
- SOLAR_PV
 - TileImprovement.h, 317
- SOLAR_PV_BUILD_COST
 - constants.h, 295
- SOLAR_PV_WATER_BUILD_MULTIPLIER
 - constants.h, 296
- SolarPV, 183
 - __breakdown, 187
 - __computeCapacityFactors, 187
 - __computeDispatch, 188
 - __computeProduction, 189
 - __computeProductionCosts, 189
 - __drawProductionMenu, 189
 - __drawUpgradeOptions, 190
 - __handleKeyPressEvents, 191
 - __handleMouseButtonEvents, 192
 - __repair, 193
 - __sendImprovementStateMessage, 193
 - __setUpTileImprovementSpriteStatic, 194
 - __upgradePowerCapacity, 194
 - ~SolarPV, 187
 - advanceTurn, 195
 - capacity_factor_vec, 199
 - capacity_kW, 199
 - dispatch_MWh, 199
 - dispatch_vec_MWh, 199
 - dispatchable_MWh, 200
 - draw, 195
 - getTileOptionsSubstring, 197
 - max_daily_production_MWh, 200
 - processEvent, 197
 - processMessage, 198
 - production_MWh, 200
 - production_vec_MWh, 200
 - setIsSelected, 198
 - SolarPV, 186
 - update, 199
- sound_map
 - AssetsManager, 18
- soundbuffer_map

- AssetsManager, 18
- source/ContextMenu.cpp, 319
- source/DieselGenerator.cpp, 319
- source/EnergyStorageSystem.cpp, 320
- source/ESC_core/AssetsManager.cpp, 320
- source/ESC_core/MessageHub.cpp, 320
- source/ESC_core/testing_utils.cpp, 321
- source/Game.cpp, 327
- source/HexMap.cpp, 327
- source/HexTile.cpp, 328
- source/main.cpp, 328
- source/Settlement.cpp, 333
- source/SolarPV.cpp, 333
- source/TidalTurbine.cpp, 334
- source/TileImprovement.cpp, 334
- source/WaveEnergyConverter.cpp, 335
- source/WindTurbine.cpp, 335
- STARTING_CREDITS
 - constants.h, 296
- STARTING_POPULATION
 - constants.h, 296
- STDEV_DAILY_DEMAND_RATIOS
 - constants.h, 296
- STDEV_DAILY_SOLAR_CAPACITY_FACTORS
 - constants.h, 296
- STDEV_DAILY_WAVE_CAPACITY_FACTORS
 - constants.h, 297
- STDEV_DAILY_WIND_CAPACITY_FACTORS
 - constants.h, 297
- STDEV_POPULATION_GROWTH_RATE
 - constants.h, 297
- stopTrack
 - AssetsManager, 17
- storage_kWh
 - TileImprovement, 240
- storage_level
 - TileImprovement, 240
- storage_upgrade_sprite
 - TileImprovement, 240
- storage_upgrade_sprite_vec
 - TileImprovement, 240
- string_payload
 - Message, 166
- subject
 - Message, 166
- substring_idx
 - Game, 90
- SYSTEM_MANAGEMENT
 - Game.h, 309
- testFloatEquals
 - testing_utils.cpp, 323
 - testing_utils.h, 304
- testGreaterThan
 - testing_utils.cpp, 324
 - testing_utils.h, 305
- testGreaterThanOrEqualTo
 - testing_utils.cpp, 324
 - testing_utils.h, 305
- testing_utils.cpp
 - expectedErrorNotDetected, 322
 - printGold, 322
 - printGreen, 322
 - printRed, 323
 - testFloatEquals, 323
 - testGreaterThan, 324
 - testGreaterThanOrEqualTo, 324
 - testLessThan, 325
 - testLessThanOrEqualTo, 326
 - testTruth, 326
- testing_utils.h
 - expectedErrorNotDetected, 303
 - printGold, 303
 - printGreen, 303
 - printRed, 304
 - testFloatEquals, 304
 - testGreaterThan, 305
 - testGreaterThanOrEqualTo, 305
 - testLessThan, 306
 - testLessThanOrEqualTo, 307
 - testTruth, 307
- testLessThan
 - testing_utils.cpp, 325
 - testing_utils.h, 306
- testLessThanOrEqualTo
 - testing_utils.cpp, 326
 - testing_utils.h, 307
- testTruth
 - testing_utils.cpp, 326
 - testing_utils.h, 307
- texture_map
 - AssetsManager, 18
- TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION
 - constants.h, 297
- TIDAL_TURBINE
 - TileImprovement.h, 317
- TIDAL_TURBINE_BUILD_COST
 - constants.h, 298
- TidalTurbine, 201
 - __breakdown, 204
 - __computeCapacityFactors, 205
 - __computeDispatch, 205
 - __computeProduction, 206
 - __computeProductionCosts, 206
 - __drawProductionMenu, 206
 - __drawUpgradeOptions, 207
 - __handleKeyPressEvents, 209
 - __handleMouseButtonEvents, 210
 - __repair, 210
 - __sendImprovementStateMessage, 210
 - __setUpTileImprovementSpriteAnimated, 211
 - __upgradePowerCapacity, 211
 - ~TidalTurbine, 204
 - advanceTurn, 212
 - bobbing_y, 217
 - capacity_factor_vec, 217
 - capacity_kW, 217

- dispatch_MWh, 217
- dispatch_vec_MWh, 217
- dispatchable_MWh, 217
- draw, 213
- getTileOptionsSubstring, 214
- max_daily_production_MWh, 218
- processEvent, 215
- processMessage, 215
- production_MWh, 218
- production_vec_MWh, 218
- rotor_drotation, 218
- setIsSelected, 216
- TidalTurbine, 203
- update, 216
- TILE
 - ContextMenu.h, 280
- tile_decoration_sprite
 - HexTile, 164
- tile_improvement_ptr
 - HexTile, 164
- tile_improvement_sprite_animated
 - TileImprovement, 240
- tile_improvement_sprite_static
 - TileImprovement, 240
- tile_improvement_string
 - TileImprovement, 241
- tile_improvement_type
 - TileImprovement, 241
- tile_position_x_vec
 - HexMap, 118
- tile_position_y_vec
 - HexMap, 118
- tile_resource
 - HexTile, 164
 - TileImprovement, 241
- TILE_RESOURCE_CUMULATIVE_PROBABILITIES
 - constants.h, 298
- tile_resource_scalar
 - TileImprovement, 241
- tile_selected
 - HexMap, 118
- TILE_SELECTED_CHANNEL
 - constants.h, 298
- tile_sprite
 - HexTile, 164
- TILE_STATE_CHANNEL
 - constants.h, 298
- tile_type
 - HexTile, 164
- TILE_TYPE_CUMULATIVE_PROBABILITIES
 - constants.h, 298
- TileImprovement, 219
 - __breakdown, 224
 - __closeProductionMenu, 225
 - __closeUpgradeMenu, 225
 - __drawDispatch, 225
 - __handleKeyPressEvents, 226
 - __handleMouseButtonEvents, 227
 - __openProductionMenu, 227
 - __openUpgradeMenu, 227
 - __repair, 228
 - __sendCreditsSpentMessage, 228
 - __sendGameStateRequest, 229
 - __sendInsufficientCreditsMessage, 229
 - __sendTileStateRequest, 229
 - __setUpDispatchIllustration, 229
 - __setUpProductionMenu, 230
 - __setUpUpgradeMenu, 230
 - __upgradeStorageCapacity, 231
 - ~TileImprovement, 224
- advanceTurn, 232
- assets_manager_ptr, 236
- credits, 236
- demand_MWh, 236
- demand_vec_MWh, 236
- dispatch_backing, 236
- dispatch_text, 236
- draw, 232
- event_ptr, 237
- frame, 237
- game_phase, 237
- getTileOptionsSubstring, 234
- health, 237
- is_broken, 237
- is_running, 237
- is_selected, 238
- just_built, 238
- just_upgraded, 238
- message_hub_ptr, 238
- month, 238
- operation_maintenance_cost, 238
- position_x, 239
- position_y, 239
- processEvent, 234
- processMessage, 234
- production_menu_backing, 239
- production_menu_backing_text, 239
- production_menu_open, 239
- render_window_ptr, 239
- setIsSelected, 235
- storage_kWh, 240
- storage_level, 240
- storage_upgrade_sprite, 240
- storage_upgrade_sprite_vec, 240
- tile_improvement_sprite_animated, 240
- tile_improvement_sprite_static, 240
- tile_improvement_string, 241
- tile_improvement_type, 241
- tile_resource, 241
- tile_resource_scalar, 241
- TileImprovement, 223
- update, 235
- upgrade_arrow_sprite, 241
- upgrade_frame, 241
- upgrade_level, 242
- upgrade_menu_backing, 242

- upgrade_menu_backing_text, 242
 - upgrade_menu_open, 242
 - upgrade_plus_sprite, 242
- TileImprovement.h
 - DIESEL_GENERATOR, 317
 - N_TILE_IMPROVEMENT_TYPES, 317
 - SETTLEMENT, 317
 - SOLAR_PV, 317
 - TIDAL_TURBINE, 317
 - TileImprovementType, 316
 - WAVE_ENERGY_CONVERTER, 317
 - WIND_TURBINE, 317
- TileImprovementType
 - TileImprovement.h, 316
- TileResource
 - HexTile.h, 312
- TileType
 - HexTile.h, 312
- time_since_start_s
 - Game, 90
- toggleResourceOverlay
 - HexMap, 114
 - HexTile, 158
- track_map
 - AssetsManager, 19
- turn
 - Game, 90
- turn_advance_alpha
 - Game, 90
- turn_emissions_tonnes
 - Game, 90
- turn_end
 - Game, 90
- turn_fuel_cost
 - Game, 91
- turn_operation_maintenance_cost
 - Game, 91
- turn_summary_string
 - Game, 91
- turn_summary_text
 - Game, 91
- update
 - SolarPV, 199
 - TidalTurbine, 216
 - TileImprovement, 235
 - WaveEnergyConverter, 259
 - WindTurbine, 276
- upgrade_arrow_sprite
 - TileImprovement, 241
- upgrade_frame
 - TileImprovement, 241
- upgrade_level
 - TileImprovement, 242
- upgrade_menu_backing
 - TileImprovement, 242
- upgrade_menu_backing_text
 - TileImprovement, 242
- upgrade_menu_open
 - TileImprovement, 242
- upgrade_plus_sprite
 - TileImprovement, 242
- vector_payload
 - Message, 166
- VICTORY
 - Game.h, 309
- visual_screen
 - ContextMenu, 36
- visual_screen_frame_bottom
 - ContextMenu, 36
- VISUAL_SCREEN_FRAME_GREY
 - constants.h, 289
- visual_screen_frame_left
 - ContextMenu, 36
- visual_screen_frame_right
 - ContextMenu, 37
- visual_screen_frame_top
 - ContextMenu, 37
- WAVE_ENERGY_CONVERTER
 - TileImprovement.h, 317
- WAVE_ENERGY_CONVERTER_BUILD_COST
 - constants.h, 299
- WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION
 - constants.h, 299
- WaveEnergyConverter, 243
 - __breakdown, 246
 - __computeCapacityFactors, 247
 - __computeDispatch, 247
 - __computeProduction, 248
 - __computeProductionCosts, 249
 - __drawProductionMenu, 249
 - __drawUpgradeOptions, 250
 - __handleKeyPressEvents, 251
 - __handleMouseButtonEvents, 252
 - __repair, 252
 - __sendImprovementStateMessage, 253
 - __setUpTileImprovementSpriteAnimated, 253
 - __upgradePowerCapacity, 254
 - ~WaveEnergyConverter, 246
 - advanceTurn, 254
 - bobbing_y, 259
 - capacity_factor_vec, 259
 - capacity_kW, 259
 - dispatch_MWh, 259
 - dispatch_vec_MWh, 260
 - dispatchable_MWh, 260
 - draw, 255
 - getTileOptionsSubstring, 257
 - max_daily_production_MWh, 260
 - processEvent, 257
 - processMessage, 258
 - production_MWh, 260
 - production_vec_MWh, 260
 - setIsSelected, 258
 - update, 259
 - WaveEnergyConverter, 245

WIND_OP_MAINT_COST_PER_MWH_PRODUCTION

constants.h, [299](#)

WIND_TURBINE

TileImprovement.h, [317](#)

WIND_TURBINE_BUILD_COST

constants.h, [299](#)

WIND_TURBINE_WATER_BUILD_MULTIPLIER

constants.h, [299](#)

WindTurbine, [261](#)

__breakdown, [264](#)

__computeCapacityFactors, [265](#)

__computeDispatch, [265](#)

__computeProduction, [266](#)

__computeProductionCosts, [267](#)

__drawProductionMenu, [267](#)

__drawUpgradeOptions, [268](#)

__handleKeyPressEvents, [269](#)

__handleMouseButtonEvents, [270](#)

__repair, [270](#)

__sendImprovementStateMessage, [271](#)

__setUpTileImprovementSpriteAnimated, [271](#)

__upgradePowerCapacity, [272](#)

~WindTurbine, [264](#)

advanceTurn, [272](#)

capacity_factor_vec, [277](#)

capacity_kW, [277](#)

dispatch_MWh, [277](#)

dispatch_vec_MWh, [277](#)

dispatchable_MWh, [277](#)

draw, [273](#)

getTileOptionsSubstring, [274](#)

max_daily_production_MWh, [277](#)

processEvent, [275](#)

processMessage, [275](#)

production_MWh, [278](#)

production_vec_MWh, [278](#)

rotor_drotation, [278](#)

setIsSelected, [276](#)

update, [276](#)

WindTurbine, [263](#)

year

Game, [91](#)