

PGMcpp: PRIMED Grid Modelling (in C++)

Generated by Doxygen 1.9.1

1 Hierarchical Index	1
1.1 Class Hierarchy	1
2 Class Index	3
2.1 Class List	3
3 File Index	5
3.1 File List	5
4 Class Documentation	9
4.1 Combustion Class Reference	9
4.1.1 Detailed Description	12
4.1.2 Constructor & Destructor Documentation	12
4.1.2.1 Combustion() [1/2]	12
4.1.2.2 Combustion() [2/2]	12
4.1.2.3 ~Combustion()	13
4.1.3 Member Function Documentation	13
4.1.3.1 __checkInputs()	13
4.1.3.2 __writeSummary()	14
4.1.3.3 __writeTimeSeries()	14
4.1.3.4 commit()	14
4.1.3.5 computeEconomics()	15
4.1.3.6 computeFuelAndEmissions()	16
4.1.3.7 getEmissionskg()	16
4.1.3.8 getFuelConsumptionL()	17
4.1.3.9 handleReplacement()	17
4.1.3.10 requestProductionkW()	17
4.1.3.11 writeResults()	18
4.1.4 Member Data Documentation	19
4.1.4.1 CH4_emissions_intensity_kgL	19
4.1.4.2 CH4_emissions_vec_kg	19
4.1.4.3 CO2_emissions_intensity_kgL	19
4.1.4.4 CO2_emissions_vec_kg	19
4.1.4.5 CO_emissions_intensity_kgL	19
4.1.4.6 CO_emissions_vec_kg	20
4.1.4.7 fuel_consumption_vec_L	20
4.1.4.8 fuel_cost_L	20
4.1.4.9 fuel_cost_vec	20
4.1.4.10 linear_fuel_intercept_LkWh	20
4.1.4.11 linear_fuel_slope_LkWh	20
4.1.4.12 nominal_fuel_escalation_annual	21
4.1.4.13 NOx_emissions_intensity_kgL	21
4.1.4.14 NOx_emissions_vec_kg	21

4.1.4.15 PM_emissions_intensity_kgL	21
4.1.4.16 PM_emissions_vec_kg	21
4.1.4.17 real_fuel_escalation_annual	21
4.1.4.18 SOx_emissions_intensity_kgL	22
4.1.4.19 SOx_emissions_vec_kg	22
4.1.4.20 total_emissions	22
4.1.4.21 total_fuel_consumed_L	22
4.1.4.22 type	22
4.2 CombustionInputs Struct Reference	23
4.2.1 Detailed Description	23
4.2.2 Member Data Documentation	23
4.2.2.1 nominal_fuel_escalation_annual	23
4.2.2.2 production_inputs	24
4.3 Controller Class Reference	24
4.3.1 Detailed Description	25
4.3.2 Constructor & Destructor Documentation	25
4.3.2.1 Controller()	25
4.3.2.2 ~Controller()	26
4.3.3 Member Function Documentation	26
4.3.3.1 __applyCycleChargingControl_CHARGING()	26
4.3.3.2 __applyCycleChargingControl_DISCHARGING()	26
4.3.3.3 __applyLoadFollowingControl_CHARGING()	28
4.3.3.4 __applyLoadFollowingControl_DISCHARGING()	28
4.3.3.5 __computeNetLoad()	30
4.3.3.6 __constructCombustionMap()	30
4.3.3.7 __getRenewableProduction()	32
4.3.3.8 __handleCombustionDispatch()	33
4.3.3.9 __handleStorageCharging() [1/2]	34
4.3.3.10 __handleStorageCharging() [2/2]	35
4.3.3.11 __handleStorageDischarging()	36
4.3.3.12 applyDispatchControl()	37
4.3.3.13 clear()	38
4.3.3.14 init()	39
4.3.3.15 setControlMode()	39
4.3.4 Member Data Documentation	40
4.3.4.1 combustion_map	40
4.3.4.2 control_mode	40
4.3.4.3 control_string	40
4.3.4.4 missed_load_vec_kW	40
4.3.4.5 net_load_vec_kW	41
4.4 Diesel Class Reference	41
4.4.1 Detailed Description	43

4.4.2 Constructor & Destructor Documentation	43
4.4.2.1 Diesel() [1/2]	43
4.4.2.2 Diesel() [2/2]	43
4.4.2.3 ~Diesel()	44
4.4.3 Member Function Documentation	45
4.4.3.1 __checkInputs()	45
4.4.3.2 __getGenericCapitalCost()	46
4.4.3.3 __getGenericFuelIntercept()	47
4.4.3.4 __getGenericFuelSlope()	47
4.4.3.5 __getGenericOpMaintCost()	48
4.4.3.6 __handleStartStop()	48
4.4.3.7 __writeSummary()	49
4.4.3.8 __writeTimeSeries()	51
4.4.3.9 commit()	51
4.4.3.10 handleReplacement()	52
4.4.3.11 requestProductionkW()	53
4.4.4 Member Data Documentation	53
4.4.4.1 minimum_load_ratio	54
4.4.4.2 minimum_runtime_hrs	54
4.4.4.3 time_since_last_start_hrs	54
4.5 DieselInputs Struct Reference	54
4.5.1 Detailed Description	55
4.5.2 Member Data Documentation	56
4.5.2.1 capital_cost	56
4.5.2.2 CH4_emissions_intensity_kgL	56
4.5.2.3 CO2_emissions_intensity_kgL	56
4.5.2.4 CO_emissions_intensity_kgL	56
4.5.2.5 combustion_inputs	56
4.5.2.6 fuel_cost_L	57
4.5.2.7 linear_fuel_intercept_LkWh	57
4.5.2.8 linear_fuel_slope_LkWh	57
4.5.2.9 minimum_load_ratio	57
4.5.2.10 minimum_runtime_hrs	57
4.5.2.11 NOx_emissions_intensity_kgL	58
4.5.2.12 operation_maintenance_cost_kWh	58
4.5.2.13 PM_emissions_intensity_kgL	58
4.5.2.14 replace_running_hrs	58
4.5.2.15 SOx_emissions_intensity_kgL	58
4.6 ElectricalLoad Class Reference	58
4.6.1 Detailed Description	59
4.6.2 Constructor & Destructor Documentation	59
4.6.2.1 ElectricalLoad() [1/2]	60

4.6.2.2 ElectricalLoad() [2/2]	60
4.6.2.3 ~ElectricalLoad()	60
4.6.3 Member Function Documentation	60
4.6.3.1 clear()	60
4.6.3.2 readLoadData()	61
4.6.4 Member Data Documentation	62
4.6.4.1 dt_vec_hrs	62
4.6.4.2 load_vec_kW	62
4.6.4.3 max_load_kW	62
4.6.4.4 mean_load_kW	62
4.6.4.5 min_load_kW	63
4.6.4.6 n_points	63
4.6.4.7 n_years	63
4.6.4.8 path_2_electrical_load_time_series	63
4.6.4.9 time_vec_hrs	63
4.7 Emissions Struct Reference	63
4.7.1 Detailed Description	64
4.7.2 Member Data Documentation	64
4.7.2.1 CH4_kg	64
4.7.2.2 CO2_kg	64
4.7.2.3 CO_kg	64
4.7.2.4 NOx_kg	65
4.7.2.5 PM_kg	65
4.7.2.6 SOx_kg	65
4.8 Interpolator Class Reference	65
4.8.1 Detailed Description	66
4.8.2 Constructor & Destructor Documentation	66
4.8.2.1 Interpolator()	66
4.8.2.2 ~Interpolator()	67
4.8.3 Member Function Documentation	67
4.8.3.1 __checkDataKey1D()	67
4.8.3.2 __checkDataKey2D()	67
4.8.3.3 __getDataStringMatrix()	68
4.8.3.4 __isNonNumeric()	68
4.8.3.5 __readData1D()	69
4.8.3.6 __readData2D()	70
4.8.3.7 __splitCommaSeparatedString()	71
4.8.3.8 __throwReadError()	71
4.8.3.9 addData1D()	72
4.8.3.10 addData2D()	72
4.8.3.11 interp1D()	73
4.8.3.12 interp2D()	73

4.8.4 Member Data Documentation	73
4.8.4.1 interp_map_1D	73
4.8.4.2 interp_map_2D	73
4.8.4.3 path_map_1D	73
4.8.4.4 path_map_2D	74
4.9 InterpolatorStruct1D Struct Reference	74
4.9.1 Detailed Description	74
4.9.2 Member Data Documentation	74
4.9.2.1 n_points	74
4.9.2.2 x_vec	75
4.9.2.3 y_vec	75
4.10 InterpolatorStruct2D Struct Reference	75
4.10.1 Detailed Description	75
4.10.2 Member Data Documentation	75
4.10.2.1 n_cols	76
4.10.2.2 n_rows	76
4.10.2.3 x_vec	76
4.10.2.4 y_vec	76
4.10.2.5 z_matrix	76
4.11 Lilon Class Reference	77
4.11.1 Detailed Description	79
4.11.2 Constructor & Destructor Documentation	79
4.11.2.1 Lilon() [1/2]	79
4.11.2.2 Lilon() [2/2]	79
4.11.2.3 ~Lilon()	80
4.11.3 Member Function Documentation	81
4.11.3.1 __checkInputs()	81
4.11.3.2 __getBcal()	83
4.11.3.3 __getEacal()	84
4.11.3.4 __getGenericCapitalCost()	84
4.11.3.5 __getGenericOpMaintCost()	85
4.11.3.6 __handleDegradation()	85
4.11.3.7 __modelDegradation()	85
4.11.3.8 __toggleDepleted()	87
4.11.3.9 __writeSummary()	87
4.11.3.10 __writeTimeSeries()	89
4.11.3.11 commitCharge()	89
4.11.3.12 commitDischarge()	90
4.11.3.13 getAcceptablekW()	91
4.11.3.14 getAvailablekW()	92
4.11.3.15 handleReplacement()	92
4.11.4 Member Data Documentation	93

4.11.4.1 charging_efficiency	93
4.11.4.2 degradation_a_cal	93
4.11.4.3 degradation_alpha	93
4.11.4.4 degradation_B_hat_cal_0	93
4.11.4.5 degradation_beta	94
4.11.4.6 degradation_Ea_cal_0	94
4.11.4.7 degradation_r_cal	94
4.11.4.8 degradation_s_cal	94
4.11.4.9 discharging_efficiency	94
4.11.4.10 dynamic_energy_capacity_kWh	94
4.11.4.11 gas_constant_JmolK	95
4.11.4.12 hysteresis_SOC	95
4.11.4.13 init_SOC	95
4.11.4.14 max_SOC	95
4.11.4.15 min_SOC	95
4.11.4.16 replace_SOH	95
4.11.4.17 SOH	96
4.11.4.18 SOH_vec	96
4.11.4.19 temperature_K	96
4.12 LilonInputs Struct Reference	96
4.12.1 Detailed Description	97
4.12.2 Member Data Documentation	98
4.12.2.1 capital_cost	98
4.12.2.2 charging_efficiency	98
4.12.2.3 degradation_a_cal	98
4.12.2.4 degradation_alpha	98
4.12.2.5 degradation_B_hat_cal_0	98
4.12.2.6 degradation_beta	99
4.12.2.7 degradation_Ea_cal_0	99
4.12.2.8 degradation_r_cal	99
4.12.2.9 degradation_s_cal	99
4.12.2.10 discharging_efficiency	99
4.12.2.11 gas_constant_JmolK	99
4.12.2.12 hysteresis_SOC	100
4.12.2.13 init_SOC	100
4.12.2.14 max_SOC	100
4.12.2.15 min_SOC	100
4.12.2.16 operation_maintenance_cost_kWh	100
4.12.2.17 replace_SOH	100
4.12.2.18 storage_inputs	101
4.12.2.19 temperature_K	101
4.13 Model Class Reference	101

4.13.1 Detailed Description	103
4.13.2 Constructor & Destructor Documentation	103
4.13.2.1 Model() [1/2]	103
4.13.2.2 Model() [2/2]	103
4.13.2.3 ~Model()	104
4.13.3 Member Function Documentation	104
4.13.3.1 __checkInputs()	104
4.13.3.2 __computeEconomics()	105
4.13.3.3 __computeFuelAndEmissions()	105
4.13.3.4 __computeLevellizedCostOfEnergy()	106
4.13.3.5 __computeNetPresentCost()	106
4.13.3.6 __writeSummary()	107
4.13.3.7 __writeTimeSeries()	109
4.13.3.8 addDiesel()	110
4.13.3.9 addLilon()	110
4.13.3.10 addResource()	111
4.13.3.11 addSolar()	111
4.13.3.12 addTidal()	112
4.13.3.13 addWave()	112
4.13.3.14 addWind()	113
4.13.3.15 clear()	113
4.13.3.16 reset()	113
4.13.3.17 run()	114
4.13.3.18 writeResults()	114
4.13.4 Member Data Documentation	115
4.13.4.1 combustion_ptr_vec	116
4.13.4.2 controller	116
4.13.4.3 electrical_load	116
4.13.4.4 levellized_cost_of_energy_kWh	116
4.13.4.5 net_present_cost	116
4.13.4.6 renewable_ptr_vec	116
4.13.4.7 resources	117
4.13.4.8 storage_ptr_vec	117
4.13.4.9 total_dispatch_discharge_kWh	117
4.13.4.10 total_emissions	117
4.13.4.11 total_fuel_consumed_L	117
4.14 ModelInputs Struct Reference	117
4.14.1 Detailed Description	118
4.14.2 Member Data Documentation	118
4.14.2.1 control_mode	118
4.14.2.2 path_2_electrical_load_time_series	118
4.15 Production Class Reference	119

4.15.1 Detailed Description	121
4.15.2 Constructor & Destructor Documentation	121
4.15.2.1 Production() [1/2]	121
4.15.2.2 Production() [2/2]	122
4.15.2.3 ~Production()	122
4.15.3 Member Function Documentation	123
4.15.3.1 __checkInputs()	123
4.15.3.2 commit()	124
4.15.3.3 computeEconomics()	125
4.15.3.4 computeRealDiscountAnnual()	126
4.15.3.5 handleReplacement()	126
4.15.4 Member Data Documentation	126
4.15.4.1 capacity_kW	127
4.15.4.2 capital_cost	127
4.15.4.3 capital_cost_vec	127
4.15.4.4 curtailment_vec_kW	127
4.15.4.5 dispatch_vec_kW	127
4.15.4.6 interpolator	127
4.15.4.7 is_running	128
4.15.4.8 is_running_vec	128
4.15.4.9 is_sunk	128
4.15.4.10 levlized_cost_of_energy_kWh	128
4.15.4.11 n_points	128
4.15.4.12 n_replacements	128
4.15.4.13 n_starts	129
4.15.4.14 n_years	129
4.15.4.15 net_present_cost	129
4.15.4.16 nominal_discount_annual	129
4.15.4.17 nominal_inflation_annual	129
4.15.4.18 operation_maintenance_cost_kWh	129
4.15.4.19 operation_maintenance_cost_vec	130
4.15.4.20 print_flag	130
4.15.4.21 production_vec_kW	130
4.15.4.22 real_discount_annual	130
4.15.4.23 replace_running_hrs	130
4.15.4.24 running_hours	130
4.15.4.25 storage_vec_kW	131
4.15.4.26 total_dispatch_kWh	131
4.15.4.27 type_str	131
4.16 ProductionInputs Struct Reference	131
4.16.1 Detailed Description	132
4.16.2 Member Data Documentation	132

4.16.2.1 capacity_kW	132
4.16.2.2 is_sunk	132
4.16.2.3 nominal_discount_annual	132
4.16.2.4 nominal_inflation_annual	132
4.16.2.5 print_flag	132
4.16.2.6 replace_running_hrs	133
4.17 Renewable Class Reference	133
4.17.1 Detailed Description	135
4.17.2 Constructor & Destructor Documentation	135
4.17.2.1 Renewable() [1/2]	135
4.17.2.2 Renewable() [2/2]	135
4.17.2.3 ~Renewable()	136
4.17.3 Member Function Documentation	136
4.17.3.1 __checkInputs()	136
4.17.3.2 __handleStartStop()	137
4.17.3.3 __writeSummary()	137
4.17.3.4 __writeTimeSeries()	137
4.17.3.5 commit()	137
4.17.3.6 computeEconomics()	138
4.17.3.7 computeProductionkW() [1/2]	138
4.17.3.8 computeProductionkW() [2/2]	139
4.17.3.9 handleReplacement()	139
4.17.3.10 writeResults()	139
4.17.4 Member Data Documentation	140
4.17.4.1 resource_key	140
4.17.4.2 type	141
4.18 RenewableInputs Struct Reference	141
4.18.1 Detailed Description	141
4.18.2 Member Data Documentation	141
4.18.2.1 production_inputs	142
4.19 Resources Class Reference	142
4.19.1 Detailed Description	143
4.19.2 Constructor & Destructor Documentation	143
4.19.2.1 Resources()	143
4.19.2.2 ~Resources()	143
4.19.3 Member Function Documentation	144
4.19.3.1 __checkResourceKey1D()	144
4.19.3.2 __checkResourceKey2D()	144
4.19.3.3 __checkTimePoint()	145
4.19.3.4 __readSolarResource()	146
4.19.3.5 __readTidalResource()	147
4.19.3.6 __readWaveResource()	148

4.19.3.7	<code>__readWindResource()</code>	149
4.19.3.8	<code>__throwLengthError()</code>	149
4.19.3.9	<code>addResource()</code>	150
4.19.3.10	<code>clear()</code>	151
4.19.4	Member Data Documentation	151
4.19.4.1	<code>path_map_1D</code>	152
4.19.4.2	<code>path_map_2D</code>	152
4.19.4.3	<code>resource_map_1D</code>	152
4.19.4.4	<code>resource_map_2D</code>	152
4.19.4.5	<code>string_map_1D</code>	152
4.19.4.6	<code>string_map_2D</code>	152
4.20	Solar Class Reference	153
4.20.1	Detailed Description	154
4.20.2	Constructor & Destructor Documentation	154
4.20.2.1	<code>Solar()</code> [1/2]	155
4.20.2.2	<code>Solar()</code> [2/2]	155
4.20.2.3	<code>~Solar()</code>	156
4.20.3	Member Function Documentation	156
4.20.3.1	<code>__checkInputs()</code>	156
4.20.3.2	<code>__getGenericCapitalCost()</code>	156
4.20.3.3	<code>__getGenericOpMaintCost()</code>	157
4.20.3.4	<code>__writeSummary()</code>	157
4.20.3.5	<code>__writeTimeSeries()</code>	158
4.20.3.6	<code>commit()</code>	159
4.20.3.7	<code>computeProductionkW()</code>	160
4.20.3.8	<code>handleReplacement()</code>	160
4.20.4	Member Data Documentation	161
4.20.4.1	<code>derating</code>	161
4.21	SolarInputs Struct Reference	161
4.21.1	Detailed Description	162
4.21.2	Member Data Documentation	162
4.21.2.1	<code>capital_cost</code>	162
4.21.2.2	<code>derating</code>	162
4.21.2.3	<code>operation_maintenance_cost_kWh</code>	163
4.21.2.4	<code>renewable_inputs</code>	163
4.21.2.5	<code>resource_key</code>	163
4.22	Storage Class Reference	163
4.22.1	Detailed Description	166
4.22.2	Constructor & Destructor Documentation	166
4.22.2.1	<code>Storage()</code> [1/2]	166
4.22.2.2	<code>Storage()</code> [2/2]	166
4.22.2.3	<code>~Storage()</code>	167

4.22.3 Member Function Documentation	167
4.22.3.1 __checkInputs()	167
4.22.3.2 __computeRealDiscountAnnual()	168
4.22.3.3 __writeSummary()	169
4.22.3.4 __writeTimeSeries()	169
4.22.3.5 commitCharge()	169
4.22.3.6 commitDischarge()	169
4.22.3.7 computeEconomics()	170
4.22.3.8 getAcceptablekW()	170
4.22.3.9 getAvailablekW()	171
4.22.3.10 handleReplacement()	171
4.22.3.11 writeResults()	171
4.22.4 Member Data Documentation	172
4.22.4.1 capital_cost	172
4.22.4.2 capital_cost_vec	172
4.22.4.3 charge_kWh	173
4.22.4.4 charge_vec_kWh	173
4.22.4.5 charging_power_vec_kW	173
4.22.4.6 discharging_power_vec_kW	173
4.22.4.7 energy_capacity_kWh	173
4.22.4.8 interpolator	173
4.22.4.9 is_depleted	174
4.22.4.10 is_sunk	174
4.22.4.11 levlized_cost_of_energy_kWh	174
4.22.4.12 n_points	174
4.22.4.13 n_replacements	174
4.22.4.14 n_years	174
4.22.4.15 net_present_cost	175
4.22.4.16 nominal_discount_annual	175
4.22.4.17 nominal_inflation_annual	175
4.22.4.18 operation_maintenance_cost_kWh	175
4.22.4.19 operation_maintenance_cost_vec	175
4.22.4.20 power_capacity_kW	175
4.22.4.21 power_kW	176
4.22.4.22 print_flag	176
4.22.4.23 real_discount_annual	176
4.22.4.24 total_discharge_kWh	176
4.22.4.25 type	176
4.22.4.26 type_str	176
4.23 StorageInputs Struct Reference	177
4.23.1 Detailed Description	177
4.23.2 Member Data Documentation	177

4.23.2.1 energy_capacity_kWh	177
4.23.2.2 is_sunk	177
4.23.2.3 nominal_discount_annual	178
4.23.2.4 nominal_inflation_annual	178
4.23.2.5 power_capacity_kW	178
4.23.2.6 print_flag	178
4.24 Tidal Class Reference	179
4.24.1 Detailed Description	180
4.24.2 Constructor & Destructor Documentation	181
4.24.2.1 Tidal() [1/2]	181
4.24.2.2 Tidal() [2/2]	181
4.24.2.3 ~Tidal()	182
4.24.3 Member Function Documentation	182
4.24.3.1 __checkInputs()	182
4.24.3.2 __computeCubicProductionkW()	183
4.24.3.3 __computeExponentialProductionkW()	184
4.24.3.4 __computeLookupProductionkW()	184
4.24.3.5 __getGenericCapitalCost()	185
4.24.3.6 __getGenericOpMaintCost()	185
4.24.3.7 __writeSummary()	185
4.24.3.8 __writeTimeSeries()	187
4.24.3.9 commit()	187
4.24.3.10 computeProductionkW()	188
4.24.3.11 handleReplacement()	189
4.24.4 Member Data Documentation	190
4.24.4.1 design_speed_ms	190
4.24.4.2 power_model	190
4.24.4.3 power_model_string	190
4.25 TidalInputs Struct Reference	190
4.25.1 Detailed Description	191
4.25.2 Member Data Documentation	191
4.25.2.1 capital_cost	191
4.25.2.2 design_speed_ms	191
4.25.2.3 operation_maintenance_cost_kWh	192
4.25.2.4 power_model	192
4.25.2.5 renewable_inputs	192
4.25.2.6 resource_key	192
4.26 Wave Class Reference	193
4.26.1 Detailed Description	195
4.26.2 Constructor & Destructor Documentation	195
4.26.2.1 Wave() [1/2]	195
4.26.2.2 Wave() [2/2]	195

4.26.2.3 ~Wave()	196
4.26.3 Member Function Documentation	196
4.26.3.1 __checkInputs()	197
4.26.3.2 __computeGaussianProductionkW()	197
4.26.3.3 __computeLookupProductionkW()	198
4.26.3.4 __computeParaboloidProductionkW()	198
4.26.3.5 __getGenericCapitalCost()	200
4.26.3.6 __getGenericOpMaintCost()	201
4.26.3.7 __writeSummary()	201
4.26.3.8 __writeTimeSeries()	202
4.26.3.9 commit()	203
4.26.3.10 computeProductionkW()	204
4.26.3.11 handleReplacement()	205
4.26.4 Member Data Documentation	205
4.26.4.1 design_energy_period_s	206
4.26.4.2 design_significant_wave_height_m	206
4.26.4.3 power_model	206
4.26.4.4 power_model_string	206
4.27 WaveInputs Struct Reference	207
4.27.1 Detailed Description	208
4.27.2 Member Data Documentation	208
4.27.2.1 capital_cost	208
4.27.2.2 design_energy_period_s	208
4.27.2.3 design_significant_wave_height_m	208
4.27.2.4 operation_maintenance_cost_kWh	208
4.27.2.5 power_model	209
4.27.2.6 renewable_inputs	209
4.27.2.7 resource_key	209
4.28 Wind Class Reference	209
4.28.1 Detailed Description	211
4.28.2 Constructor & Destructor Documentation	211
4.28.2.1 Wind() [1/2]	211
4.28.2.2 Wind() [2/2]	211
4.28.2.3 ~Wind()	212
4.28.3 Member Function Documentation	213
4.28.3.1 __checkInputs()	213
4.28.3.2 __computeExponentialProductionkW()	213
4.28.3.3 __computeLookupProductionkW()	214
4.28.3.4 __getGenericCapitalCost()	214
4.28.3.5 __getGenericOpMaintCost()	215
4.28.3.6 __writeSummary()	215
4.28.3.7 __writeTimeSeries()	216

4.28.3.8 commit()	217
4.28.3.9 computeProductionkW()	218
4.28.3.10 handleReplacement()	219
4.28.4 Member Data Documentation	219
4.28.4.1 design_speed_ms	220
4.28.4.2 power_model	220
4.28.4.3 power_model_string	220
4.29 WindInputs Struct Reference	220
4.29.1 Detailed Description	221
4.29.2 Member Data Documentation	221
4.29.2.1 capital_cost	221
4.29.2.2 design_speed_ms	221
4.29.2.3 operation_maintenance_cost_kWh	222
4.29.2.4 power_model	222
4.29.2.5 renewable_inputs	222
4.29.2.6 resource_key	222
5 File Documentation	223
5.1 header/Controller.h File Reference	223
5.1.1 Detailed Description	224
5.1.2 Enumeration Type Documentation	224
5.1.2.1 ControlMode	224
5.2 header/ElectricalLoad.h File Reference	225
5.2.1 Detailed Description	225
5.3 header/Interpolator.h File Reference	226
5.3.1 Detailed Description	226
5.4 header/Model.h File Reference	226
5.4.1 Detailed Description	227
5.5 header/Production/Combustion/Combustion.h File Reference	228
5.5.1 Detailed Description	228
5.5.2 Enumeration Type Documentation	229
5.5.2.1 CombustionType	229
5.6 header/Production/Combustion/Diesel.h File Reference	229
5.6.1 Detailed Description	230
5.7 header/Production/Production.h File Reference	230
5.7.1 Detailed Description	231
5.8 header/Production/Renewable/Renewable.h File Reference	231
5.8.1 Detailed Description	232
5.8.2 Enumeration Type Documentation	232
5.8.2.1 RenewableType	232
5.9 header/Production/Renewable/Solar.h File Reference	232
5.9.1 Detailed Description	233

5.10 header/Production/Renewable/Tidal.h File Reference	233
5.10.1 Detailed Description	234
5.10.2 Enumeration Type Documentation	234
5.10.2.1 TidalPowerProductionModel	234
5.11 header/Production/Renewable/Wave.h File Reference	235
5.11.1 Detailed Description	236
5.11.2 Enumeration Type Documentation	236
5.11.2.1 WavePowerProductionModel	236
5.12 header/Production/Renewable/Wind.h File Reference	236
5.12.1 Detailed Description	237
5.12.2 Enumeration Type Documentation	237
5.12.2.1 WindPowerProductionModel	237
5.13 header/Resources.h File Reference	238
5.13.1 Detailed Description	238
5.14 header/std_includes.h File Reference	239
5.14.1 Detailed Description	239
5.15 header/Storage/Lilon.h File Reference	239
5.15.1 Detailed Description	240
5.16 header/Storage/Storage.h File Reference	240
5.16.1 Detailed Description	241
5.16.2 Enumeration Type Documentation	241
5.16.2.1 StorageType	241
5.17 pybindings/PYBIND11_PGM.cpp File Reference	242
5.17.1 Detailed Description	242
5.17.2 Function Documentation	242
5.17.2.1 PYBIND11_MODULE()	243
5.18 source/Controller.cpp File Reference	243
5.18.1 Detailed Description	244
5.19 source/ElectricalLoad.cpp File Reference	244
5.19.1 Detailed Description	244
5.20 source/Interpolator.cpp File Reference	245
5.20.1 Detailed Description	245
5.21 source/Model.cpp File Reference	245
5.21.1 Detailed Description	245
5.22 source/Production/Combustion/Combustion.cpp File Reference	246
5.22.1 Detailed Description	246
5.23 source/Production/Combustion/Diesel.cpp File Reference	246
5.23.1 Detailed Description	247
5.24 source/Production/Production.cpp File Reference	247
5.24.1 Detailed Description	247
5.25 source/Production/Renewable/Renewable.cpp File Reference	247
5.25.1 Detailed Description	248

5.26 source/Production/Renewable/Solar.cpp File Reference	248
5.26.1 Detailed Description	248
5.27 source/Production/Renewable/Tidal.cpp File Reference	248
5.27.1 Detailed Description	249
5.28 source/Production/Renewable/Wave.cpp File Reference	249
5.28.1 Detailed Description	249
5.29 source/Production/Renewable/Wind.cpp File Reference	250
5.29.1 Detailed Description	250
5.30 source/Resources.cpp File Reference	250
5.30.1 Detailed Description	251
5.31 source/Storage/Lilon.cpp File Reference	251
5.31.1 Detailed Description	251
5.32 source/Storage/Storage.cpp File Reference	251
5.32.1 Detailed Description	252
5.33 test/source/Production/Combustion/test_Combustion.cpp File Reference	252
5.33.1 Detailed Description	252
5.33.2 Function Documentation	252
5.33.2.1 main()	253
5.34 test/source/Production/Combustion/test_Diesel.cpp File Reference	254
5.34.1 Detailed Description	254
5.34.2 Function Documentation	255
5.34.2.1 main()	255
5.35 test/source/Production/Renewable/test_Renewable.cpp File Reference	259
5.35.1 Detailed Description	260
5.35.2 Function Documentation	260
5.35.2.1 main()	260
5.36 test/source/Production/Renewable/test_Solar.cpp File Reference	261
5.36.1 Detailed Description	261
5.36.2 Function Documentation	262
5.36.2.1 main()	262
5.37 test/source/Production/Renewable/test_Tidal.cpp File Reference	265
5.37.1 Detailed Description	265
5.37.2 Function Documentation	265
5.37.2.1 main()	266
5.38 test/source/Production/Renewable/test_Wave.cpp File Reference	268
5.38.1 Detailed Description	269
5.38.2 Function Documentation	269
5.38.2.1 main()	269
5.39 test/source/Production/Renewable/test_Wind.cpp File Reference	272
5.39.1 Detailed Description	273
5.39.2 Function Documentation	273
5.39.2.1 main()	273

5.40 test/source/Production/test_Production.cpp File Reference	276
5.40.1 Detailed Description	277
5.40.2 Function Documentation	277
5.40.2.1 main()	277
5.41 test/source/Storage/test_Lilon.cpp File Reference	279
5.41.1 Detailed Description	279
5.41.2 Function Documentation	279
5.41.2.1 main()	280
5.42 test/source/Storage/test_Storage.cpp File Reference	282
5.42.1 Detailed Description	282
5.42.2 Function Documentation	282
5.42.2.1 main()	283
5.43 test/source/test_Controller.cpp File Reference	284
5.43.1 Detailed Description	285
5.43.2 Function Documentation	285
5.43.2.1 main()	285
5.44 test/source/test_ElectricalLoad.cpp File Reference	286
5.44.1 Detailed Description	286
5.44.2 Function Documentation	286
5.44.2.1 main()	286
5.45 test/source/test_Interpolator.cpp File Reference	288
5.45.1 Detailed Description	289
5.45.2 Function Documentation	289
5.45.2.1 main()	289
5.46 test/source/test_Model.cpp File Reference	292
5.46.1 Detailed Description	293
5.46.2 Function Documentation	293
5.46.2.1 main()	293
5.47 test/source/test_Resources.cpp File Reference	301
5.47.1 Detailed Description	301
5.47.2 Function Documentation	301
5.47.2.1 main()	302
5.48 test/utls/testing_utils.cpp File Reference	307
5.48.1 Detailed Description	308
5.48.2 Function Documentation	308
5.48.2.1 expectedErrorNotDetected()	308
5.48.2.2 printGold()	309
5.48.2.3 printGreen()	309
5.48.2.4 printRed()	309
5.48.2.5 testFloatEquals()	310
5.48.2.6 testGreaterThan()	310
5.48.2.7 testGreaterThanOrEqualTo()	311

5.48.2.8 testLessThan()	312
5.48.2.9 testLessThanOrEqualTo()	312
5.48.2.10 testTruth()	313
5.49 test/utls/testing_utils.h File Reference	313
5.49.1 Detailed Description	314
5.49.2 Macro Definition Documentation	315
5.49.2.1 FLOAT_TOLERANCE	315
5.49.3 Function Documentation	315
5.49.3.1 expectedErrorNotDetected()	315
5.49.3.2 printGold()	315
5.49.3.3 printGreen()	316
5.49.3.4 printRed()	316
5.49.3.5 testFloatEquals()	316
5.49.3.6 testGreaterThan()	317
5.49.3.7 testGreaterThanOrEqualTo()	318
5.49.3.8 testLessThan()	318
5.49.3.9 testLessThanOrEqualTo()	319
5.49.3.10 testTruth()	319
Bibliography	321
Index	323

Chapter 1

Hierarchical Index

1.1 Class Hierarchy

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

CombustionInputs	23
Controller	24
DieselInputs	54
ElectricalLoad	58
Emissions	63
Interpolator	65
InterpolatorStruct1D	74
InterpolatorStruct2D	75
LilonInputs	96
Model	101
ModelInputs	117
Production	119
Combustion	9
Diesel	41
Renewable	133
Solar	153
Tidal	179
Wave	193
Wind	209
ProductionInputs	131
RenewableInputs	141
Resources	142
SolarInputs	161
Storage	163
Lilon	77
StorageInputs	177
TidalInputs	190
WaveInputs	207
WindInputs	220

Chapter 2

Class Index

2.1 Class List

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

Combustion	The root of the Combustion branch of the Production hierarchy. This branch contains derived classes which model the production of energy by way of combustibles	9
CombustionInputs	A structure which bundles the necessary inputs for the Combustion constructor. Provides default values for every necessary input. Note that this structure encapsulates ProductionInputs . . .	23
Controller	A class which contains a various dispatch control logic. Intended to serve as a component class of Model	24
Diesel	A derived class of the Combustion branch of Production which models production using a diesel generator	41
DieselInputs	A structure which bundles the necessary inputs for the Diesel constructor. Provides default values for every necessary input. Note that this structure encapsulates CombustionInputs . . .	54
ElectricalLoad	A class which contains time and electrical load data. Intended to serve as a component class of Model	58
Emissions	A structure which bundles the emitted masses of various emissions chemistries	63
Interpolator	A class which contains interpolation data and functionality. Intended to serve as a component of the Production and Storage hierarchies	65
InterpolatorStruct1D	A struct which holds two parallel vectors for use in 1D interpolation	74
InterpolatorStruct2D	A struct which holds two parallel vectors and a matrix for use in 2D interpolation	75
Lilon	A derived class of Storage which models energy storage by way of lithium-ion batteries	77
LilonInputs	A structure which bundles the necessary inputs for the Lilon constructor. Provides default values for every necessary input. Note that this structure encapsulates StorageInputs	96
Model	A container class which forms the centre of PGMcpp. The Model class is intended to serve as the primary user interface with the functionality of PGMcpp, and as such it contains all other classes	101

ModellInputs	A structure which bundles the necessary inputs for the Model constructor. Provides default values for every necessary input (except <code>path_2_electrical_load_time_series</code> , for which a valid input must be provided)	117
Production	The base class of the Production hierarchy. This hierarchy contains derived classes which model the production of energy, be it renewable or otherwise	119
ProductionInputs	A structure which bundles the necessary inputs for the Production constructor. Provides default values for every necessary input	131
Renewable	The root of the Renewable branch of the Production hierarchy. This branch contains derived classes which model the renewable production of energy	133
RenewableInputs	A structure which bundles the necessary inputs for the Renewable constructor. Provides default values for every necessary input. Note that this structure encapsulates ProductionInputs . . .	141
Resources	A class which contains renewable resource data. Intended to serve as a component class of Model	142
Solar	A derived class of the Renewable branch of Production which models solar production	153
SolarInputs	A structure which bundles the necessary inputs for the Solar constructor. Provides default values for every necessary input. Note that this structure encapsulates RenewableInputs	161
Storage	The base class of the Storage hierarchy. This hierarchy contains derived classes which model the storage of energy	163
StorageInputs	A structure which bundles the necessary inputs for the Storage constructor. Provides default values for every necessary input	177
Tidal	A derived class of the Renewable branch of Production which models tidal production	179
TidalInputs	A structure which bundles the necessary inputs for the Tidal constructor. Provides default values for every necessary input. Note that this structure encapsulates RenewableInputs	190
Wave	A derived class of the Renewable branch of Production which models wave production	193
WaveInputs	A structure which bundles the necessary inputs for the Wave constructor. Provides default values for every necessary input. Note that this structure encapsulates RenewableInputs	207
Wind	A derived class of the Renewable branch of Production which models wind production	209
WindInputs	A structure which bundles the necessary inputs for the Wind constructor. Provides default values for every necessary input. Note that this structure encapsulates RenewableInputs	220

Chapter 3

File Index

3.1 File List

Here is a list of all files with brief descriptions:

header/ Controller.h	Header file for the Controller class	223
header/ ElectricalLoad.h	Header file for the ElectricalLoad class	225
header/ Interpolator.h	Header file for the Interpolator class	226
header/ Model.h	Header file for the Model class	226
header/ Resources.h	Header file for the Resources class	238
header/ std_includes.h	Header file which simply batches together some standard includes	239
header/Production/ Production.h	Header file for the Production class	230
header/Production/Combustion/ Combustion.h	Header file for the Combustion class	228
header/Production/Combustion/ Diesel.h	Header file for the Diesel class	229
header/Production/Renewable/ Renewable.h	Header file for the Renewable class	231
header/Production/Renewable/ Solar.h	Header file for the Solar class	232
header/Production/Renewable/ Tidal.h	Header file for the Tidal class	233
header/Production/Renewable/ Wave.h	Header file for the Wave class	235
header/Production/Renewable/ Wind.h	Header file for the Wind class	236
header/Storage/ Lilon.h	Header file for the Lilon class	239
header/Storage/ Storage.h	Header file for the Storage class	240
pybindings/ PYBIND11_PGM.cpp	Python 3 bindings file for PGMcpp	242
source/ Controller.cpp	Implementation file for the Controller class	243

source/ ElectricalLoad.cpp	
Implementation file for the ElectricalLoad class	244
source/ Interpolator.cpp	
Implementation file for the Interpolator class	245
source/ Model.cpp	
Implementation file for the Model class	245
source/ Resources.cpp	
Implementation file for the Resources class	250
source/Production/ Production.cpp	
Implementation file for the Production class	247
source/Production/Combustion/ Combustion.cpp	
Implementation file for the Combustion class	246
source/Production/Combustion/ Diesel.cpp	
Implementation file for the Diesel class	246
source/Production/Renewable/ Renewable.cpp	
Implementation file for the Renewable class	247
source/Production/Renewable/ Solar.cpp	
Implementation file for the Solar class	248
source/Production/Renewable/ Tidal.cpp	
Implementation file for the Tidal class	248
source/Production/Renewable/ Wave.cpp	
Implementation file for the Wave class	249
source/Production/Renewable/ Wind.cpp	
Implementation file for the Wind class	250
source/Storage/ Lilon.cpp	
Implementation file for the Lilon class	251
source/Storage/ Storage.cpp	
Implementation file for the Storage class	251
test/source/ test_Controller.cpp	
Testing suite for Controller class	284
test/source/ test_ElectricalLoad.cpp	
Testing suite for ElectricalLoad class	286
test/source/ test_Interpolator.cpp	
Testing suite for Interpolator class	288
test/source/ test_Model.cpp	
Testing suite for Model class	292
test/source/ test_Resources.cpp	
Testing suite for Resources class	301
test/source/Production/ test_Production.cpp	
Testing suite for Production class	276
test/source/Production/Combustion/ test_Combustion.cpp	
Testing suite for Combustion class	252
test/source/Production/Combustion/ test_Diesel.cpp	
Testing suite for Diesel class	254
test/source/Production/Renewable/ test_Renewable.cpp	
Testing suite for Renewable class	259
test/source/Production/Renewable/ test_Solar.cpp	
Testing suite for Solar class	261
test/source/Production/Renewable/ test_Tidal.cpp	
Testing suite for Tidal class	265
test/source/Production/Renewable/ test_Wave.cpp	
Testing suite for Wave class	268
test/source/Production/Renewable/ test_Wind.cpp	
Testing suite for Wind class	272
test/source/Storage/ test_Lilon.cpp	
Testing suite for Lilon class	279
test/source/Storage/ test_Storage.cpp	
Testing suite for Storage class	282

test/utls/ testing_utils.cpp	
Header file for various PGMcpp testing utilities	307
test/utls/ testing_utils.h	
Header file for various PGMcpp testing utilities	313

Chapter 4

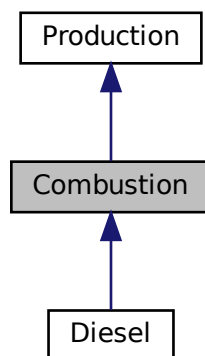
Class Documentation

4.1 Combustion Class Reference

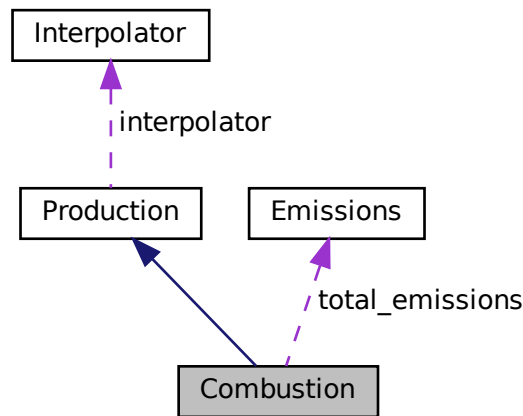
The root of the [Combustion](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the production of energy by way of combustibles.

```
#include <Combustion.h>
```

Inheritance diagram for Combustion:



Collaboration diagram for Combustion:



Public Member Functions

- **Combustion** (void)
*Constructor (dummy) for the **Combustion** class.*
- **Combustion** (int, double, **CombustionInputs**)
*Constructor (intended) for the **Combustion** class.*
- virtual void **handleReplacement** (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- void **computeFuelAndEmissions** (void)
*Helper method to compute the total fuel consumption and emissions over the **Model** run.*
- void **computeEconomics** (std::vector< double > *)
*Helper method to compute key economic metrics for the **Model** run.*
- virtual double **requestProductionkW** (int, double, double)
- virtual double **commit** (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- double **getFuelConsumptionL** (double, double)
Method which takes in production and returns volume of fuel burned over the given interval of time.
- **Emissions** **getEmissionskg** (double)
Method which takes in volume of fuel consumed and returns mass spectrum of resulting emissions.
- void **writeResults** (std::string, std::vector< double > *, int, int=-1)
*Method which writes **Combustion** results to an output directory.*
- virtual **~Combustion** (void)
*Destructor for the **Combustion** class.*

Public Attributes

- [CombustionType](#) type
The type (CombustionType) of the asset.
- double [fuel_cost_L](#)
The cost of fuel [1/L] (undefined currency).
- double [nominal_fuel_escalation_annual](#)
The nominal, annual fuel escalation rate to use in computing model economics.
- double [real_fuel_escalation_annual](#)
The real, annual fuel escalation rate used in computing model economics. Is computed from the given nominal inflation and discount rates.
- double [linear_fuel_slope_LkWh](#)
The slope [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced.
- double [linear_fuel_intercept_LkWh](#)
The intercept [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced.
- double [CO2_emissions_intensity_kgL](#)
Carbon dioxide (CO2) emissions intensity [kg/L].
- double [CO_emissions_intensity_kgL](#)
Carbon monoxide (CO) emissions intensity [kg/L].
- double [NOx_emissions_intensity_kgL](#)
Nitrogen oxide (NOx) emissions intensity [kg/L].
- double [SOx_emissions_intensity_kgL](#)
Sulfur oxide (SOx) emissions intensity [kg/L].
- double [CH4_emissions_intensity_kgL](#)
Methane (CH4) emissions intensity [kg/L].
- double [PM_emissions_intensity_kgL](#)
Particulate Matter (PM) emissions intensity [kg/L].
- double [total_fuel_consumed_L](#)
The total fuel consumed [L] over a model run.
- [Emissions](#) total_emissions
An [Emissions](#) structure for holding total emissions [kg].
- `std::vector< double >` [fuel_consumption_vec_L](#)
A vector of fuel consumed [L] over each modelling time step.
- `std::vector< double >` [fuel_cost_vec](#)
A vector of fuel costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).
- `std::vector< double >` [CO2_emissions_vec_kg](#)
A vector of carbon dioxide (CO2) emitted [kg] over each modelling time step.
- `std::vector< double >` [CO_emissions_vec_kg](#)
A vector of carbon monoxide (CO) emitted [kg] over each modelling time step.
- `std::vector< double >` [NOx_emissions_vec_kg](#)
A vector of nitrogen oxide (NOx) emitted [kg] over each modelling time step.
- `std::vector< double >` [SOx_emissions_vec_kg](#)
A vector of sulfur oxide (SOx) emitted [kg] over each modelling time step.
- `std::vector< double >` [CH4_emissions_vec_kg](#)
A vector of methane (CH4) emitted [kg] over each modelling time step.
- `std::vector< double >` [PM_emissions_vec_kg](#)
A vector of particulate matter (PM) emitted [kg] over each modelling time step.

Private Member Functions

- void `__checkInputs` (`CombustionInputs`)
Helper method to check inputs to the `Combustion` constructor.
- virtual void `__writeSummary` (`std::string`)
- virtual void `__writeTimeSeries` (`std::string`, `std::vector< double > *`, `int=-1`)

4.1.1 Detailed Description

The root of the `Combustion` branch of the `Production` hierarchy. This branch contains derived classes which model the production of energy by way of combustibles.

4.1.2 Constructor & Destructor Documentation

4.1.2.1 `Combustion()` [1/2]

```
Combustion::Combustion (
    void )
```

Constructor (dummy) for the `Combustion` class.

```
63 {
64     return;
65 } /* Combustion() */
```

4.1.2.2 `Combustion()` [2/2]

```
Combustion::Combustion (
    int n_points,
    double n_years,
    CombustionInputs combustion_inputs )
```

Constructor (intended) for the `Combustion` class.

Parameters

<code>n_points</code>	The number of points in the modelling time series.
<code>n_years</code>	The number of years being modelled.
<code>combustion_inputs</code>	A structure of <code>Combustion</code> constructor inputs.

```
93 :
94 Production (
95     n_points,
96     n_years,
97     combustion_inputs.production_inputs
98 )
99 {
100     // 1. check inputs
101     this->__checkInputs(combustion_inputs);
102 }
```



```

103 // 2. set attributes
104 this->fuel_cost_L = 0;
105 this->nominal_fuel_escalation_annual =
106     combustion_inputs.nominal_fuel_escalation_annual;
107
108 this->real_fuel_escalation_annual = this->computeRealDiscountAnnual(
109     combustion_inputs.nominal_fuel_escalation_annual,
110     combustion_inputs.production_inputs.nominal_discount_annual
111 );
112
113 this->linear_fuel_slope_LkWh = 0;
114 this->linear_fuel_intercept_LkWh = 0;
115
116 this->CO2_emissions_intensity_kgL = 0;
117 this->CO_emissions_intensity_kgL = 0;
118 this->NOx_emissions_intensity_kgL = 0;
119 this->SOx_emissions_intensity_kgL = 0;
120 this->CH4_emissions_intensity_kgL = 0;
121 this->PM_emissions_intensity_kgL = 0;
122
123 this->total_fuel_consumed_L = 0;
124
125 this->fuel_consumption_vec_L.resize(this->n_points, 0);
126 this->fuel_cost_vec.resize(this->n_points, 0);
127
128 this->CO2_emissions_vec_kg.resize(this->n_points, 0);
129 this->CO_emissions_vec_kg.resize(this->n_points, 0);
130 this->NOx_emissions_vec_kg.resize(this->n_points, 0);
131 this->SOx_emissions_vec_kg.resize(this->n_points, 0);
132 this->CH4_emissions_vec_kg.resize(this->n_points, 0);
133 this->PM_emissions_vec_kg.resize(this->n_points, 0);
134
135 // 3. construction print
136 if (this->print_flag) {
137     std::cout << "Combustion object constructed at " << this << std::endl;
138 }
139
140 return;
141 } /* Combustion() */

```

4.1.2.3 ~Combustion()

```

Combustion::~Combustion (
    void ) [virtual]

```

Destructor for the [Combustion](#) class.

```

448 {
449     // 1. destruction print
450     if (this->print_flag) {
451         std::cout << "Combustion object at " << this << " destroyed" << std::endl;
452     }
453
454     return;
455 } /* ~Combustion() */

```

4.1.3 Member Function Documentation

4.1.3.1 __checkInputs()

```

void Combustion::__checkInputs (
    CombustionInputs combustion_inputs ) [private]

```

Helper method to check inputs to the [Combustion](#) constructor.

Parameters

<i>combustion_inputs</i>	A structure of Combustion constructor inputs.
--------------------------	---

```

40 {
41     // ...
42
43     return;
44 } /* __checkInputs() */

```

4.1.3.2 __writeSummary()

```

virtual void Combustion::__writeSummary (
    std::string ) [inline], [private], [virtual]

```

Reimplemented in [Diesel](#).

```

87 {return;}

```

4.1.3.3 __writeTimeSeries()

```

virtual void Combustion::__writeTimeSeries (
    std::string ,
    std::vector< double > * ,
    int = -1 ) [inline], [private], [virtual]

```

Reimplemented in [Diesel](#).

```

92 {return;}

```

4.1.3.4 commit()

```

double Combustion::commit (
    int timestep,
    double dt_hrs,
    double production_kW,
    double load_kW ) [virtual]

```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented from [Production](#).

Reimplemented in [Diesel](#).

```

271 {
272     // 1. invoke base class method
273     load_kW = Production::commit(
274         timestep,
275         dt_hrs,
276         production_kW,
277         load_kW
278     );
279
280
281     if (this->is_running) {
282         // 2. compute and record fuel consumption
283         double fuel_consumed_L = this->getFuelConsumptionL(dt_hrs, production_kW);
284         this->fuel_consumption_vec_L[timestep] = fuel_consumed_L;
285
286         // 3. compute and record emissions
287         Emissions emissions = this->getEmissionskg(fuel_consumed_L);
288         this->CO2_emissions_vec_kg[timestep] = emissions.CO2_kg;
289         this->CO_emissions_vec_kg[timestep] = emissions.CO_kg;
290         this->NOx_emissions_vec_kg[timestep] = emissions.NOx_kg;
291         this->SOx_emissions_vec_kg[timestep] = emissions.SOx_kg;
292         this->CH4_emissions_vec_kg[timestep] = emissions.CH4_kg;
293         this->PM_emissions_vec_kg[timestep] = emissions.PM_kg;
294
295         // 4. incur fuel costs
296         this->fuel_cost_vec[timestep] = fuel_consumed_L * this->fuel_cost_L;
297     }
298
299     return load_kW;
300 } /* commit() */

```

4.1.3.5 computeEconomics()

```

void Combustion::computeEconomics (
    std::vector< double > * time_vec_hrs_ptr ) [virtual]

```

Helper method to compute key economic metrics for the [Model](#) run.

Ref: [HOMER \[2023b\]](#)

Parameters

<i>time_vec_hrs_ptr</i>	A pointer to the <i>time_vec_hrs</i> attribute of the ElectricalLoad .
-------------------------	--

Reimplemented from [Production](#).

```

215 {
216     // 1. account for fuel costs in net present cost
217     double t_hrs = 0;
218     double real_fuel_escalation_scalar = 0;
219
220     for (int i = 0; i < this->n_points; i++) {
221         t_hrs = time_vec_hrs_ptr->at(i);
222
223         real_fuel_escalation_scalar = 1.0 / pow(
224             1 + this->real_fuel_escalation_annual,
225             t_hrs / 8760
226         );
227
228         this->net_present_cost += real_fuel_escalation_scalar * this->fuel_cost_vec[i];
229     }

```

```

230
231 // 2. invoke base class method
232 Production::computeEconomics(time_vec_hrs_ptr);
233
234 return;
235 } /* computeEconomics() */

```

4.1.3.6 computeFuelAndEmissions()

```

void Combustion::computeFuelAndEmissions (
    void )

```

Helper method to compute the total fuel consumption and emissions over the [Model](#) run.

```

183 {
184     for (int i = 0; i < n_points; i++) {
185         this->total_fuel_consumed_L += this->fuel_consumption_vec_L[i];
186
187         this->total_emissions.CO2_kg += this->CO2_emissions_vec_kg[i];
188         this->total_emissions.CO_kg += this->CO_emissions_vec_kg[i];
189         this->total_emissions.NOx_kg += this->NOx_emissions_vec_kg[i];
190         this->total_emissions.SOx_kg += this->SOx_emissions_vec_kg[i];
191         this->total_emissions.CH4_kg += this->CH4_emissions_vec_kg[i];
192         this->total_emissions.PM_kg += this->PM_emissions_vec_kg[i];
193     }
194
195     return;
196 } /* computeFuelAndEmissions() */

```

4.1.3.7 getEmissionskg()

```

Emissions Combustion::getEmissionskg (
    double fuel_consumed_L )

```

Method which takes in volume of fuel consumed and returns mass spectrum of resulting emissions.

Parameters

<i>fuel_consumed_L</i>	The volume of fuel consumed [L].
------------------------	----------------------------------

Returns

A structure containing the mass spectrum of resulting emissions.

```

348                                     {
349     Emissions emissions;
350
351     emissions.CO2_kg = this->CO2_emissions_intensity_kgL * fuel_consumed_L;
352     emissions.CO_kg = this->CO_emissions_intensity_kgL * fuel_consumed_L;
353     emissions.NOx_kg = this->NOx_emissions_intensity_kgL * fuel_consumed_L;
354     emissions.SOx_kg = this->SOx_emissions_intensity_kgL * fuel_consumed_L;
355     emissions.CH4_kg = this->CH4_emissions_intensity_kgL * fuel_consumed_L;
356     emissions.PM_kg = this->PM_emissions_intensity_kgL * fuel_consumed_L;
357
358     return emissions;
359 } /* getEmissionskg() */

```

4.1.3.8 getFuelConsumptionL()

```
double Combustion::getFuelConsumptionL (
    double dt_hrs,
    double production_kW )
```

Method which takes in production and returns volume of fuel burned over the given interval of time.

Parameters

<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.

Returns

The volume of fuel consumed [L].

```
322 {
323     double fuel_consumed_L = (
324         this->linear_fuel_slope_LkWh * production_kW +
325         this->linear_fuel_intercept_LkWh * this->capacity_kW
326     ) * dt_hrs;
327
328     return fuel_consumed_L;
329 } /* getFuelConsumptionL() */
```

4.1.3.9 handleReplacement()

```
void Combustion::handleReplacement (
    int timestep ) [virtual]
```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Production](#).

Reimplemented in [Diesel](#).

```
159 {
160     // 1. reset attributes
161     //...
162
163     // 2. invoke base class method
164     Production::handleReplacement(timestep);
165
166     return;
167 } /* __handleReplacement() */
```

4.1.3.10 requestProductionkW()

```
virtual double Combustion::requestProductionkW (
    int ,
```

```
double ,
double ) [inline], [virtual]
```

Reimplemented in [Diesel](#).

```
135 {return 0;}
```

4.1.3.11 writeResults()

```
void Combustion::writeResults (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    int combustion_index,
    int max_lines = -1 )
```

Method which writes [Combustion](#) results to an output directory.

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <code>time_vec_hrs</code> attribute of the ElectricalLoad .
<i>combustion_index</i>	An integer which corresponds to the index of the Combustion asset in the Model .
<i>max_lines</i>	The maximum number of lines of output to write. If <0, then all available lines are written. If =0, then only summary results are written.

```
395 {
396     // 1. handle sentinel
397     if (max_lines < 0) {
398         max_lines = this->n_points;
399     }
400
401     // 2. create subdirectories
402     write_path += "Production/";
403     if (not std::filesystem::is_directory(write_path)) {
404         std::filesystem::create_directory(write_path);
405     }
406
407     write_path += "Combustion/";
408     if (not std::filesystem::is_directory(write_path)) {
409         std::filesystem::create_directory(write_path);
410     }
411
412     write_path += this->type_str;
413     write_path += "_";
414     write_path += std::to_string(int(ceil(this->capacity_kW)));
415     write_path += "kW_idx";
416     write_path += std::to_string(combustion_index);
417     write_path += "/";
418     std::filesystem::create_directory(write_path);
419
420     // 3. write summary
421     this->__writeSummary(write_path);
422
423     // 4. write time series
424     if (max_lines > this->n_points) {
425         max_lines = this->n_points;
426     }
427
428     if (max_lines > 0) {
429         this->__writeTimeSeries(write_path, time_vec_hrs_ptr, max_lines);
430     }
431
432     return;
433 } /* writeResults() */
```

4.1.4 Member Data Documentation

4.1.4.1 CH4_emissions_intensity_kgL

```
double Combustion::CH4_emissions_intensity_kgL
```

Methane (CH4) emissions intensity [kg/L].

4.1.4.2 CH4_emissions_vec_kg

```
std::vector<double> Combustion::CH4_emissions_vec_kg
```

A vector of methane (CH4) emitted [kg] over each modelling time step.

4.1.4.3 CO2_emissions_intensity_kgL

```
double Combustion::CO2_emissions_intensity_kgL
```

Carbon dioxide (CO2) emissions intensity [kg/L].

4.1.4.4 CO2_emissions_vec_kg

```
std::vector<double> Combustion::CO2_emissions_vec_kg
```

A vector of carbon dioxide (CO2) emitted [kg] over each modelling time step.

4.1.4.5 CO_emissions_intensity_kgL

```
double Combustion::CO_emissions_intensity_kgL
```

Carbon monoxide (CO) emissions intensity [kg/L].

4.1.4.6 CO_emissions_vec_kg

```
std::vector<double> Combustion::CO_emissions_vec_kg
```

A vector of carbon monoxide (CO) emitted [kg] over each modelling time step.

4.1.4.7 fuel_consumption_vec_L

```
std::vector<double> Combustion::fuel_consumption_vec_L
```

A vector of fuel consumed [L] over each modelling time step.

4.1.4.8 fuel_cost_L

```
double Combustion::fuel_cost_L
```

The cost of fuel [1/L] (undefined currency).

4.1.4.9 fuel_cost_vec

```
std::vector<double> Combustion::fuel_cost_vec
```

A vector of fuel costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).

4.1.4.10 linear_fuel_intercept_LkWh

```
double Combustion::linear_fuel_intercept_LkWh
```

The intercept [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced.

4.1.4.11 linear_fuel_slope_LkWh

```
double Combustion::linear_fuel_slope_LkWh
```

The slope [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced.

4.1.4.12 nominal_fuel_escalation_annual

```
double Combustion::nominal_fuel_escalation_annual
```

The nominal, annual fuel escalation rate to use in computing model economics.

4.1.4.13 NOx_emissions_intensity_kgL

```
double Combustion::NOx_emissions_intensity_kgL
```

Nitrogen oxide (NOx) emissions intensity [kg/L].

4.1.4.14 NOx_emissions_vec_kg

```
std::vector<double> Combustion::NOx_emissions_vec_kg
```

A vector of nitrogen oxide (NOx) emitted [kg] over each modelling time step.

4.1.4.15 PM_emissions_intensity_kgL

```
double Combustion::PM_emissions_intensity_kgL
```

Particulate Matter (PM) emissions intensity [kg/L].

4.1.4.16 PM_emissions_vec_kg

```
std::vector<double> Combustion::PM_emissions_vec_kg
```

A vector of particulate matter (PM) emitted [kg] over each modelling time step.

4.1.4.17 real_fuel_escalation_annual

```
double Combustion::real_fuel_escalation_annual
```

The real, annual fuel escalation rate used in computing model economics. Is computed from the given nominal inflation and discount rates.

4.1.4.18 SOx_emissions_intensity_kgL

```
double Combustion::SOx_emissions_intensity_kgL
```

Sulfur oxide (SOx) emissions intensity [kg/L].

4.1.4.19 SOx_emissions_vec_kg

```
std::vector<double> Combustion::SOx_emissions_vec_kg
```

A vector of sulfur oxide (SOx) emitted [kg] over each modelling time step.

4.1.4.20 total_emissions

```
Emissions Combustion::total_emissions
```

An [Emissions](#) structure for holding total emissions [kg].

4.1.4.21 total_fuel_consumed_L

```
double Combustion::total_fuel_consumed_L
```

The total fuel consumed [L] over a model run.

4.1.4.22 type

```
CombustionType Combustion::type
```

The type (CombustionType) of the asset.

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

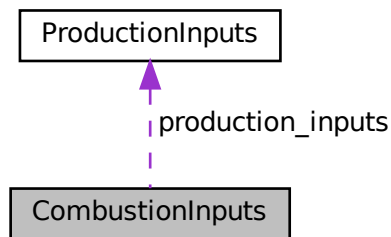
- [header/Production/Combustion/Combustion.h](#)
- [source/Production/Combustion/Combustion.cpp](#)

4.2 CombustionInputs Struct Reference

A structure which bundles the necessary inputs for the [Combustion](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [ProductionInputs](#).

```
#include <Combustion.h>
```

Collaboration diagram for CombustionInputs:



Public Attributes

- [ProductionInputs](#) `production_inputs`
An encapsulated [ProductionInputs](#) instance.
- double `nominal_fuel_escalation_annual` = 0.05
The nominal, annual fuel escalation rate to use in computing model economics.

4.2.1 Detailed Description

A structure which bundles the necessary inputs for the [Combustion](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [ProductionInputs](#).

4.2.2 Member Data Documentation

4.2.2.1 nominal_fuel_escalation_annual

```
double CombustionInputs::nominal_fuel_escalation_annual = 0.05
```

The nominal, annual fuel escalation rate to use in computing model economics.

4.2.2.2 production_inputs

`ProductionInputs` `CombustionInputs::production_inputs`

An encapsulated `ProductionInputs` instance.

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

- `header/Production/Combustion/Combustion.h`

4.3 Controller Class Reference

A class which contains a various dispatch control logic. Intended to serve as a component class of `Model`.

```
#include <Controller.h>
```

Public Member Functions

- `Controller` (void)
Constructor for the `Controller` class.
- void `setControlMode` (`ControlMode`)
- void `init` (`ElectricalLoad` *, `std::vector`< `Renewable` * > *, `Resources` *, `std::vector`< `Combustion` * > *)
Method to initialize the `Controller` component of the `Model`.
- void `applyDispatchControl` (`ElectricalLoad` *, `std::vector`< `Combustion` * > *, `std::vector`< `Renewable` * > *, `std::vector`< `Storage` * > *)
Method to apply dispatch control at every point in the modelling time series.
- void `clear` (void)
Method to clear all attributes of the `Controller` object.
- `~Controller` (void)
Destructor for the `Controller` class.

Public Attributes

- `ControlMode` `control_mode`
The `ControlMode` that is active in the `Model`.
- `std::string` `control_string`
A string describing the active `ControlMode`.
- `std::vector`< `double` > `net_load_vec_kW`
A vector of net load values [kW] at each point in the modelling time series. Net load is defined as load minus all available `Renewable` production.
- `std::vector`< `double` > `missed_load_vec_kW`
A vector of missed load values [kW] at each point in the modelling time series.
- `std::map`< `double`, `std::vector`< `bool` > > `combustion_map`
A map of all possible combustion states, for use in determining optimal dispatch.

Private Member Functions

- void `__computeNetLoad` (`ElectricalLoad *`, `std::vector< Renewable * > *`, `Resources *`)
Helper method to compute and populate the net load vector.
- void `__constructCombustionMap` (`std::vector< Combustion * > *`)
Helper method to construct a `Combustion` map, for use in determining.
- void `__applyLoadFollowingControl_CHARGING` (`int`, `ElectricalLoad *`, `std::vector< Combustion * > *`, `std::vector< Renewable * > *`, `std::vector< Storage * > *`)
Helper method to apply load following control action for given timestep of the `Model` run when net load ≤ 0 .
- void `__applyLoadFollowingControl_DISCHARGING` (`int`, `ElectricalLoad *`, `std::vector< Combustion * > *`, `std::vector< Renewable * > *`, `std::vector< Storage * > *`)
Helper method to apply load following control action for given timestep of the `Model` run when net load > 0 .
- void `__applyCycleChargingControl_CHARGING` (`int`, `ElectricalLoad *`, `std::vector< Combustion * > *`, `std::vector< Renewable * > *`, `std::vector< Storage * > *`)
Helper method to apply cycle charging control action for given timestep of the `Model` run when net load ≤ 0 . Simply defaults to load following control.
- void `__applyCycleChargingControl_DISCHARGING` (`int`, `ElectricalLoad *`, `std::vector< Combustion * > *`, `std::vector< Renewable * > *`, `std::vector< Storage * > *`)
Helper method to apply cycle charging control action for given timestep of the `Model` run when net load > 0 . Defaults to load following control if no depleted storage assets.
- void `__handleStorageCharging` (`int`, `double`, `std::list< Storage * > *`, `std::vector< Combustion * > *`, `std::vector< Renewable * > *`)
Helper method to handle the charging of the given `Storage` assets.
- void `__handleStorageCharging` (`int`, `double`, `std::vector< Storage * > *`, `std::vector< Combustion * > *`, `std::vector< Renewable * > *`)
Helper method to handle the charging of the given `Storage` assets.
- double `__getRenewableProduction` (`int`, `double`, `Renewable *`, `Resources *`)
Helper method to compute the production from the given `Renewable` asset at the given point in time.
- double `__handleCombustionDispatch` (`int`, `double`, `double`, `std::vector< Combustion * > *`, `bool`)
bool is_cycle_charging)
- double `__handleStorageDischarging` (`int`, `double`, `double`, `std::list< Storage * > *`)
Helper method to handle the discharging of the given `Storage` assets.

4.3.1 Detailed Description

A class which contains a various dispatch control logic. Intended to serve as a component class of `Model`.

4.3.2 Constructor & Destructor Documentation

4.3.2.1 Controller()

```
Controller::Controller (
    void )
```

Constructor for the `Controller` class.

```
1000 {
1001     return;
1002 } /* Controller() */
```

4.3.2.2 ~Controller()

```
Controller::~~Controller (
    void )
```

Destructor for the [Controller](#) class.

```
1229 {
1230     this->clear();
1231
1232     return;
1233 } /* ~Controller() */
```

4.3.3 Member Function Documentation

4.3.3.1 __applyCycleChargingControl_CHARGING()

```
void Controller::__applyCycleChargingControl_CHARGING (
    int timestep,
    ElectricalLoad * electrical_load_ptr,
    std::vector< Combustion * > * combustion_ptr_vec_ptr,
    std::vector< Renewable * > * renewable_ptr_vec_ptr,
    std::vector< Storage * > * storage_ptr_vec_ptr ) [private]
```

Helper method to apply cycle charging control action for given timestep of the [Model](#) run when net load <= 0. Simply defaults to load following control.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>electrical_load_ptr</i>	A pointer to the ElectricalLoad component of the Model .
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .
<i>storage_ptr_vec_ptr</i>	A pointer to the Storage pointer vector of the Model .

```
403 {
404     // 1. default to load following
405     this->__applyLoadFollowingControl_CHARGING(
406         timestep,
407         electrical_load_ptr,
408         combustion_ptr_vec_ptr,
409         renewable_ptr_vec_ptr,
410         storage_ptr_vec_ptr
411     );
412
413     return;
414 } /* __applyCycleChargingControl_CHARGING() */
```

4.3.3.2 __applyCycleChargingControl_DISCHARGING()

```
void Controller::__applyCycleChargingControl_DISCHARGING (
    int timestep,
    ElectricalLoad * electrical_load_ptr,
```

```

std::vector< Combustion * > * combustion_ptr_vec_ptr,
std::vector< Renewable * > * renewable_ptr_vec_ptr,
std::vector< Storage * > * storage_ptr_vec_ptr ) [private]

```

Helper method to apply cycle charging control action for given timestep of the [Model](#) run when net load > 0. Defaults to load following control if no depleted storage assets.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>electrical_load_ptr</i>	A pointer to the ElectricalLoad component of the Model .
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .
<i>storage_ptr_vec_ptr</i>	A pointer to the Storage pointer vector of the Model .

curtailment

```

453 {
454     // 1. get dt_hrs, net load
455     double dt_hrs = electrical_load_ptr->dt_vec_hrs[timestep];
456     double net_load_kW = this->net_load_vec_kW[timestep];
457
458     // 2. partition Storage assets into depleted and non-depleted
459     std::list<Storage*> depleted_storage_ptr_list;
460     std::list<Storage*> nondepleted_storage_ptr_list;
461
462     Storage* storage_ptr;
463     for (size_t i = 0; i < storage_ptr_vec_ptr->size(); i++) {
464         storage_ptr = storage_ptr_vec_ptr->at(i);
465
466         if (storage_ptr->is_depleted) {
467             depleted_storage_ptr_list.push_back(storage_ptr);
468         }
469
470         else {
471             nondepleted_storage_ptr_list.push_back(storage_ptr);
472         }
473     }
474
475     // 3. discharge non-depleted storage assets
476     net_load_kW = this->__handleStorageDischarging(
477         timestep,
478         dt_hrs,
479         net_load_kW,
480         nondepleted_storage_ptr_list
481     );
482
483     // 4. request optimal production from all Combustion assets
484     // default to load following if no depleted storage
485     if (depleted_storage_ptr_list.empty()) {
486         net_load_kW = this->__handleCombustionDispatch(
487             timestep,
488             dt_hrs,
489             net_load_kW,
490             combustion_ptr_vec_ptr,
491             false // is_cycle_charging
492         );
493     }
494
495     else {
496         net_load_kW = this->__handleCombustionDispatch(
497             timestep,
498             dt_hrs,
499             net_load_kW,
500             combustion_ptr_vec_ptr,
501             true // is_cycle_charging
502         );
503     }
504
505     // 5. attempt to charge depleted Storage assets using any and all available
506     // charge priority is Combustion, then Renewable
507     this->__handleStorageCharging(
508         timestep,
509         dt_hrs,
510         depleted_storage_ptr_list,
511         combustion_ptr_vec_ptr,
512         renewable_ptr_vec_ptr
513     );
514 }

```

```

515
516 // 6. record any missed load
517 if (net_load_kW > 1e-6) {
518     this->missed_load_vec_kW[timestep] = net_load_kW;
519 }
520
521 return;
522 } /* __applyCycleChargingControl_DISCHARGING() */

```

4.3.3.3 __applyLoadFollowingControl_CHARGING()

```

void Controller::__applyLoadFollowingControl_CHARGING (
    int timestep,
    ElectricalLoad * electrical_load_ptr,
    std::vector< Combustion * > * combustion_ptr_vec_ptr,
    std::vector< Renewable * > * renewable_ptr_vec_ptr,
    std::vector< Storage * > * storage_ptr_vec_ptr ) [private]

```

Helper method to apply load following control action for given timestep of the [Model](#) run when net load ≤ 0 ;

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>electrical_load_ptr</i>	A pointer to the ElectricalLoad component of the Model .
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .
<i>storage_ptr_vec_ptr</i>	A pointer to the Storage pointer vector of the Model .

```

246 {
247     // 1. get dt_hrs, set net load
248     double dt_hrs = electrical_load_ptr->dt_vec_hrs[timestep];
249     double net_load_kW = 0;
250
251     // 2. request zero production from all Combustion assets
252     this->__handleCombustionDispatch(
253         timestep,
254         dt_hrs,
255         net_load_kW,
256         combustion_ptr_vec_ptr,
257         false // is_cycle_charging
258     );
259
260     // 3. attempt to charge all Storage assets using any and all available curtailment
261     // charge priority is Combustion, then Renewable
262     this->__handleStorageCharging(
263         timestep,
264         dt_hrs,
265         storage_ptr_vec_ptr,
266         combustion_ptr_vec_ptr,
267         renewable_ptr_vec_ptr
268     );
269
270     return;
271 } /* __applyLoadFollowingControl_CHARGING() */

```

4.3.3.4 __applyLoadFollowingControl_DISCHARGING()

```

void Controller::__applyLoadFollowingControl_DISCHARGING (
    int timestep,
    ElectricalLoad * electrical_load_ptr,

```



```

std::vector< Combustion * > * combustion_ptr_vec_ptr,
std::vector< Renewable * > * renewable_ptr_vec_ptr,
std::vector< Storage * > * storage_ptr_vec_ptr ) [private]

```

Helper method to apply load following control action for given timestep of the [Model](#) run when net load > 0;.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>electrical_load_ptr</i>	A pointer to the ElectricalLoad component of the Model .
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .
<i>storage_ptr_vec_ptr</i>	A pointer to the Storage pointer vector of the Model .

curtailment

```

309 {
310     // 1. get dt_hrs, net load
311     double dt_hrs = electrical_load_ptr->dt_vec_hrs[timestep];
312     double net_load_kW = this->net_load_vec_kW[timestep];
313
314     // 2. partition Storage assets into depleted and non-depleted
315     std::list<Storage*> depleted_storage_ptr_list;
316     std::list<Storage*> nondepleted_storage_ptr_list;
317
318     Storage* storage_ptr;
319     for (size_t i = 0; i < storage_ptr_vec_ptr->size(); i++) {
320         storage_ptr = storage_ptr_vec_ptr->at(i);
321
322         if (storage_ptr->is_depleted) {
323             depleted_storage_ptr_list.push_back(storage_ptr);
324         }
325
326         else {
327             nondepleted_storage_ptr_list.push_back(storage_ptr);
328         }
329     }
330
331     // 3. discharge non-depleted storage assets
332     net_load_kW = this->__handleStorageDischarging(
333         timestep,
334         dt_hrs,
335         net_load_kW,
336         nondepleted_storage_ptr_list
337     );
338
339     // 4. request optimal production from all Combustion assets
340     net_load_kW = this->__handleCombustionDispatch(
341         timestep,
342         dt_hrs,
343         net_load_kW,
344         combustion_ptr_vec_ptr,
345         false // is_cycle_charging
346     );
347
348     // 5. attempt to charge Depleted Storage assets using any and all available
349     // charge priority is Combustion, then Renewable
350     this->__handleStorageCharging(
351         timestep,
352         dt_hrs,
353         depleted_storage_ptr_list,
354         combustion_ptr_vec_ptr,
355         renewable_ptr_vec_ptr
356     );
357
358     // 6. record any missed load
359     if (net_load_kW > 1e-6) {
360         this->missed_load_vec_kW[timestep] = net_load_kW;
361     }
362
363     return;
364 }
365 } /* __applyLoadFollowingControl_DISCHARGING() */

```

4.3.3.5 __computeNetLoad()

```
void Controller::__computeNetLoad (
    ElectricalLoad * electrical_load_ptr,
    std::vector< Renewable * > * renewable_ptr_vec_ptr,
    Resources * resources_ptr ) [private]
```

Helper method to compute and populate the net load vector.

The net load at a given point in time is defined as the load at that point in time, minus the sum of all [Renewable](#) production at that point in time. Therefore, a negative net load indicates a surplus of [Renewable](#) production, and a positive net load indicates a deficit of [Renewable](#) production.

Parameters

<i>electrical_load_ptr</i>	A pointer to the ElectricalLoad component of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .
<i>resources_ptr</i>	A pointer to the Resources component of the Model .

```
57 {
58     // 1. init
59     this->net_load_vec_kW.resize(electrical_load_ptr->n_points, 0);
60     this->missed_load_vec_kW.resize(electrical_load_ptr->n_points, 0);
61
62     // 2. populate net load vector
63     double dt_hrs = 0;
64     double load_kW = 0;
65     double net_load_kW = 0;
66     double production_kW = 0;
67
68     Renewable* renewable_ptr;
69
70     for (int i = 0; i < electrical_load_ptr->n_points; i++) {
71         dt_hrs = electrical_load_ptr->dt_vec_hrs[i];
72         load_kW = electrical_load_ptr->load_vec_kW[i];
73         net_load_kW = load_kW;
74
75         for (size_t j = 0; j < renewable_ptr_vec_ptr->size(); j++) {
76             renewable_ptr = renewable_ptr_vec_ptr->at(j);
77
78             production_kW = this->__getRenewableProduction(
79                 i,
80                 dt_hrs,
81                 renewable_ptr,
82                 resources_ptr
83             );
84
85             load_kW = renewable_ptr->commit(
86                 i,
87                 dt_hrs,
88                 production_kW,
89                 load_kW
90             );
91
92             net_load_kW -= production_kW;
93         }
94         this->net_load_vec_kW[i] = net_load_kW;
95     }
96 }
97
98 return;
99 } /* __computeNetLoad() */
```

4.3.3.6 __constructCombustionMap()

```
void Controller::__constructCombustionMap (
    std::vector< Combustion * > * combustion_ptr_vec_ptr ) [private]
```

Helper method to construct a [Combustion](#) map, for use in determining.

Parameters

<code>combustion_ptr_vec_ptr</code>	A pointer to the Combustion pointer vector of the Model .
-------------------------------------	---

```

121 {
122     // 1. get state table dimensions
123     int n_cols = combustion_ptr_vec_ptr->size();
124     int n_rows = pow(2, n_cols);
125
126     // 2. init state table (all possible on/off combinations)
127     std::vector<std::vector<bool>> state_table;
128     state_table.resize(n_rows, {});
129
130     int x = 0;
131     for (int i = 0; i < n_rows; i++) {
132         state_table[i].resize(n_cols, false);
133
134         x = i;
135         for (int j = 0; j < n_cols; j++) {
136             if (x % 2 == 0) {
137                 state_table[i][j] = true;
138             }
139             x /= 2;
140         }
141     }
142
143     // 3. construct combustion map (handle duplicates by keeping rows with minimum
144     //    trues)
145     double total_capacity_kW = 0;
146     int truth_count = 0;
147     int current_truth_count = 0;
148
149     for (int i = 0; i < n_rows; i++) {
150         total_capacity_kW = 0;
151         truth_count = 0;
152         current_truth_count = 0;
153
154         for (int j = 0; j < n_cols; j++) {
155             if (state_table[i][j]) {
156                 total_capacity_kW += combustion_ptr_vec_ptr->at(j)->capacity_kW;
157                 truth_count++;
158             }
159         }
160
161         if (this->combustion_map.count(total_capacity_kW) > 0) {
162             for (int j = 0; j < n_cols; j++) {
163                 if (this->combustion_map[total_capacity_kW][j]) {
164                     current_truth_count++;
165                 }
166             }
167
168             if (truth_count < current_truth_count) {
169                 this->combustion_map.erase(total_capacity_kW);
170             }
171         }
172
173         this->combustion_map.insert(
174             std::pair<double, std::vector<bool>> (
175                 total_capacity_kW,
176                 state_table[i]
177             )
178         );
179     }
180
181     /*
182     // ==== TEST PRINT ==== //
183     std::cout << std::endl;
184
185     std::cout << "\t\t";
186     for (size_t i = 0; i < combustion_ptr_vec_ptr->size(); i++) {
187         std::cout << combustion_ptr_vec_ptr->at(i)->capacity_kW << "\t";
188     }
189     std::cout << std::endl;
190
191     std::map<double, std::vector<bool>>::iterator iter;
192     for (
193         iter = this->combustion_map.begin();
194         iter != this->combustion_map.end();
195         iter++
196     ) {
197         std::cout << iter->first << "\t\t";
198
199         for (size_t i = 0; i < iter->second.size(); i++) {
200             std::cout << iter->second[i] << "\t";
201         }
202         std::cout << "]" << std::endl;

```

```

203     }
204     // ==== END TEST PRINT ==== //
205     /**/
206
207     return;
208 } /* __constructCombustionTable() */

```

4.3.3.7 __getRenewableProduction()

```

double Controller::__getRenewableProduction (
    int timestep,
    double dt_hrs,
    Renewable * renewable_ptr,
    Resources * resources_ptr ) [private]

```

Helper method to compute the production from the given [Renewable](#) asset at the given point in time.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>renewable_ptr</i>	A pointer to the Renewable asset.
<i>resources_ptr</i>	A pointer to the Resources component of the Model .

Returns

The production [kW] of the [Renewable](#) asset.

```

759 {
760     double production_kW = 0;
761
762     switch (renewable_ptr->type) {
763         case (RenewableType :: SOLAR): {
764             production_kW = renewable_ptr->computeProductionkW(
765                 timestep,
766                 dt_hrs,
767                 resources_ptr->resource_map_1D[renewable_ptr->resource_key][timestep]
768             );
769
770             break;
771         }
772
773         case (RenewableType :: TIDAL): {
774             production_kW = renewable_ptr->computeProductionkW(
775                 timestep,
776                 dt_hrs,
777                 resources_ptr->resource_map_1D[renewable_ptr->resource_key][timestep]
778             );
779
780             break;
781         }
782
783         case (RenewableType :: WAVE): {
784             production_kW = renewable_ptr->computeProductionkW(
785                 timestep,
786                 dt_hrs,
787                 resources_ptr->resource_map_2D[renewable_ptr->resource_key][timestep][0],
788                 resources_ptr->resource_map_2D[renewable_ptr->resource_key][timestep][1]
789             );
790
791             break;
792         }
793
794         case (RenewableType :: WIND): {
795             production_kW = renewable_ptr->computeProductionkW(
796                 timestep,
797                 dt_hrs,
798                 resources_ptr->resource_map_1D[renewable_ptr->resource_key][timestep]

```

```

799         );
800
801         break;
802     }
803
804     default: {
805         std::string error_str = "ERROR: Controller::__getRenewableProduction(): ";
806         error_str += "renewable type ";
807         error_str += std::to_string(renewable_ptr->type);
808         error_str += " not recognized";
809
810         #ifdef _WIN32
811             std::cout << error_str << std::endl;
812         #endif
813
814         throw std::runtime_error(error_str);
815
816         break;
817     }
818 }
819
820 return production_kW;
821 } /* __getRenewableProduction() */

```

4.3.3.8 __handleCombustionDispatch()

```

double Controller::__handleCombustionDispatch (
    int timestep,
    double dt_hrs,
    double net_load_kW,
    std::vector< Combustion * > * combustion_ptr_vec_ptr,
    bool is_cycle_charging ) [private]

```

bool is_cycle_charging)

Helper method to handle the optimal dispatch of [Combustion](#) assets. Dispatches for 1.2x the received net load, so as to ensure a "20% spinning reserve". Dispatches a minimum number of [Combustion](#) assets, which then share the load proportional to their rated capacities.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>net_load_kW</i>	The net load [kW] before the dispatch is deducted from it.
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>is_cycle_charging</i>	A boolean which defines whether to apply cycle charging logic or not.

Returns

The net load [kW] remaining after the dispatch is deducted from it.

```

863 {
864     // 1. get minimal Combustion dispatch
865     double target_production_kW = 1.2 * net_load_kW;
866     double total_capacity_kW = 0;
867
868     std::map<double, std::vector<bool>::iterator> iter = this->combustion_map.begin();
869     while (iter != std::prev(this->combustion_map.end(), 1)) {
870         if (target_production_kW <= total_capacity_kW) {
871             break;
872         }
873
874         iter++;
875         total_capacity_kW = iter->first;

```

```

876     }
877
878     // 2. share load proportionally (by rated capacity) over active diesels
879     Combustion* combustion_ptr;
880     double production_kW = 0;
881     double request_kW = 0;
882     double _net_load_kW = net_load_kW;
883
884     for (size_t i = 0; i < this->combustion_map[total_capacity_kW].size(); i++) {
885         combustion_ptr = combustion_ptr_vec_ptr->at(i);
886
887         if (total_capacity_kW > 0) {
888             request_kW =
889                 int(this->combustion_map[total_capacity_kW][i]) *
890                 net_load_kW *
891                 (combustion_ptr->capacity_kW / total_capacity_kW);
892         }
893
894         else {
895             request_kW = 0;
896         }
897
898         if (is_cycle_charging and request_kW > 0) {
899             if (request_kW < 0.85 * combustion_ptr->capacity_kW) {
900                 request_kW = 0.85 * combustion_ptr->capacity_kW;
901             }
902         }
903
904         production_kW = combustion_ptr->requestProductionkW(
905             timestep,
906             dt_hrs,
907             request_kW
908         );
909
910         _net_load_kW = combustion_ptr->commit(
911             timestep,
912             dt_hrs,
913             production_kW,
914             _net_load_kW
915         );
916     }
917
918     return _net_load_kW;
919 } /* __handleCombustionDispatch() */

```

4.3.3.9 __handleStorageCharging() [1/2]

```

void Controller::__handleStorageCharging (
    int timestep,
    double dt_hrs,
    std::list< Storage * > storage_ptr_list,
    std::vector< Combustion * > * combustion_ptr_vec_ptr,
    std::vector< Renewable * > * renewable_ptr_vec_ptr ) [private]

```

Helper method to handle the charging of the given [Storage](#) assets.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>storage_ptr_list</i>	A list of pointers to the Storage assets that are to be charged.
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .

```

560 {
561     double acceptable_kW = 0;
562     double curtailment_kW = 0;
563
564     Storage* storage_ptr;

```

```

565     Combustion* combustion_ptr;
566     Renewable* renewable_ptr;
567
568     std::list<Storage*>::iterator iter;
569     for (
570         iter = storage_ptr_list.begin();
571         iter != storage_ptr_list.end();
572         iter++
573     ){
574         storage_ptr = (*iter);
575
576         // 1. attempt to charge from Combustion curtailment first
577         for (size_t i = 0; i < combustion_ptr_vec_ptr->size(); i++) {
578             combustion_ptr = combustion_ptr_vec_ptr->at(i);
579             curtailment_kW = combustion_ptr->curtailment_vec_kW[timestep];
580
581             if (curtailment_kW <= 0) {
582                 continue;
583             }
584
585             acceptable_kW = storage_ptr->getAcceptablekW(dt_hrs);
586
587             if (acceptable_kW > curtailment_kW) {
588                 acceptable_kW = curtailment_kW;
589             }
590
591             combustion_ptr->curtailment_vec_kW[timestep] -= acceptable_kW;
592             combustion_ptr->storage_vec_kW[timestep] += acceptable_kW;
593             storage_ptr->power_kW += acceptable_kW;
594         }
595
596         // 2. attempt to charge from Renewable curtailment second
597         for (size_t i = 0; i < renewable_ptr_vec_ptr->size(); i++) {
598             renewable_ptr = renewable_ptr_vec_ptr->at(i);
599             curtailment_kW = renewable_ptr->curtailment_vec_kW[timestep];
600
601             if (curtailment_kW <= 0) {
602                 continue;
603             }
604
605             acceptable_kW = storage_ptr->getAcceptablekW(dt_hrs);
606
607             if (acceptable_kW > curtailment_kW) {
608                 acceptable_kW = curtailment_kW;
609             }
610
611             renewable_ptr->curtailment_vec_kW[timestep] -= acceptable_kW;
612             renewable_ptr->storage_vec_kW[timestep] += acceptable_kW;
613             storage_ptr->power_kW += acceptable_kW;
614         }
615
616         // 3. commit charge
617         storage_ptr->commitCharge(
618             timestep,
619             dt_hrs,
620             storage_ptr->power_kW
621         );
622     }
623
624     return;
625 } /* __handleStorageCharging() */

```

4.3.3.10 __handleStorageCharging() [2/2]

```

void Controller::__handleStorageCharging (
    int timestep,
    double dt_hrs,
    std::vector< Storage * > * storage_ptr_vec_ptr,
    std::vector< Combustion * > * combustion_ptr_vec_ptr,
    std::vector< Renewable * > * renewable_ptr_vec_ptr ) [private]

```

Helper method to handle the charging of the given [Storage](#) assets.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>storage_ptr_vec_ptr</i>	A pointer to a vector of pointers to the Storage assets that are to be charged.
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .

```

663 {
664     double acceptable_kW = 0;
665     double curtailment_kW = 0;
666
667     Storage* storage_ptr;
668     Combustion* combustion_ptr;
669     Renewable* renewable_ptr;
670
671     for (size_t j = 0; j < storage_ptr_vec_ptr->size(); j++) {
672         storage_ptr = storage_ptr_vec_ptr->at(j);
673
674         // 1. attempt to charge from Combustion curtailment first
675         for (size_t i = 0; i < combustion_ptr_vec_ptr->size(); i++) {
676             combustion_ptr = combustion_ptr_vec_ptr->at(i);
677             curtailment_kW = combustion_ptr->curtailment_vec_kW[timestep];
678
679             if (curtailment_kW <= 0) {
680                 continue;
681             }
682
683             acceptable_kW = storage_ptr->getAcceptablekW(dt_hrs);
684
685             if (acceptable_kW > curtailment_kW) {
686                 acceptable_kW = curtailment_kW;
687             }
688
689             combustion_ptr->curtailment_vec_kW[timestep] -= acceptable_kW;
690             combustion_ptr->storage_vec_kW[timestep] += acceptable_kW;
691             storage_ptr->power_kW += acceptable_kW;
692         }
693
694         // 2. attempt to charge from Renewable curtailment second
695         for (size_t i = 0; i < renewable_ptr_vec_ptr->size(); i++) {
696             renewable_ptr = renewable_ptr_vec_ptr->at(i);
697             curtailment_kW = renewable_ptr->curtailment_vec_kW[timestep];
698
699             if (curtailment_kW <= 0) {
700                 continue;
701             }
702
703             acceptable_kW = storage_ptr->getAcceptablekW(dt_hrs);
704
705             if (acceptable_kW > curtailment_kW) {
706                 acceptable_kW = curtailment_kW;
707             }
708
709             renewable_ptr->curtailment_vec_kW[timestep] -= acceptable_kW;
710             renewable_ptr->storage_vec_kW[timestep] += acceptable_kW;
711             storage_ptr->power_kW += acceptable_kW;
712         }
713
714         // 3. commit charge
715         storage_ptr->commitCharge(
716             timestep,
717             dt_hrs,
718             storage_ptr->power_kW
719         );
720     }
721
722     return;
723 } /* __handleStorageCharging() */

```

4.3.3.11 __handleStorageDischarging()

```

double Controller::__handleStorageDischarging (
    int timestep,

```



```
double dt_hrs,
double net_load_kW,
std::list< Storage * > storage_ptr_list ) [private]
```

Helper method to handle the discharging of the given [Storage](#) assets.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>storage_ptr_list</i>	A list of pointers to the Storage assets that are to be discharged.

Returns

The net load [kW] remaining after the discharge is deducted from it.

```
953 {
954     double discharging_kW = 0;
955
956     Storage* storage_ptr;
957
958     std::list<Storage*>::iterator iter;
959     for (
960         iter = storage_ptr_list.begin();
961         iter != storage_ptr_list.end();
962         iter++
963     ){
964         storage_ptr = (*iter);
965
966         discharging_kW = storage_ptr->getAvailablekW(dt_hrs);
967
968         if (discharging_kW > net_load_kW) {
969             discharging_kW = net_load_kW;
970         }
971
972         net_load_kW = storage_ptr->commitDischarge(
973             timestep,
974             dt_hrs,
975             discharging_kW,
976             net_load_kW
977         );
978     }
979
980     return net_load_kW;
981 } /* __handleStorageDischarging() */
```

4.3.3.12 applyDispatchControl()

```
void Controller::applyDispatchControl (
    ElectricalLoad * electrical_load_ptr,
    std::vector< Combustion * > * combustion_ptr_vec_ptr,
    std::vector< Renewable * > * renewable_ptr_vec_ptr,
    std::vector< Storage * > * storage_ptr_vec_ptr )
```

Method to apply dispatch control at every point in the modelling time series.

Parameters

<i>electrical_load_ptr</i>	A pointer to the ElectricalLoad component of the Model .
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .
<i>storage_ptr_vec_ptr</i>	A pointer to the Storage pointer vector of the Model .

```

1124 {
1125     for (int i = 0; i < electrical_load_ptr->n_points; i++) {
1126         switch (this->control_mode) {
1127             case (ControlMode :: LOAD_FOLLOWING): {
1128                 if (this->net_load_vec_kW[i] <= 0) {
1129                     this->__applyLoadFollowingControl_CHARGING(
1130                         i,
1131                         electrical_load_ptr,
1132                         combustion_ptr_vec_ptr,
1133                         renewable_ptr_vec_ptr,
1134                         storage_ptr_vec_ptr
1135                     );
1136                 }
1137             }
1138             else {
1139                 this->__applyLoadFollowingControl_DISCHARGING(
1140                     i,
1141                     electrical_load_ptr,
1142                     combustion_ptr_vec_ptr,
1143                     renewable_ptr_vec_ptr,
1144                     storage_ptr_vec_ptr
1145                 );
1146             }
1147             break;
1148         }
1149     }
1150
1151     case (ControlMode :: CYCLE_CHARGING): {
1152         if (this->net_load_vec_kW[i] <= 0) {
1153             this->__applyCycleChargingControl_CHARGING(
1154                 i,
1155                 electrical_load_ptr,
1156                 combustion_ptr_vec_ptr,
1157                 renewable_ptr_vec_ptr,
1158                 storage_ptr_vec_ptr
1159             );
1160         }
1161         else {
1162             this->__applyCycleChargingControl_DISCHARGING(
1163                 i,
1164                 electrical_load_ptr,
1165                 combustion_ptr_vec_ptr,
1166                 renewable_ptr_vec_ptr,
1167                 storage_ptr_vec_ptr
1168             );
1169         }
1170     }
1171     break;
1172 }
1173
1174 default: {
1175     std::string error_str = "ERROR: Controller :: applyDispatchControl(): ";
1176     error_str += "control mode ";
1177     error_str += std::to_string(this->control_mode);
1178     error_str += " not recognized";
1179
1180     #ifdef _WIN32
1181         std::cout << error_str << std::endl;
1182     #endif
1183
1184     throw std::runtime_error(error_str);
1185     break;
1186 }
1187 }
1188 }
1189 }
1190 }
1191
1192 return;
1193 } /* applyDispatchControl() */

```

4.3.3.13 clear()

```

void Controller::clear (
    void )

```

Method to clear all attributes of the [Controller](#) object.

```

1208 {

```

```

1209     this->net_load_vec_kW.clear();
1210     this->missed_load_vec_kW.clear();
1211     this->combustion_map.clear();
1212
1213     return;
1214 } /* clear() */

```

4.3.3.14 init()

```

void Controller::init (
    ElectricalLoad * electrical_load_ptr,
    std::vector< Renewable * > * renewable_ptr_vec_ptr,
    Resources * resources_ptr,
    std::vector< Combustion * > * combustion_ptr_vec_ptr )

```

Method to initialize the [Controller](#) component of the [Model](#).

Parameters

<i>electrical_load_ptr</i>	A pointer to the ElectricalLoad component of the Model .
<i>renewable_ptr_vec_ptr</i>	A pointer to the Renewable pointer vector of the Model .
<i>resources_ptr</i>	A pointer to the Resources component of the Model .
<i>combustion_ptr_vec_ptr</i>	A pointer to the Combustion pointer vector of the Model .

```

1083 {
1084     // 1. compute net load
1085     this->__computeNetLoad(electrical_load_ptr, renewable_ptr_vec_ptr, resources_ptr);
1086
1087     // 2. construct Combustion table
1088     this->__constructCombustionMap(combustion_ptr_vec_ptr);
1089
1090     return;
1091 } /* init() */

```

4.3.3.15 setControlMode()

```

void Controller::setControlMode (
    ControlMode control_mode )

```

Parameters

<i>control_mode</i>	The ControlMode which is to be active in the Controller .
---------------------	---

```

1017 {
1018     this->control_mode = control_mode;
1019
1020     switch(control_mode) {
1021         case (ControlMode :: LOAD_FOLLOWING): {
1022             this->control_string = "LOAD_FOLLOWING";
1023
1024             break;
1025         }
1026
1027         case (ControlMode :: CYCLE_CHARGING): {
1028             this->control_string = "CYCLE_CHARGING";
1029
1030             break;
1031         }
1032     }

```

```

1033         default: {
1034             std::string error_str = "ERROR: Controller :: setControlMode(): ";
1035             error_str += "control mode ";
1036             error_str += std::to_string(control_mode);
1037             error_str += " not recognized";
1038
1039             #ifdef _WIN32
1040                 std::cout << error_str << std::endl;
1041             #endif
1042
1043             throw std::runtime_error(error_str);
1044
1045             break;
1046         }
1047     }
1048
1049     return;
1050 } /* setControlMode() */

```

4.3.4 Member Data Documentation

4.3.4.1 combustion_map

`std::map<double, std::vector<bool> > Controller::combustion_map`

A map of all possible combustion states, for use in determining optimal dispatch.

4.3.4.2 control_mode

`ControlMode Controller::control_mode`

The ControlMode that is active in the [Model](#).

4.3.4.3 control_string

`std::string Controller::control_string`

A string describing the active ControlMode.

4.3.4.4 missed_load_vec_kW

`std::vector<double> Controller::missed_load_vec_kW`

A vector of missed load values [kW] at each point in the modelling time series.

4.3.4.5 net_load_vec_kW

```
std::vector<double> Controller::net_load_vec_kW
```

A vector of net load values [kW] at each point in the modelling time series. Net load is defined as load minus all available [Renewable](#) production.

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

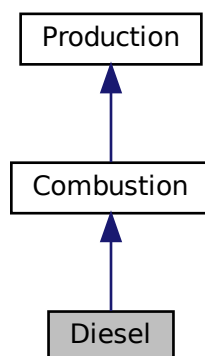
- header/[Controller.h](#)
- source/[Controller.cpp](#)

4.4 Diesel Class Reference

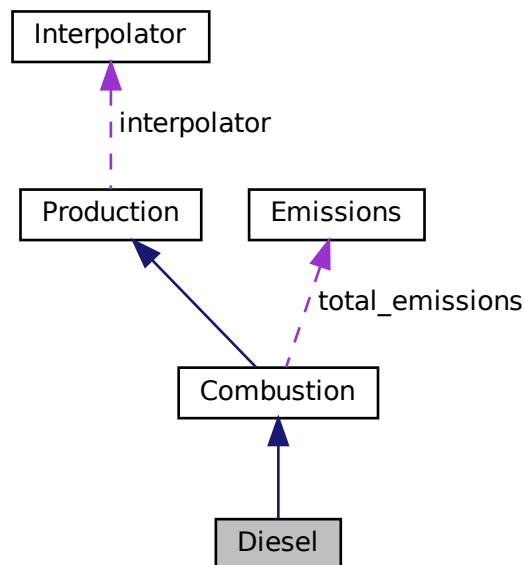
A derived class of the [Combustion](#) branch of [Production](#) which models production using a diesel generator.

```
#include <Diesel.h>
```

Inheritance diagram for Diesel:



Collaboration diagram for Diesel:



Public Member Functions

- [Diesel](#) (void)
Constructor (dummy) for the [Diesel](#) class.
- [Diesel](#) (int, double, [DieselInputs](#))
Constructor (intended) for the [Diesel](#) class.
- void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- double [requestProductionkW](#) (int, double, double)
Method which takes in production request, and then returns what the asset can deliver (subject to operating constraints, etc.).
- double [commit](#) (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- [~Diesel](#) (void)
Destructor for the [Diesel](#) class.

Public Attributes

- double [minimum_load_ratio](#)
The minimum load ratio of the asset. That is, when the asset is producing, it must produce at least this ratio of its rated capacity.
- double [minimum_runtime_hrs](#)
The minimum runtime [hrs] of the asset. This is the minimum time that must elapse between successive starts and stops.
- double [time_since_last_start_hrs](#)
The time that has elapsed [hrs] since the last start of the asset.

Private Member Functions

- void `__checkInputs` ([DieselInputs](#))
Helper method to check inputs to the [Diesel](#) constructor.
- void `__handleStartStop` (int, double, double)
Helper method (private) to handle the starting/stopping of the diesel generator. The minimum runtime constraint is enforced in this method.
- double `__getGenericFuelSlope` (void)
Helper method to generate a generic, linearized fuel consumption slope for a diesel generator.
- double `__getGenericFuelIntercept` (void)
Helper method to generate a generic, linearized fuel consumption intercept for a diesel generator.
- double `__getGenericCapitalCost` (void)
Helper method to generate a generic diesel generator capital cost.
- double `__getGenericOpMaintCost` (void)
Helper method (private) to generate a generic diesel generator operation and maintenance cost. This is a cost incurred per unit energy produced.
- void `__writeSummary` (std::string)
Helper method to write summary results for [Diesel](#).
- void `__writeTimeSeries` (std::string, std::vector< double > *, int=-1)
Helper method to write time series results for [Diesel](#).

4.4.1 Detailed Description

A derived class of the [Combustion](#) branch of [Production](#) which models production using a diesel generator.

4.4.2 Constructor & Destructor Documentation

4.4.2.1 `Diesel()` [1/2]

```
Diesel::Diesel (
    void )
```

Constructor (dummy) for the [Diesel](#) class.

```
575 {
576     return;
577 } /* Diesel() */
```

4.4.2.2 `Diesel()` [2/2]

```
Diesel::Diesel (
    int n_points,
    double n_years,
    DieselInputs diesel_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>diesel_inputs</i>	A structure of Diesel constructor inputs.

```

605 :
606 Combustion(
607     n_points,
608     n_years,
609     diesel_inputs.combustion_inputs
610 )
611 {
612     // 1. check inputs
613     this->__checkInputs(diesel_inputs);
614
615     // 2. set attributes
616     this->type = CombustionType :: DIESEL;
617     this->type_str = "DIESEL";
618
619     this->replace_running_hrs = diesel_inputs.replace_running_hrs;
620
621     this->fuel_cost_L = diesel_inputs.fuel_cost_L;
622
623     this->minimum_load_ratio = diesel_inputs.minimum_load_ratio;
624     this->minimum_runtime_hrs = diesel_inputs.minimum_runtime_hrs;
625     this->time_since_last_start_hrs = 0;
626
627     this->CO2_emissions_intensity_kgL = diesel_inputs.CO2_emissions_intensity_kgL;
628     this->CO_emissions_intensity_kgL = diesel_inputs.CO_emissions_intensity_kgL;
629     this->NOx_emissions_intensity_kgL = diesel_inputs.NOx_emissions_intensity_kgL;
630     this->SOx_emissions_intensity_kgL = diesel_inputs.SOx_emissions_intensity_kgL;
631     this->CH4_emissions_intensity_kgL = diesel_inputs.CH4_emissions_intensity_kgL;
632     this->PM_emissions_intensity_kgL = diesel_inputs.PM_emissions_intensity_kgL;
633
634     if (diesel_inputs.linear_fuel_slope_LkWh < 0) {
635         this->linear_fuel_slope_LkWh = this->__getGenericFuelSlope();
636     }
637
638     if (diesel_inputs.linear_fuel_intercept_LkWh < 0) {
639         this->linear_fuel_intercept_LkWh = this->__getGenericFuelIntercept();
640     }
641
642     if (diesel_inputs.capital_cost < 0) {
643         this->capital_cost = this->__getGenericCapitalCost();
644     }
645
646     if (diesel_inputs.operation_maintenance_cost_kWh < 0) {
647         this->operation_maintenance_cost_kWh = this->__getGenericOpMaintCost();
648     }
649
650     if (not this->is_sunk) {
651         this->capital_cost_vec[0] = this->capital_cost;
652     }
653
654     // 3. construction print
655     if (this->print_flag) {
656         std::cout << "Diesel object constructed at " << this << std::endl;
657     }
658
659     return;
660 } /* Diesel() */

```

4.4.2.3 ~Diesel()

```

Diesel::~Diesel (
    void )

```

Destructor for the [Diesel](#) class.

```

815 {
816     // 1. destruction print
817     if (this->print_flag) {
818         std::cout << "Diesel object at " << this << " destroyed" << std::endl;
819     }
820
821     return;
822 } /* ~Diesel() */

```


4.4.3 Member Function Documentation

4.4.3.1 __checkInputs()

```
void Diesel::__checkInputs (
    DieselInputs diesel_inputs ) [private]
```

Helper method to check inputs to the [Diesel](#) constructor.

Parameters

<i>diesel_inputs</i>	A structure of Diesel constructor inputs.
----------------------	---

```
39 {
40     // 1. check fuel_cost_L
41     if (diesel_inputs.fuel_cost_L < 0) {
42         std::string error_str = "ERROR: Diesel(): ";
43         error_str += "DieselInputs::fuel_cost_L must be >= 0";
44
45         #ifdef _WIN32
46             std::cout << error_str << std::endl;
47         #endif
48
49         throw std::invalid_argument(error_str);
50     }
51
52     // 2. check CO2_emissions_intensity_kgL
53     if (diesel_inputs.CO2_emissions_intensity_kgL < 0) {
54         std::string error_str = "ERROR: Diesel(): ";
55         error_str += "DieselInputs::CO2_emissions_intensity_kgL must be >= 0";
56
57         #ifdef _WIN32
58             std::cout << error_str << std::endl;
59         #endif
60
61         throw std::invalid_argument(error_str);
62     }
63
64     // 3. check CO_emissions_intensity_kgL
65     if (diesel_inputs.CO_emissions_intensity_kgL < 0) {
66         std::string error_str = "ERROR: Diesel(): ";
67         error_str += "DieselInputs::CO_emissions_intensity_kgL must be >= 0";
68
69         #ifdef _WIN32
70             std::cout << error_str << std::endl;
71         #endif
72
73         throw std::invalid_argument(error_str);
74     }
75
76     // 4. check NOx_emissions_intensity_kgL
77     if (diesel_inputs.NOx_emissions_intensity_kgL < 0) {
78         std::string error_str = "ERROR: Diesel(): ";
79         error_str += "DieselInputs::NOx_emissions_intensity_kgL must be >= 0";
80
81         #ifdef _WIN32
82             std::cout << error_str << std::endl;
83         #endif
84
85         throw std::invalid_argument(error_str);
86     }
87
88     // 5. check SOx_emissions_intensity_kgL
89     if (diesel_inputs.SOx_emissions_intensity_kgL < 0) {
90         std::string error_str = "ERROR: Diesel(): ";
91         error_str += "DieselInputs::SOx_emissions_intensity_kgL must be >= 0";
92
93         #ifdef _WIN32
94             std::cout << error_str << std::endl;
95         #endif
96
97         throw std::invalid_argument(error_str);
98     }
99 }
```

```

100 // 6. check CH4_emissions_intensity_kgL
101 if (diesel_inputs.CH4_emissions_intensity_kgL < 0) {
102     std::string error_str = "ERROR: Diesel(): ";
103     error_str += "DieselInputs::CH4_emissions_intensity_kgL must be >= 0";
104
105     #ifdef _WIN32
106         std::cout << error_str << std::endl;
107     #endif
108
109     throw std::invalid_argument(error_str);
110 }
111
112 // 7. check PM_emissions_intensity_kgL
113 if (diesel_inputs.PM_emissions_intensity_kgL < 0) {
114     std::string error_str = "ERROR: Diesel(): ";
115     error_str += "DieselInputs::PM_emissions_intensity_kgL must be >= 0";
116
117     #ifdef _WIN32
118         std::cout << error_str << std::endl;
119     #endif
120
121     throw std::invalid_argument(error_str);
122 }
123
124 // 8. check minimum_load_ratio
125 if (diesel_inputs.minimum_load_ratio < 0) {
126     std::string error_str = "ERROR: Diesel(): ";
127     error_str += "DieselInputs::minimum_load_ratio must be >= 0";
128
129     #ifdef _WIN32
130         std::cout << error_str << std::endl;
131     #endif
132
133     throw std::invalid_argument(error_str);
134 }
135
136 // 9. check minimum_runtime_hrs
137 if (diesel_inputs.minimum_runtime_hrs < 0) {
138     std::string error_str = "ERROR: Diesel(): ";
139     error_str += "DieselInputs::minimum_runtime_hrs must be >= 0";
140
141     #ifdef _WIN32
142         std::cout << error_str << std::endl;
143     #endif
144
145     throw std::invalid_argument(error_str);
146 }
147
148 // 10. check replace_running_hrs
149 if (diesel_inputs.replace_running_hrs <= 0) {
150     std::string error_str = "ERROR: Diesel(): ";
151     error_str += "DieselInputs::replace_running_hrs must be > 0";
152
153     #ifdef _WIN32
154         std::cout << error_str << std::endl;
155     #endif
156
157     throw std::invalid_argument(error_str);
158 }
159
160 return;
161 } /* __checkInputs() */

```

4.4.3.2 __getGenericCapitalCost()

```

double Diesel::__getGenericCapitalCost (
    void ) [private]

```

Helper method to generate a generic diesel generator capital cost.

This model was obtained by way of surveying an assortment of published diesel generator costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars [CAD].

Returns

A generic capital cost for the diesel generator [CAD].

```
238 {  
239     double capital_cost_per_kW = 1000 * pow(this->capacity_kW, -0.425) + 800;  
240  
241     return capital_cost_per_kW * this->capacity_kW;  
242 } /* __getGenericCapitalCost() */
```

4.4.3.3 __getGenericFuelIntercept()

```
double Diesel::__getGenericFuelIntercept (  
    void ) [private]
```

Helper method to generate a generic, linearized fuel consumption intercept for a diesel generator.

This model was obtained by way of surveying an assortment of published diesel generator fuel consumption data, and then constructing a best fit model.

Ref: [HOMER \[2023c\]](#)

Ref: [HOMER \[2023d\]](#)

Returns

A generic fuel intercept coefficient for the diesel generator [L/kWh].

```
213 {  
214     double linear_fuel_intercept_LkWh = 0.0940 * pow(this->capacity_kW, -0.2735);  
215  
216     return linear_fuel_intercept_LkWh;  
217 } /* __getGenericFuelIntercept() */
```

4.4.3.4 __getGenericFuelSlope()

```
double Diesel::__getGenericFuelSlope (  
    void ) [private]
```

Helper method to generate a generic, linearized fuel consumption slope for a diesel generator.

This model was obtained by way of surveying an assortment of published diesel generator fuel consumption data, and then constructing a best fit model.

Ref: [HOMER \[2023c\]](#)

Ref: [HOMER \[2023e\]](#)

Returns

A generic fuel slope for the diesel generator [L/kWh].

```
185 {  
186     double linear_fuel_slope_LkWh = 0.4234 * pow(this->capacity_kW, -0.1012);  
187  
188     return linear_fuel_slope_LkWh;  
189 } /* __getGenericFuelSlope() */
```

4.4.3.5 `__getGenericOpMaintCost()`

```
double Diesel::__getGenericOpMaintCost (
    void ) [private]
```

Helper method (private) to generate a generic diesel generator operation and maintenance cost. This is a cost incurred per unit energy produced.

This model was obtained by way of surveying an assortment of published diesel generator costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars per kiloWatt-hour production [CAD/kWh].

Returns

A generic operation and maintenance cost, per unit energy produced, for the diesel generator [CAD/kWh].

```
266 {
267     double operation_maintenance_cost_kWh = 0.05 * pow(this->capacity_kW, -0.2) + 0.05;
268
269     return operation_maintenance_cost_kWh;
270 } /* __getGenericOpMaintCost() */
```

4.4.3.6 `__handleStartStop()`

```
void Diesel::__handleStartStop (
    int timestep,
    double dt_hrs,
    double production_kW ) [private]
```

Helper method (private) to handle the starting/stopping of the diesel generator. The minimum runtime constraint is enforced in this method.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>production_kW</i>	The current rate of production [kW] of the generator.

```
300 {
301     /*
302     * Helper method (private) to handle the starting/stopping of the diesel
303     * generator. The minimum runtime constraint is enforced in this method.
304     */
305
306     if (this->is_running) {
307         // handle stopping
308         if (
309             production_kW <= 0 and
310             this->time_since_last_start_hrs >= this->minimum_runtime_hrs
311         ) {
312             this->is_running = false;
313         }
314     }
315
316     else {
317         // handle starting
318         if (production_kW > 0) {
319             this->is_running = true;
320             this->n_starts++;
321             this->time_since_last_start_hrs = 0;
322         }
323     }
324 }
```

```

325     return;
326 } /* __handleStartStop() */

```

4.4.3.7 __writeSummary()

```

void Diesel::__writeSummary (
    std::string write_path ) [private], [virtual]

```

Helper method to write summary results for [Diesel](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
-------------------	--

Reimplemented from [Combustion](#).

```

345 {
346     // 1. create filestream
347     write_path += "summary_results.md";
348     std::ofstream ofs;
349     ofs.open(write_path, std::ofstream::out);
350
351     // 2. write to summary results (markdown)
352     ofs << "# ";
353     ofs << std::to_string(int(ceil(this->capacity_kW)));
354     ofs << " kW DIESEL Summary Results\n";
355     ofs << "\n-----\n\n";
356
357     // 2.1. Production attributes
358     ofs << "## Production Attributes\n";
359     ofs << "\n";
360
361     ofs << "Capacity: " << this->capacity_kW << "kW \n";
362     ofs << "\n";
363
364     ofs << "Sunk Cost (N = 0 / Y = 1): " << this->is_sunk << " \n";
365     ofs << "Capital Cost: " << this->capital_cost << " \n";
366     ofs << "Operation and Maintenance Cost: " << this->operation_maintenance_cost_kWh
367         << " per kWh produced \n";
368     ofs << "Nominal Inflation Rate (annual): " << this->nominal_inflation_annual
369         << " \n";
370     ofs << "Nominal Discount Rate (annual): " << this->nominal_discount_annual
371         << " \n";
372     ofs << "Real Discount Rate (annual): " << this->real_discount_annual << " \n";
373     ofs << "\n";
374
375     ofs << "Replacement Running Hours: " << this->replace_running_hrs << " \n";
376     ofs << "\n-----\n\n";
377
378     // 2.2. Combustion attributes
379     ofs << "## Combustion Attributes\n";
380     ofs << "\n";
381
382     ofs << "Fuel Cost: " << this->fuel_cost_L << " per L \n";
383     ofs << "Nominal Fuel Escalation Rate (annual): "
384         << this->nominal_fuel_escalation_annual << " \n";
385     ofs << "Real Fuel Escalation Rate (annual): "
386         << this->real_fuel_escalation_annual << " \n";
387     ofs << "\n";
388
389     ofs << "Linear Fuel Slope: " << this->linear_fuel_slope_LkWh << " L/kWh \n";
390     ofs << "Linear Fuel Intercept Coefficient: " << this->linear_fuel_intercept_LkWh
391         << " L/kWh \n";
392     ofs << "\n";
393
394     ofs << "Carbon Dioxide (CO2) Emissions Intensity: "
395         << this->CO2_emissions_intensity_kgL << " kg/L \n";
396
397     ofs << "Carbon Monoxide (CO) Emissions Intensity: "
398         << this->CO_emissions_intensity_kgL << " kg/L \n";
399
400     ofs << "Nitrogen Oxides (NOx) Emissions Intensity: "

```

```

401         « this->NOx_emissions_intensity_kgL « " kg/L  \n";
402
403     ofs « "Sulfur Oxides (SOx) Emissions Intensity: "
404         « this->SOx_emissions_intensity_kgL « " kg/L  \n";
405
406     ofs « "Methane (CH4) Emissions Intensity: "
407         « this->CH4_emissions_intensity_kgL « " kg/L  \n";
408
409     ofs « "Particulate Matter (PM) Emissions Intensity: "
410         « this->PM_emissions_intensity_kgL « " kg/L  \n";
411
412     ofs « "\n-----\n\n";
413
414     // 2.3. Diesel attributes
415     ofs « "## Diesel Attributes\n";
416     ofs « "\n";
417
418     ofs « "Minimum Load Ratio: " « this->minimum_load_ratio « " \n";
419     ofs « "Minimum Runtime: " « this->minimum_runtime_hrs « " hrs  \n";
420
421     ofs « "\n-----\n\n";
422
423     // 2.4. Diesel Results
424     ofs « "## Results\n";
425     ofs « "\n";
426
427     ofs « "Net Present Cost: " « this->net_present_cost « " \n";
428     ofs « "\n";
429
430     ofs « "Total Dispatch: " « this->total_dispatch_kWh
431         « " kWh  \n";
432
433     ofs « "Levellized Cost of Energy: " « this->levellized_cost_of_energy_kWh
434         « " per kWh dispatched  \n";
435     ofs « "\n";
436
437     ofs « "Running Hours: " « this->running_hours « " \n";
438     ofs « "Starts: " « this->n_starts « " \n";
439     ofs « "Replacements: " « this->n_replacements « " \n";
440
441     ofs « "Total Fuel Consumed: " « this->total_fuel_consumed_L « " L "
442         « "(Annual Average: " « this->total_fuel_consumed_L / this->n_years
443         « " L/yr)  \n";
444     ofs « "\n";
445
446     ofs « "Total Carbon Dioxide (CO2) Emissions: " «
447         this->total_emissions.CO2_kg « " kg "
448         « "(Annual Average: " « this->total_emissions.CO2_kg / this->n_years
449         « " kg/yr)  \n";
450
451     ofs « "Total Carbon Monoxide (CO) Emissions: " «
452         this->total_emissions.CO_kg « " kg "
453         « "(Annual Average: " « this->total_emissions.CO_kg / this->n_years
454         « " kg/yr)  \n";
455
456     ofs « "Total Nitrogen Oxides (NOx) Emissions: " «
457         this->total_emissions.NOx_kg « " kg "
458         « "(Annual Average: " « this->total_emissions.NOx_kg / this->n_years
459         « " kg/yr)  \n";
460
461     ofs « "Total Sulfur Oxides (SOx) Emissions: " «
462         this->total_emissions.SOx_kg « " kg "
463         « "(Annual Average: " « this->total_emissions.SOx_kg / this->n_years
464         « " kg/yr)  \n";
465
466     ofs « "Total Methane (CH4) Emissions: " « this->total_emissions.CH4_kg « " kg "
467         « "(Annual Average: " « this->total_emissions.CH4_kg / this->n_years
468         « " kg/yr)  \n";
469
470     ofs « "Total Particulate Matter (PM) Emissions: " «
471         this->total_emissions.PM_kg « " kg "
472         « "(Annual Average: " « this->total_emissions.PM_kg / this->n_years
473         « " kg/yr)  \n";
474
475     ofs « "\n-----\n\n";
476
477     ofs.close();
478     return;
479 } /* __writeSummary() */

```

4.4.3.8 `__writeTimeSeries()`

```
void Diesel::__writeTimeSeries (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    int max_lines = -1 ) [private], [virtual]
```

Helper method to write time series results for [Diesel](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <code>time_vec_hrs</code> attribute of the ElectricalLoad .
<i>max_lines</i>	The maximum number of lines of output to write.

Reimplemented from [Combustion](#).

```
509 {
510     // 1. create filestream
511     write_path += "time_series_results.csv";
512     std::ofstream ofs;
513     ofs.open(write_path, std::ofstream::out);
514
515     // 2. write time series results (comma separated value)
516     ofs << "Time (since start of data) [hrs],";
517     ofs << "Production [kW],";
518     ofs << "Dispatch [kW],";
519     ofs << "Storage [kW],";
520     ofs << "Curtailment [kW],";
521     ofs << "Is Running (N = 0 / Y = 1),";
522     ofs << "Fuel Consumption [L],";
523     ofs << "Fuel Cost (actual),";
524     ofs << "Carbon Dioxide (CO2) Emissions [kg],";
525     ofs << "Carbon Monoxide (CO) Emissions [kg],";
526     ofs << "Nitrogen Oxides (NOx) Emissions [kg],";
527     ofs << "Sulfur Oxides (SOx) Emissions [kg],";
528     ofs << "Methane (CH4) Emissions [kg],";
529     ofs << "Particulate Matter (PM) Emissions [kg],";
530     ofs << "Capital Cost (actual),";
531     ofs << "Operation and Maintenance Cost (actual),";
532     ofs << "\n";
533
534     for (int i = 0; i < max_lines; i++) {
535         ofs << time_vec_hrs_ptr->at(i) << ",";
536         ofs << this->production_vec_kW[i] << ",";
537         ofs << this->dispatch_vec_kW[i] << ",";
538         ofs << this->storage_vec_kW[i] << ",";
539         ofs << this->curtailment_vec_kW[i] << ",";
540         ofs << this->is_running_vec[i] << ",";
541         ofs << this->fuel_consumption_vec_L[i] << ",";
542         ofs << this->fuel_cost_vec[i] << ",";
543         ofs << this->CO2_emissions_vec_kg[i] << ",";
544         ofs << this->CO_emissions_vec_kg[i] << ",";
545         ofs << this->NOx_emissions_vec_kg[i] << ",";
546         ofs << this->SOx_emissions_vec_kg[i] << ",";
547         ofs << this->CH4_emissions_vec_kg[i] << ",";
548         ofs << this->PM_emissions_vec_kg[i] << ",";
549         ofs << this->capital_cost_vec[i] << ",";
550         ofs << this->operation_maintenance_cost_vec[i] << ",";
551         ofs << "\n";
552     }
553
554     ofs.close();
555     return;
556 } /* __writeTimeSeries() */
```

4.4.3.9 `commit()`

```
double Diesel::commit (
    int timestep,
```

```
double dt_hrs,
double production_kW,
double load_kW ) [virtual]
```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented from [Combustion](#).

```
773 {
774     // 1. handle start/stop, enforce minimum runtime constraint
775     this->__handleStartStop(timestep, dt_hrs, production_kW);
776
777     // 2. invoke base class method
778     load_kW = Combustion::commit(
779         timestep,
780         dt_hrs,
781         production_kW,
782         load_kW
783     );
784
785     if (this->is_running) {
786         // 3. log time since last start
787         this->time_since_last_start_hrs += dt_hrs;
788
789         // 4. correct operation and maintenance costs (should be non-zero if idling)
790         if (production_kW <= 0) {
791             double produced_kWh = 0.01 * this->capacity_kW * dt_hrs;
792
793             double operation_maintenance_cost =
794                 this->operation_maintenance_cost_kWh * produced_kWh;
795             this->operation_maintenance_cost_vec[timestep] = operation_maintenance_cost;
796         }
797     }
798
799     return load_kW;
800 } /* commit() */
```

4.4.3.10 handleReplacement()

```
void Diesel::handleReplacement (
    int timestep ) [virtual]
```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Combustion](#).


```

678 {
679     // 1. reset attributes
680     this->time_since_last_start_hrs = 0;
681
682     // 2. invoke base class method
683     Combustion :: handleReplacement(timestep);
684
685     return;
686 } /* __handleReplacement() */

```

4.4.3.11 requestProductionkW()

```

double Diesel::requestProductionkW (
    int timestep,
    double dt_hrs,
    double request_kW ) [virtual]

```

Method which takes in production request, and then returns what the asset can deliver (subject to operating constraints, etc.).

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>request_kW</i>	The requested production [kW].

Returns

The production [kW] delivered by the diesel generator.

Reimplemented from [Combustion](#).

```

718 {
719     // 1. return on request of zero
720     if (request_kW <= 0) {
721         return 0;
722     }
723
724     double deliver_kW = request_kW;
725
726     // 2. enforce capacity constraint
727     if (deliver_kW > this->capacity_kW) {
728         deliver_kW = this->capacity_kW;
729     }
730
731     // 3. enforce minimum load ratio
732     if (deliver_kW < this->minimum_load_ratio * this->capacity_kW) {
733         deliver_kW = this->minimum_load_ratio * this->capacity_kW;
734     }
735
736     return deliver_kW;
737 } /* requestProductionkW() */

```

4.4.4 Member Data Documentation

4.4.4.1 minimum_load_ratio

```
double Diesel::minimum_load_ratio
```

The minimum load ratio of the asset. That is, when the asset is producing, it must produce at least this ratio of its rated capacity.

4.4.4.2 minimum_runtime_hrs

```
double Diesel::minimum_runtime_hrs
```

The minimum runtime [hrs] of the asset. This is the minimum time that must elapse between successive starts and stops.

4.4.4.3 time_since_last_start_hrs

```
double Diesel::time_since_last_start_hrs
```

The time that has elapsed [hrs] since the last start of the asset.

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

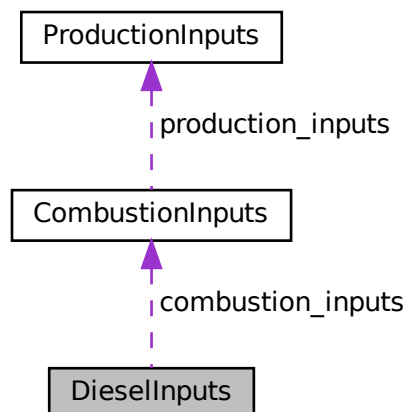
- [header/Production/Combustion/Diesel.h](#)
- [source/Production/Combustion/Diesel.cpp](#)

4.5 DieselInputs Struct Reference

A structure which bundles the necessary inputs for the [Diesel](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [CombustionInputs](#).

```
#include <Diesel.h>
```

Collaboration diagram for DieselInputs:



Public Attributes

- [CombustionInputs combustion_inputs](#)
An encapsulated [CombustionInputs](#) instance.
- double [replace_running_hrs](#) = 30000
The number of running hours after which the asset must be replaced. Overwrites the [ProductionInputs](#) attribute.
- double [capital_cost](#) = -1
The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].
- double [operation_maintenance_cost_kWh](#) = -1
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].
- double [fuel_cost_L](#) = 1.70
The cost of fuel [1/L] (undefined currency).
- double [minimum_load_ratio](#) = 0.2
The minimum load ratio of the asset. That is, when the asset is producing, it must produce at least this ratio of its rated capacity.
- double [minimum_runtime_hrs](#) = 4
The minimum runtime [hrs] of the asset. This is the minimum time that must elapse between successive starts and stops.
- double [linear_fuel_slope_LkWh](#) = -1
The slope [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced. -1 is a sentinel value, which triggers a generic fuel consumption model on construction (in fact, any negative value here will trigger).
- double [linear_fuel_intercept_LkWh](#) = -1
The intercept [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced. -1 is a sentinel value, which triggers a generic fuel consumption model on construction (in fact, any negative value here will trigger).
- double [CO2_emissions_intensity_kgL](#) = 2.7
Carbon dioxide (CO2) emissions intensity [kg/L].
- double [CO_emissions_intensity_kgL](#) = 0.0178
Carbon monoxide (CO) emissions intensity [kg/L].
- double [NOx_emissions_intensity_kgL](#) = 0.0014
Nitrogen oxide (NOx) emissions intensity [kg/L].
- double [SOx_emissions_intensity_kgL](#) = 0.0042
Sulfur oxide (SOx) emissions intensity [kg/L].
- double [CH4_emissions_intensity_kgL](#) = 0.0007
Methane (CH4) emissions intensity [kg/L].
- double [PM_emissions_intensity_kgL](#) = 0.0001
Particulate Matter (PM) emissions intensity [kg/L].

4.5.1 Detailed Description

A structure which bundles the necessary inputs for the [Diesel](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [CombustionInputs](#).

Ref: [HOMER \[2023c\]](#)

Ref: [HOMER \[2023d\]](#)

Ref: [HOMER \[2023e\]](#)

Ref: [NRCan \[2014\]](#)

Ref: [CIMAC \[2008\]](#)

4.5.2 Member Data Documentation

4.5.2.1 capital_cost

```
double DieselInputs::capital_cost = -1
```

The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].

4.5.2.2 CH4_emissions_intensity_kgL

```
double DieselInputs::CH4_emissions_intensity_kgL = 0.0007
```

Methane (CH4) emissions intensity [kg/L].

4.5.2.3 CO2_emissions_intensity_kgL

```
double DieselInputs::CO2_emissions_intensity_kgL = 2.7
```

Carbon dioxide (CO2) emissions intensity [kg/L].

4.5.2.4 CO_emissions_intensity_kgL

```
double DieselInputs::CO_emissions_intensity_kgL = 0.0178
```

Carbon monoxide (CO) emissions intensity [kg/L].

4.5.2.5 combustion_inputs

```
CombustionInputs DieselInputs::combustion_inputs
```

An encapsulated [CombustionInputs](#) instance.

4.5.2.6 fuel_cost_L

```
double DieselInputs::fuel_cost_L = 1.70
```

The cost of fuel [1/L] (undefined currency).

4.5.2.7 linear_fuel_intercept_LkWh

```
double DieselInputs::linear_fuel_intercept_LkWh = -1
```

The intercept [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced. -1 is a sentinel value, which triggers a generic fuel consumption model on construction (in fact, any negative value here will trigger).

4.5.2.8 linear_fuel_slope_LkWh

```
double DieselInputs::linear_fuel_slope_LkWh = -1
```

The slope [L/kWh] to use in computing linearized fuel consumption. This is fuel consumption per unit energy produced. -1 is a sentinel value, which triggers a generic fuel consumption model on construction (in fact, any negative value here will trigger).

4.5.2.9 minimum_load_ratio

```
double DieselInputs::minimum_load_ratio = 0.2
```

The minimum load ratio of the asset. That is, when the asset is producing, it must produce at least this ratio of its rated capacity.

4.5.2.10 minimum_runtime_hrs

```
double DieselInputs::minimum_runtime_hrs = 4
```

The minimum runtime [hrs] of the asset. This is the minimum time that must elapse between successive starts and stops.

4.5.2.11 NOx_emissions_intensity_kgL

```
double DieselInputs::NOx_emissions_intensity_kgL = 0.0014
```

Nitrogen oxide (NOx) emissions intensity [kg/L].

4.5.2.12 operation_maintenance_cost_kWh

```
double DieselInputs::operation_maintenance_cost_kWh = -1
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].

4.5.2.13 PM_emissions_intensity_kgL

```
double DieselInputs::PM_emissions_intensity_kgL = 0.0001
```

Particulate Matter (PM) emissions intensity [kg/L].

4.5.2.14 replace_running_hrs

```
double DieselInputs::replace_running_hrs = 30000
```

The number of running hours after which the asset must be replaced. Overwrites the [ProductionInputs](#) attribute.

4.5.2.15 SOx_emissions_intensity_kgL

```
double DieselInputs::SOx_emissions_intensity_kgL = 0.0042
```

Sulfur oxide (SOx) emissions intensity [kg/L].

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

- [header/Production/Combustion/Diesel.h](#)

4.6 ElectricalLoad Class Reference

A class which contains time and electrical load data. Intended to serve as a component class of [Model](#).

```
#include <ElectricalLoad.h>
```

Public Member Functions

- [ElectricalLoad](#) (void)
Constructor (dummy) for the [ElectricalLoad](#) class.
- [ElectricalLoad](#) (std::string)
Constructor (intended) for the [ElectricalLoad](#) class.
- void [readLoadData](#) (std::string)
Method to read electrical load data into an already existing [ElectricalLoad](#) object. Clears and overwrites any existing attribute values.
- void [clear](#) (void)
Method to clear all attributes of the [ElectricalLoad](#) object.
- [~ElectricalLoad](#) (void)
Destructor for the [ElectricalLoad](#) class.

Public Attributes

- int [n_points](#)
The number of points in the modelling time series.
- double [n_years](#)
The number of years being modelled (inferred from [time_vec_hrs](#)).
- double [min_load_kW](#)
The minimum [kW] of the given electrical load time series.
- double [mean_load_kW](#)
The mean, or average, [kW] of the given electrical load time series.
- double [max_load_kW](#)
The maximum [kW] of the given electrical load time series.
- std::string [path_2_electrical_load_time_series](#)
A string defining the path (either relative or absolute) to the given electrical load time series.
- std::vector< double > [time_vec_hrs](#)
A vector to hold a given sequence of model times [hrs]. This defines the modelling time series.
- std::vector< double > [dt_vec_hrs](#)
A vector to hold a sequence of model time deltas [hrs].
- std::vector< double > [load_vec_kW](#)
A vector to hold a given sequence of electrical load values [kW].

4.6.1 Detailed Description

A class which contains time and electrical load data. Intended to serve as a component class of [Model](#).

4.6.2 Constructor & Destructor Documentation

4.6.2.1 ElectricalLoad() [1/2]

```
ElectricalLoad::ElectricalLoad (
    void )
```

Constructor (dummy) for the [ElectricalLoad](#) class.

```
37 {
38     return;
39 } /* ElectricalLoad() */
```

4.6.2.2 ElectricalLoad() [2/2]

```
ElectricalLoad::ElectricalLoad (
    std::string path_2_electrical_load_time_series )
```

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

Parameters

<i>path_2_electrical_load_time_series</i>	A string defining the path (either relative or absolute) to the given electrical load time series.
---	--

```
57 {
58     this->readLoadData(path_2_electrical_load_time_series);
59
60     return;
61 } /* ElectricalLoad() */
```

4.6.2.3 ~ElectricalLoad()

```
ElectricalLoad::~~ElectricalLoad (
    void )
```

Destructor for the [ElectricalLoad](#) class.

```
184 {
185     this->clear();
186     return;
187 } /* ~ElectricalLoad() */
```

4.6.3 Member Function Documentation

4.6.3.1 clear()

```
void ElectricalLoad::clear (
    void )
```

Method to clear all attributes of the [ElectricalLoad](#) object.

```
157 {
158     this->n_points = 0;
```



```

159     this->n_years = 0;
160     this->min_load_kW = 0;
161     this->mean_load_kW = 0;
162     this->max_load_kW = 0;
163
164     this->path_2_electrical_load_time_series.clear();
165     this->time_vec_hrs.clear();
166     this->dt_vec_hrs.clear();
167     this->load_vec_kW.clear();
168
169     return;
170 } /* clear() */

```

4.6.3.2 readLoadData()

```

void ElectricalLoad::readLoadData (
    std::string path_2_electrical_load_time_series )

```

Method to read electrical load data into an already existing [ElectricalLoad](#) object. Clears and overwrites any existing attribute values.

Parameters

<i>path_2_electrical_load_time_series</i>	A string defining the path (either relative or absolute) to the given electrical load time series.
---	--

```

79 {
80     // 1. clear
81     this->clear();
82
83     // 2. init CSV reader, record path
84     io::CSVReader<2> CSV(path_2_electrical_load_time_series);
85
86     CSV.read_header(
87         io::ignore_extra_column,
88         "Time (since start of data) [hrs]",
89         "Electrical Load [kW]"
90     );
91
92     this->path_2_electrical_load_time_series = path_2_electrical_load_time_series;
93
94     // 3. read in time and load data, increment n_points, track min and max load
95     double time_hrs = 0;
96     double load_kW = 0;
97     double load_sum_kW = 0;
98
99     this->n_points = 0;
100
101     this->min_load_kW = std::numeric_limits<double>::infinity();
102     this->max_load_kW = -1 * std::numeric_limits<double>::infinity();
103
104     while (CSV.read_row(time_hrs, load_kW)) {
105         this->time_vec_hrs.push_back(time_hrs);
106         this->load_vec_kW.push_back(load_kW);
107
108         load_sum_kW += load_kW;
109
110         this->n_points++;
111
112         if (this->min_load_kW > load_kW) {
113             this->min_load_kW = load_kW;
114         }
115
116         if (this->max_load_kW < load_kW) {
117             this->max_load_kW = load_kW;
118         }
119     }
120
121     // 4. compute mean load
122     this->mean_load_kW = load_sum_kW / this->n_points;
123
124     // 5. set number of years (assuming 8,760 hours per year)
125     this->n_years = this->time_vec_hrs[this->n_points - 1] / 8760;
126

```

```

127 // 6. populate dt_vec_hrs
128 this->dt_vec_hrs.resize(n_points, 0);
129
130 for (int i = 0; i < n_points; i++) {
131     if (i == n_points - 1) {
132         this->dt_vec_hrs[i] = this->dt_vec_hrs[i - 1];
133     }
134     else {
135         double dt_hrs = this->time_vec_hrs[i + 1] - this->time_vec_hrs[i];
136         this->dt_vec_hrs[i] = dt_hrs;
137     }
138 }
139
140 }
141
142 return;
143 } /* readLoadData() */

```

4.6.4 Member Data Documentation

4.6.4.1 dt_vec_hrs

`std::vector<double> ElectricalLoad::dt_vec_hrs`

A vector to hold a sequence of model time deltas [hrs].

4.6.4.2 load_vec_kW

`std::vector<double> ElectricalLoad::load_vec_kW`

A vector to hold a given sequence of electrical load values [kW].

4.6.4.3 max_load_kW

`double ElectricalLoad::max_load_kW`

The maximum [kW] of the given electrical load time series.

4.6.4.4 mean_load_kW

`double ElectricalLoad::mean_load_kW`

The mean, or average, [kW] of the given electrical load time series.

4.6.4.5 min_load_kW

```
double ElectricalLoad::min_load_kW
```

The minimum [kW] of the given electrical load time series.

4.6.4.6 n_points

```
int ElectricalLoad::n_points
```

The number of points in the modelling time series.

4.6.4.7 n_years

```
double ElectricalLoad::n_years
```

The number of years being modelled (inferred from time_vec_hrs).

4.6.4.8 path_2_electrical_load_time_series

```
std::string ElectricalLoad::path_2_electrical_load_time_series
```

A string defining the path (either relative or absolute) to the given electrical load time series.

4.6.4.9 time_vec_hrs

```
std::vector<double> ElectricalLoad::time_vec_hrs
```

A vector to hold a given sequence of model times [hrs]. This defines the modelling time series.

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

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

4.7 Emissions Struct Reference

A structure which bundles the emitted masses of various emissions chemistries.

```
#include <Combustion.h>
```

Public Attributes

- double `CO2_kg` = 0
The mass of carbon dioxide (CO2) emitted [kg].
- double `CO_kg` = 0
The mass of carbon monoxide (CO) emitted [kg].
- double `NOx_kg` = 0
The mass of nitrogen oxides (NOx) emitted [kg].
- double `SOx_kg` = 0
The mass of sulfur oxides (SOx) emitted [kg].
- double `CH4_kg` = 0
The mass of methane (CH4) emitted [kg].
- double `PM_kg` = 0
The mass of particulate matter (PM) emitted [kg].

4.7.1 Detailed Description

A structure which bundles the emitted masses of various emissions chemistries.

4.7.2 Member Data Documentation

4.7.2.1 CH4_kg

```
double Emissions::CH4_kg = 0
```

The mass of methane (CH4) emitted [kg].

4.7.2.2 CO2_kg

```
double Emissions::CO2_kg = 0
```

The mass of carbon dioxide (CO2) emitted [kg].

4.7.2.3 CO_kg

```
double Emissions::CO_kg = 0
```

The mass of carbon monoxide (CO) emitted [kg].

4.7.2.4 NOx_kg

```
double Emissions::NOx_kg = 0
```

The mass of nitrogen oxides (NOx) emitted [kg].

4.7.2.5 PM_kg

```
double Emissions::PM_kg = 0
```

The mass of particulate matter (PM) emitted [kg].

4.7.2.6 SOx_kg

```
double Emissions::SOx_kg = 0
```

The mass of sulfur oxides (SOx) emitted [kg].

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

- [header/Production/Combustion/Combustion.h](#)

4.8 Interpolator Class Reference

A class which contains interpolation data and functionality. Intended to serve as a component of the [Production](#) and [Storage](#) hierarchies.

```
#include <Interpolator.h>
```

Public Member Functions

- [Interpolator](#) (void)
Constructor for the [Interpolator](#) class.
- void [addData1D](#) (int, std::string)
Method to add 1D interpolation data to the [Interpolator](#).
- void [addData2D](#) (int, std::string)
Method to add 2D interpolation data to the [Interpolator](#).
- double [interp1D](#) (int, double)
- double [interp2D](#) (int, double, double)
- [~Interpolator](#) (void)
Destructor for the [Interpolator](#) class.

Public Attributes

- `std::map< int, InterpolatorStruct1D > interp_map_1D`
A map <int, [InterpolatorStruct1D](#)> of given 1D interpolation data.
- `std::map< int, std::string > path_map_1D`
A map <int, string> of the paths (either relative or absolute) to the given 1D interpolation data.
- `std::map< int, InterpolatorStruct2D > interp_map_2D`
A map <int, [InterpolatorStruct2D](#)> of given 2D interpolation data.
- `std::map< int, std::string > path_map_2D`
A map <int, string> of the paths (either relative or absolute) to the given 2D interpolation data.

Private Member Functions

- `void __checkDataKey1D (int)`
Helper method to check if given data key (1D) is already in use.
- `void __checkDataKey2D (int)`
Helper method to check if given data key (2D) is already in use.
- `void __throwReadError (std::string, int)`
- `bool __isNonNumeric (std::string)`
- `std::vector< std::string > __splitCommaSeparatedString (std::string, std::string="|")`
- `std::vector< std::vector< std::string > > __getDataStringMatrix (std::string)`
- `void __readData1D (int, std::string)`
- `void __readData2D (int, std::string)`

4.8.1 Detailed Description

A class which contains interpolation data and functionality. Intended to serve as a component of the [Production](#) and [Storage](#) hierarchies.

4.8.2 Constructor & Destructor Documentation

4.8.2.1 Interpolator()

```
Interpolator::Interpolator (
    void )
```

Constructor for the [Interpolator](#) class.

```
445 {
446     //...
447
448     return;
449 } /* Interpolator() */
```

4.8.2.2 ~Interpolator()

```
Interpolator::~Interpolator (
    void )
```

Destructor for the [Interpolator](#) class.

```
526 {
527     ///  
528     ///  
529     return;  
530 } /* ~Interpolator() */
```

4.8.3 Member Function Documentation

4.8.3.1 __checkDataKey1D()

```
void Interpolator::__checkDataKey1D (
    int data_key ) [private]
```

Helper method to check if given data key (1D) is already in use.

Parameters

<i>data_key</i>	The key associated with the given 1D interpolation data.
-----------------	--

```
40 {
41     if (this->interp_map_1D.count(data_key) > 0) {
42         std::string error_str = "ERROR: Interpolator::addData1D() ";
43         error_str += "data key (1D) ";
44         error_str += std::to_string(data_key);
45         error_str += " is already in use";
46
47         #ifdef _WIN32
48             std::cout << error_str << std::endl;
49         #endif
50
51         throw std::invalid_argument(error_str);
52     }
53
54     return;
55 } /* __checkDataKey1D() */
```

4.8.3.2 __checkDataKey2D()

```
void Interpolator::__checkDataKey2D (
    int data_key ) [private]
```

Helper method to check if given data key (2D) is already in use.

Parameters

<i>data_key</i>	The key associated with the given 2D interpolation data.
-----------------	--

```
72 {
```

```

73     if (this->interp_map_2D.count(data_key) > 0) {
74         std::string error_str = "ERROR: Interpolator::addData2D() ";
75         error_str += "data key (2D) ";
76         error_str += std::to_string(data_key);
77         error_str += " is already in use";
78
79         #ifdef _WIN32
80             std::cout << error_str << std::endl;
81         #endif
82
83         throw std::invalid_argument(error_str);
84     }
85
86     return;
87 } /* __checkDataKey2D() */

```

4.8.3.3 __getDataStringMatrix()

```

std::vector< std::vector< std::string > > Interpolator::__getDataStringMatrix (
    std::string path_2_data ) [private]
187 {
188     // 1. create input file stream
189     std::ifstream ifs;
190     ifs.open(path_2_data);
191
192     // 2. check that open() worked
193     if (not ifs.is_open()) {
194         std::string error_str = "ERROR: Interpolator::__getDataStringMatrix() ";
195         error_str += " failed to open ";
196         error_str += path_2_data;
197
198         #ifdef _WIN32
199             std::cout << error_str << std::endl;
200         #endif
201
202         throw std::invalid_argument(error_str);
203     }
204
205     // 3. read file line by line
206     bool is_header = true;
207     std::string line;
208     std::vector<std::string> line_split_vec;
209     std::vector<std::vector<std::string>> string_matrix;
210
211     while (not ifs.eof()) {
212         std::getline(ifs, line);
213
214         if (is_header) {
215             is_header = false;
216             continue;
217         }
218
219         line_split_vec = this->__splitCommaSeparatedString(line);
220
221         if (not line_split_vec.empty()) {
222             string_matrix.push_back(line_split_vec);
223         }
224     }
225
226     ifs.close();
227     return string_matrix;
228 } /* __getDataStringMatrix() */

```

4.8.3.4 __isNonNumeric()

```

bool Interpolator::__isNonNumeric (
    std::string str ) [private]
129 {
130     for (size_t i = 0; i < str.size(); i++) {
131         if (isalpha(str[i])) {
132             return true;

```



```

133     }
134 }
135
136 return false;
137 } /* __isAlpha() */

```

4.8.3.5 __readData1D()

```

void Interpolator::__readData1D (
    int data_key,
    std::string path_2_data ) [private]
241 {
242     // 1. get string matrix
243     std::vector<std::vector<std::string>> string_matrix =
244         this->__getDataStringMatrix(path_2_data);
245
246     // 2. read string matrix contents into 1D interpolation struct
247     InterpolatorStruct1D interp_struct_1D;
248
249     interp_struct_1D.n_points = string_matrix.size();
250     interp_struct_1D.x_vec.resize(interp_struct_1D.n_points, 0);
251     interp_struct_1D.y_vec.resize(interp_struct_1D.n_points, 0);
252
253     for (int i = 0; i < interp_struct_1D.n_points; i++) {
254         try {
255             interp_struct_1D.x_vec[i] = std::stod(string_matrix[i][0]);
256             interp_struct_1D.y_vec[i] = std::stod(string_matrix[i][1]);
257         }
258
259         catch (...) {
260             this->__throwReadError(path_2_data, 1);
261         }
262     }
263
264     // 3. write struct to map
265     this->interp_map_1D.insert(
266         std::pair<int, InterpolatorStruct1D>(data_key, interp_struct_1D)
267     );
268
269     /*
270     // ==== TEST PRINT ==== //
271     std::cout << std::endl;
272     std::cout << path_2_data << std::endl;
273     std::cout << "-----" << std::endl;
274
275     std::cout << "n_points: " << this->interp_map_1D[data_key].n_points << std::endl;
276
277     std::cout << "x_vec: [";
278     for (
279         int i = 0;
280         i < this->interp_map_1D[data_key].n_points;
281         i++
282     ) {
283         std::cout << this->interp_map_1D[data_key].x_vec[i] << ", ";
284     }
285     std::cout << "]" << std::endl;
286
287     std::cout << "y_vec: [";
288     for (
289         int i = 0;
290         i < this->interp_map_1D[data_key].n_points;
291         i++
292     ) {
293         std::cout << this->interp_map_1D[data_key].y_vec[i] << ", ";
294     }
295     std::cout << "]" << std::endl;
296
297     std::cout << std::endl;
298     // ==== END TEST PRINT ==== //
299     */
300
301     return;
302 } /* __readData1D() */

```

4.8.3.6 __readData2D()

```

void Interpolator::__readData2D (
    int data_key,
    std::string path_2_data ) [private]
315 {
316     // 1. get string matrix
317     std::vector<std::vector<std::string>> string_matrix =
318         this->__getDataStringMatrix(path_2_data);
319
320     // 2. read string matrix contents into 2D interpolation map
321     InterpolatorStruct2D interp_struct_2D;
322
323     interp_struct_2D.n_rows = string_matrix.size() - 1;
324     interp_struct_2D.n_cols = string_matrix[0].size() - 1;
325
326     interp_struct_2D.x_vec.resize(interp_struct_2D.n_cols, 0);
327     interp_struct_2D.y_vec.resize(interp_struct_2D.n_rows, 0);
328
329     interp_struct_2D.z_matrix.resize(interp_struct_2D.n_rows, {});
330
331     for (int i = 0; i < interp_struct_2D.n_rows; i++) {
332         interp_struct_2D.z_matrix[i].resize(interp_struct_2D.n_cols, 0);
333     }
334
335     for (size_t i = 1; i < string_matrix[0].size(); i++) {
336         try {
337             interp_struct_2D.x_vec[i - 1] = std::stod(string_matrix[0][i]);
338         }
339         catch (...) {
340             this->__throwReadError(path_2_data, 2);
341         }
342     }
343
344     for (size_t i = 1; i < string_matrix.size(); i++) {
345         try {
346             interp_struct_2D.y_vec[i - 1] = std::stod(string_matrix[i][0]);
347         }
348         catch (...) {
349             this->__throwReadError(path_2_data, 2);
350         }
351     }
352
353     for (size_t i = 1; i < string_matrix.size(); i++) {
354         for (size_t j = 1; j < string_matrix[0].size(); j++) {
355             try {
356                 interp_struct_2D.z_matrix[i - 1][j - 1] = std::stod(string_matrix[i][j]);
357             }
358             catch (...) {
359                 this->__throwReadError(path_2_data, 2);
360             }
361         }
362     }
363
364     // 3. write struct to map
365     this->interp_map_2D.insert(
366         std::pair<int, InterpolatorStruct2D>(data_key, interp_struct_2D)
367     );
368
369     /*
370     // ==== TEST PRINT ==== //
371     std::cout << std::endl;
372     std::cout << path_2_data << std::endl;
373     std::cout << "-----" << std::endl;
374
375     std::cout << "n_rows: " << this->interp_map_2D[data_key].n_rows << std::endl;
376     std::cout << "n_cols: " << this->interp_map_2D[data_key].n_cols << std::endl;
377
378     std::cout << "x_vec: [";
379     for (
380         int i = 0;
381         i < this->interp_map_2D[data_key].n_cols;
382         i++
383     ) {
384         std::cout << this->interp_map_2D[data_key].x_vec[i] << ", ";
385     }
386     std::cout << "]" << std::endl;
387
388     std::cout << "y_vec: [";
389     for (
390         int i = 0;
391         i < this->interp_map_2D[data_key].n_rows;
392     ) {

```

```

395         i++
396     ) {
397         std::cout << this->interp_map_2D[data_key].y_vec[i] << ", ";
398     }
399     std::cout << "]" << std::endl;
400
401     std::cout << "z_matrix:" << std::endl;
402     for (
403         int i = 0;
404         i < this->interp_map_2D[data_key].n_rows;
405         i++
406     ) {
407         std::cout << "\t[";
408
409         for (
410             int j = 0;
411             j < this->interp_map_2D[data_key].n_cols;
412             j++
413         ) {
414             std::cout << this->interp_map_2D[data_key].z_matrix[i][j] << ", ";
415         }
416
417         std::cout << "]" << std::endl;
418     }
419     std::cout << std::endl;
420
421     std::cout << std::endl;
422     // ==== END TEST PRINT ==== //
423     /**/
424
425     return;
426 } /* __readData2D() */

```

4.8.3.7 __splitCommaSeparatedString()

```

std::vector< std::string > Interpolator::__splitCommaSeparatedString (
    std::string str,
    std::string break_str = "||" ) [private]
153 {
154     std::vector<std::string> str_split_vec;
155
156     size_t idx = 0;
157     std::string substr;
158
159     while ((idx = str.find(',')) != std::string::npos) {
160         substr = str.substr(0, idx);
161
162         if (substr == break_str) {
163             break;
164         }
165
166         str_split_vec.push_back(substr);
167
168         str.erase(0, idx + 1);
169     }
170
171     return str_split_vec;
172 } /* __splitCommaSeparatedString() */

```

4.8.3.8 __throwReadError()

```

void Interpolator::__throwReadError (
    std::string path_2_data,
    int dimensions ) [private]
100 {
101     std::string error_str = "ERROR: Interpolator::addData";
102     error_str += std::to_string(dimensions);
103     error_str += "D() ";
104     error_str += " failed to read ";
105     error_str += path_2_data;

```

```

106     error_str += " (this is probably a std::stod() error; is there non-numeric ";
107     error_str += "data where only numeric data should be?)";
108
109     #ifdef _WIN32
110         std::cout << error_str << std::endl;
111     #endif
112
113     throw std::runtime_error(error_str);
114
115     return;
116 } /* __throwReadError() */

```

4.8.3.9 addData1D()

```

void Interpolator::addData1D (
    int data_key,
    std::string path_2_data )

```

Method to add 1D interpolation data to the [Interpolator](#).

Parameters

<i>data_key</i>	A key used to index into the Interpolator .
<i>path_2_data</i>	A path (either relative or absolute) to the given 1D interpolation data.

```

469 {
470     // 1. check key
471     this->__checkDataKey1D(data_key);
472
473     // 2. read data into map
474     this->__readData1D(data_key, path_2_data);
475
476     // 3. record path
477     this->path_map_1D.insert(std::pair<int, std::string>(data_key, path_2_data));
478
479     return;
480 } /* addData1D() */

```

4.8.3.10 addData2D()

```

void Interpolator::addData2D (
    int data_key,
    std::string path_2_data )

```

Method to add 2D interpolation data to the [Interpolator](#).

Parameters

<i>data_key</i>	A key used to index into the Interpolator .
<i>path_2_data</i>	A path (either relative or absolute) to the given 2D interpolation data.

```

500 {
501     // 1. check key
502     this->__checkDataKey2D(data_key);
503
504     // 2. read data into map
505     this->__readData2D(data_key, path_2_data);
506
507     // 3. record path

```

```
508     this->path_map_2D.insert(std::pair<int, std::string>(data_key, path_2_data));
509
510     return;
511 } /* addData2D() */
```

4.8.3.11 interp1D()

```
double Interpolator::interp1D (
    int ,
    double )
```

4.8.3.12 interp2D()

```
double Interpolator::interp2D (
    int ,
    double ,
    double )
```

4.8.4 Member Data Documentation

4.8.4.1 interp_map_1D

```
std::map<int, InterpolatorStruct1D> Interpolator::interp_map_1D
```

A map <int, [InterpolatorStruct1D](#)> of given 1D interpolation data.

4.8.4.2 interp_map_2D

```
std::map<int, InterpolatorStruct2D> Interpolator::interp_map_2D
```

A map <int, [InterpolatorStruct2D](#)> of given 2D interpolation data.

4.8.4.3 path_map_1D

```
std::map<int, std::string> Interpolator::path_map_1D
```

A map <int, string> of the paths (either relative or absolute) to the given 1D interpolation data.

4.8.4.4 path_map_2D

```
std::map<int, std::string> Interpolator::path_map_2D
```

A map <int, string> of the paths (either relative or absolute) to the given 2D interpolation data.

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

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

4.9 InterpolatorStruct1D Struct Reference

A struct which holds two parallel vectors for use in 1D interpolation.

```
#include <Interpolator.h>
```

Public Attributes

- int [n_points](#) = 0
The number of data points in each parallel vector.
- std::vector< double > [x_vec](#) = {}
A vector of independent data.
- std::vector< double > [y_vec](#) = {}
A vector of dependent data.

4.9.1 Detailed Description

A struct which holds two parallel vectors for use in 1D interpolation.

4.9.2 Member Data Documentation

4.9.2.1 n_points

```
int InterpolatorStruct1D::n_points = 0
```

The number of data points in each parallel vector.

4.9.2.2 x_vec

```
std::vector<double> InterpolatorStruct1D::x_vec = {}
```

A vector of independent data.

4.9.2.3 y_vec

```
std::vector<double> InterpolatorStruct1D::y_vec = {}
```

A vector of dependent data.

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

- header/[Interpolator.h](#)

4.10 InterpolatorStruct2D Struct Reference

A struct which holds two parallel vectors and a matrix for use in 2D interpolation.

```
#include <Interpolator.h>
```

Public Attributes

- int [n_rows](#) = 0
The number of rows in the matrix (also the length of y_vec)
- int [n_cols](#) = 0
The number of cols in the matrix (also the length of x_vec)
- std::vector< double > [x_vec](#) = {}
A vector of independent data (columns).
- std::vector< double > [y_vec](#) = {}
A vector of independent data (rows).
- std::vector< std::vector< double > > [z_matrix](#) = {}
A matrix of dependent data.

4.10.1 Detailed Description

A struct which holds two parallel vectors and a matrix for use in 2D interpolation.

4.10.2 Member Data Documentation

4.10.2.1 n_cols

```
int InterpolatorStruct2D::n_cols = 0
```

The number of cols in the matrix (also the length of x_vec)

4.10.2.2 n_rows

```
int InterpolatorStruct2D::n_rows = 0
```

The number of rows in the matrix (also the length of y_vec)

4.10.2.3 x_vec

```
std::vector<double> InterpolatorStruct2D::x_vec = {}
```

A vector of independent data (columns).

4.10.2.4 y_vec

```
std::vector<double> InterpolatorStruct2D::y_vec = {}
```

A vector of independent data (rows).

4.10.2.5 z_matrix

```
std::vector<std::vector<double> > InterpolatorStruct2D::z_matrix = {}
```

A matrix of dependent data.

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

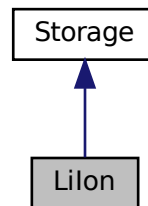
- header/[Interpolator.h](#)

4.11 Lilon Class Reference

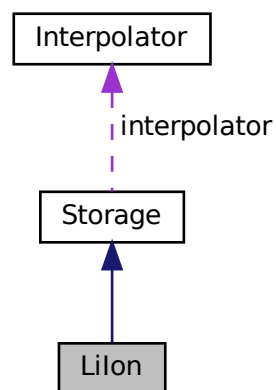
A derived class of [Storage](#) which models energy storage by way of lithium-ion batteries.

```
#include <LiIon.h>
```

Inheritance diagram for Lilon:



Collaboration diagram for Lilon:



Public Member Functions

- [Lilon](#) (void)
Constructor (dummy) for the [Lilon](#) class.
- [Lilon](#) (int, double, [LilonInputs](#))
Constructor (intended) for the [Lilon](#) class.
- void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- double [getAvailablekW](#) (double)

- Method to get the discharge power currently available from the asset.*

 - double `getAcceptablekW` (double)
- Method to get the charge power currently acceptable by the asset.*

 - void `commitCharge` (int, double, double)
- Method which takes in the charging power for the current timestep and records.*

 - double `commitDischarge` (int, double, double, double)
- Method which takes in the discharging power for the current timestep and records. Returns the load remaining after discharge.*

 - `~Lilon` (void)
- Destructor for the `Lilon` class.*

Public Attributes

- double `dynamic_energy_capacity_kWh`

The dynamic (i.e. degrading) energy capacity [kWh] of the asset.
- double `SOH`

The state of health of the asset.
- double `replace_SOH`

The state of health at which the asset is considered "dead" and must be replaced.
- double `degradation_alpha`

A dimensionless acceleration coefficient used in modelling energy capacity degradation.
- double `degradation_beta`

A dimensionless acceleration exponent used in modelling energy capacity degradation.
- double `degradation_B_hat_cal_0`

A reference (or base) pre-exponential factor [1/sqrt(hrs)] used in modelling energy capacity degradation.
- double `degradation_r_cal`

A dimensionless constant used in modelling energy capacity degradation.
- double `degradation_Ea_cal_0`

A reference (or base) activation energy [J/mol] used in modelling energy capacity degradation.
- double `degradation_a_cal`

A pre-exponential factor [J/mol] used in modelling energy capacity degradation.
- double `degradation_s_cal`

A dimensionless constant used in modelling energy capacity degradation.
- double `gas_constant_JmolK`

The universal gas constant [J/mol.K].
- double `temperature_K`

The absolute environmental temperature [K] of the lithium ion battery energy storage system.
- double `init_SOC`

The initial state of charge of the asset.
- double `min_SOC`

The minimum state of charge of the asset. Will toggle `is_depleted` when reached.
- double `hysteresis_SOC`

The state of charge the asset must achieve to toggle `is_depleted`.
- double `max_SOC`

The maximum state of charge of the asset.
- double `charging_efficiency`

The charging efficiency of the asset.
- double `discharging_efficiency`

The discharging efficiency of the asset.
- `std::vector< double >` `SOH_vec`

A vector of the state of health of the asset at each point in the modelling time series.

Private Member Functions

- void [__checkInputs](#) ([LilonInputs](#))
Helper method to check inputs to the [Lilon](#) constructor.
- double [__getGenericCapitalCost](#) (void)
Helper method to generate a generic lithium ion battery energy storage system capital cost.
- double [__getGenericOpMaintCost](#) (void)
Helper method to generate a generic lithium ion battery energy storage system operation and maintenance cost. This is a cost incurred per unit energy charged/discharged.
- void [__toggleDepleted](#) (void)
Helper method to toggle the `is_depleted` attribute of [Lilon](#).
- void [__handleDegradation](#) (int, double, double)
Helper method to apply degradation modelling and update attributes.
- void [__modelDegradation](#) (double, double)
Helper method to model energy capacity degradation as a function of operating state.
- double [__getBcal](#) (double)
Helper method to compute and return the base pre-exponential factor for a given state of charge.
- double [__getEacal](#) (double)
Helper method to compute and return the activation energy value for a given state of charge.
- void [__writeSummary](#) (std::string)
Helper method to write summary results for [Lilon](#).
- void [__writeTimeSeries](#) (std::string, std::vector< double > *, int=-1)
Helper method to write time series results for [Lilon](#).

4.11.1 Detailed Description

A derived class of [Storage](#) which models energy storage by way of lithium-ion batteries.

4.11.2 Constructor & Destructor Documentation

4.11.2.1 [Lilon\(\)](#) [1/2]

```
LiIon::LiIon (
    void )
```

Constructor (dummy) for the [Lilon](#) class.

```
646 {
647     return;
648 } /* LiIon() */
```

4.11.2.2 [Lilon\(\)](#) [2/2]

```
LiIon::LiIon (
    int n_points,
    double n_years,
    LiIonInputs liion_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>liion_inputs</i>	A structure of Lilion constructor inputs.

```

676 :
677 Storage(
678     n_points,
679     n_years,
680     liion_inputs.storage_inputs
681 )
682 {
683     // 1. check inputs
684     this->__checkInputs(liion_inputs);
685
686     // 2. set attributes
687     this->type = StorageType :: LIION;
688     this->type_str = "LIION";
689
690     this->dynamic_energy_capacity_kWh = this->energy_capacity_kWh;
691     this->SOH = 1;
692     this->replace_SOH = liion_inputs.replace_SOH;
693
694     this->degradation_alpha = liion_inputs.degradation_alpha;
695     this->degradation_beta = liion_inputs.degradation_beta;
696     this->degradation_B_hat_cal_0 = liion_inputs.degradation_B_hat_cal_0;
697     this->degradation_r_cal = liion_inputs.degradation_r_cal;
698     this->degradation_Ea_cal_0 = liion_inputs.degradation_Ea_cal_0;
699     this->degradation_a_cal = liion_inputs.degradation_a_cal;
700     this->degradation_s_cal = liion_inputs.degradation_s_cal;
701     this->gas_constant_JmolK = liion_inputs.gas_constant_JmolK;
702     this->temperature_K = liion_inputs.temperature_K;
703
704     this->init_SOC = liion_inputs.init_SOC;
705     this->charge_kWh = this->init_SOC * this->energy_capacity_kWh;
706
707     this->min_SOC = liion_inputs.min_SOC;
708     this->hysteresis_SOC = liion_inputs.hysteresis_SOC;
709     this->max_SOC = liion_inputs.max_SOC;
710
711     this->charging_efficiency = liion_inputs.charging_efficiency;
712     this->discharging_efficiency = liion_inputs.discharging_efficiency;
713
714     if (liion_inputs.capital_cost < 0) {
715         this->capital_cost = this->__getGenericCapitalCost();
716     }
717
718     if (liion_inputs.operation_maintenance_cost_kWh < 0) {
719         this->operation_maintenance_cost_kWh = this->__getGenericOpMaintCost();
720     }
721
722     if (not this->is_sunk) {
723         this->capital_cost_vec[0] = this->capital_cost;
724     }
725
726     this->SOH_vec.resize(this->n_points, 0);
727
728     // 3. construction print
729     if (this->print_flag) {
730         std::cout << "LiIon object constructed at " << this << std::endl;
731     }
732
733     return;
734 } /* LiIon() */

```

4.11.2.3 ~Lilion()

```

LiIon::~LiIon (
    void )

```

Destructor for the [Lilion](#) class.

```

990 {
991     // 1. destruction print

```

```

992     if (this->print_flag) {
993         std::cout << "LiIon object at " << this << " destroyed" << std::endl;
994     }
995     return;
996 } /* ~LiIon() */

```

4.11.3 Member Function Documentation

4.11.3.1 __checkInputs()

```

void LiIon::__checkInputs (
    LiIonInputs liion_inputs ) [private]

```

Helper method to check inputs to the [Lilon](#) constructor.

Parameters

<i>liion_inputs</i>	A structure of Lilon constructor inputs.
---------------------	--

```

39 {
40     // 1. check replace_SOH
41     if (liion_inputs.replace_SOH < 0 or liion_inputs.replace_SOH > 1) {
42         std::string error_str = "ERROR: LiIon(): replace_SOH must be in the closed ";
43         error_str += "interval [0, 1]";
44
45         #ifdef _WIN32
46             std::cout << error_str << std::endl;
47         #endif
48
49         throw std::invalid_argument(error_str);
50     }
51
52     // 2. check init_SOC
53     if (liion_inputs.init_SOC < 0 or liion_inputs.init_SOC > 1) {
54         std::string error_str = "ERROR: LiIon(): init_SOC must be in the closed ";
55         error_str += "interval [0, 1]";
56
57         #ifdef _WIN32
58             std::cout << error_str << std::endl;
59         #endif
60
61         throw std::invalid_argument(error_str);
62     }
63
64     // 3. check min_SOC
65     if (liion_inputs.min_SOC < 0 or liion_inputs.min_SOC > 1) {
66         std::string error_str = "ERROR: LiIon(): min_SOC must be in the closed ";
67         error_str += "interval [0, 1]";
68
69         #ifdef _WIN32
70             std::cout << error_str << std::endl;
71         #endif
72
73         throw std::invalid_argument(error_str);
74     }
75
76     // 4. check hysteresis_SOC
77     if (liion_inputs.hysteresis_SOC < 0 or liion_inputs.hysteresis_SOC > 1) {
78         std::string error_str = "ERROR: LiIon(): hysteresis_SOC must be in the closed ";
79         error_str += "interval [0, 1]";
80
81         #ifdef _WIN32
82             std::cout << error_str << std::endl;
83         #endif
84
85         throw std::invalid_argument(error_str);
86     }
87
88     // 5. check max_SOC
89     if (liion_inputs.max_SOC < 0 or liion_inputs.max_SOC > 1) {

```

```

90     std::string error_str = "ERROR: LiIon(): max_SOC must be in the closed ";
91     error_str += "interval [0, 1]";
92
93     #ifdef _WIN32
94         std::cout << error_str << std::endl;
95     #endif
96
97     throw std::invalid_argument(error_str);
98 }
99
100 // 6. check charging_efficiency
101 if (liion_inputs.charging_efficiency <= 0 or liion_inputs.charging_efficiency > 1) {
102     std::string error_str = "ERROR: LiIon(): charging_efficiency must be in the ";
103     error_str += "half-open interval (0, 1]";
104
105     #ifdef _WIN32
106         std::cout << error_str << std::endl;
107     #endif
108
109     throw std::invalid_argument(error_str);
110 }
111
112 // 7. check discharging_efficiency
113 if (
114     liion_inputs.discharging_efficiency <= 0 or
115     liion_inputs.discharging_efficiency > 1
116 ) {
117     std::string error_str = "ERROR: LiIon(): discharging_efficiency must be in the ";
118     error_str += "half-open interval (0, 1]";
119
120     #ifdef _WIN32
121         std::cout << error_str << std::endl;
122     #endif
123
124     throw std::invalid_argument(error_str);
125 }
126
127 // 8. check degradation_alpha
128 if (liion_inputs.degradation_alpha <= 0) {
129     std::string error_str = "ERROR: LiIon(): degradation_alpha must be > 0";
130
131     #ifdef _WIN32
132         std::cout << error_str << std::endl;
133     #endif
134
135     throw std::invalid_argument(error_str);
136 }
137
138 // 9. check degradation_beta
139 if (liion_inputs.degradation_beta <= 0) {
140     std::string error_str = "ERROR: LiIon(): degradation_beta must be > 0";
141
142     #ifdef _WIN32
143         std::cout << error_str << std::endl;
144     #endif
145
146     throw std::invalid_argument(error_str);
147 }
148
149 // 10. check degradation_B_hat_cal_0
150 if (liion_inputs.degradation_B_hat_cal_0 <= 0) {
151     std::string error_str = "ERROR: LiIon(): degradation_B_hat_cal_0 must be > 0";
152
153     #ifdef _WIN32
154         std::cout << error_str << std::endl;
155     #endif
156
157     throw std::invalid_argument(error_str);
158 }
159
160 // 11. check degradation_r_cal
161 if (liion_inputs.degradation_r_cal < 0) {
162     std::string error_str = "ERROR: LiIon(): degradation_r_cal must be >= 0";
163
164     #ifdef _WIN32
165         std::cout << error_str << std::endl;
166     #endif
167
168     throw std::invalid_argument(error_str);
169 }
170
171 // 12. check degradation_Ea_cal_0
172 if (liion_inputs.degradation_Ea_cal_0 <= 0) {
173     std::string error_str = "ERROR: LiIon(): degradation_Ea_cal_0 must be > 0";
174
175     #ifdef _WIN32
176         std::cout << error_str << std::endl;

```

```

177         #endif
178
179         throw std::invalid_argument(error_str);
180     }
181
182     // 13. check degradation_a_cal
183     if (lilion_inputs.degradation_a_cal < 0) {
184         std::string error_str = "ERROR: LiIon(): degradation_a_cal must be >= 0";
185
186         #ifdef _WIN32
187             std::cout << error_str << std::endl;
188         #endif
189
190         throw std::invalid_argument(error_str);
191     }
192
193     // 14. check degradation_s_cal
194     if (lilion_inputs.degradation_s_cal < 0) {
195         std::string error_str = "ERROR: LiIon(): degradation_s_cal must be >= 0";
196
197         #ifdef _WIN32
198             std::cout << error_str << std::endl;
199         #endif
200
201         throw std::invalid_argument(error_str);
202     }
203
204     // 15. check gas_constant_JmolK
205     if (lilion_inputs.gas_constant_JmolK <= 0) {
206         std::string error_str = "ERROR: LiIon(): gas_constant_JmolK must be > 0";
207
208         #ifdef _WIN32
209             std::cout << error_str << std::endl;
210         #endif
211
212         throw std::invalid_argument(error_str);
213     }
214
215     // 16. check temperature_K
216     if (lilion_inputs.temperature_K < 0) {
217         std::string error_str = "ERROR: LiIon(): temperature_K must be >= 0";
218
219         #ifdef _WIN32
220             std::cout << error_str << std::endl;
221         #endif
222
223         throw std::invalid_argument(error_str);
224     }
225
226     return;
227 } /* __checkInputs() */

```

4.11.3.2 __getBcal()

```
double LiIon::__getBcal (
    double SOC ) [private]
```

Helper method to compute and return the base pre-exponential factor for a given state of charge.

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

Parameters

SOC	The current state of charge of the asset.
-----	---

Returns

The base pre-exponential factor for the given state of charge.

```

427 {
428     double B_cal = this->degradation_B_hat_cal_0 *
429         exp(this->degradation_r_cal * SOC);
430
431     return B_cal;
432 } /* __getBcal() */

```

4.11.3.3 __getEacal()

```

double LiIon::__getEacal (
    double SOC ) [private]

```

Helper method to compute and return the activation energy value for a given state of charge.

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

Parameters

<i>SOC</i>	The current state of charge of the asset.
------------	---

Returns

The activation energy value for the given state of charge.

```

454 {
455     double Ea_cal = this->degradation_Ea_cal_0;
456
457     Ea_cal -= this->degradation_a_cal *
458         (exp(this->degradation_s_cal * SOC) - 1);
459
460     return Ea_cal;
461 } /* __getEacal() */

```

4.11.3.4 __getGenericCapitalCost()

```

double LiIon::__getGenericCapitalCost (
    void ) [private]

```

Helper method to generate a generic lithium ion battery energy storage system capital cost.

This model was obtained by way of surveying an assortment of published lithium ion battery energy storage system costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars [CAD].

Returns

A generic capital cost for the lithium ion battery energy storage system [CAD].

```

250 {
251     double capital_cost_per_kWh = 250 * pow(this->energy_capacity_kWh, -0.15) + 650;
252
253     return capital_cost_per_kWh * this->energy_capacity_kWh;
254 } /* __getGenericCapitalCost() */

```


4.11.3.5 `__getGenericOpMaintCost()`

```
double LiIon::__getGenericOpMaintCost (
    void ) [private]
```

Helper method to generate a generic lithium ion battery energy storage system operation and maintenance cost. This is a cost incurred per unit energy charged/discharged.

This model was obtained by way of surveying an assortment of published lithium ion battery energy storage system costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars [CAD/kWh].

Returns

A generic operation and maintenance cost, per unit energy charged/discharged, for the lithium ion battery energy storage system [CAD/kWh].

```
278 {
279     return 0.01;
280 } /* __getGenericOpMaintCost() */
```

4.11.3.6 `__handleDegradation()`

```
void LiIon::__handleDegradation (
    int timestep,
    double dt_hrs,
    double charging_discharging_kW ) [private]
```

Helper method to apply degradation modelling and update attributes.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>charging_discharging_kW</i>	The charging/discharging power [kW] being sent to the asset.

```
348 {
349     // 1. model degradation
350     this->__modelDegradation(dt_hrs, charging_discharging_kW);
351
352     // 2. update and record
353     this->SOH_vec[timestep] = this->SOH;
354     this->dynamic_energy_capacity_kWh = this->SOH * this->energy_capacity_kWh;
355
356     return;
357 } /* __handleDegradation() */
```

4.11.3.7 `__modelDegradation()`

```
void LiIon::__modelDegradation (
    double dt_hrs,
    double charging_discharging_kW ) [private]
```

Helper method to model energy capacity degradation as a function of operating state.

Ref: [Truelove](#) [2023]

Parameters

<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>charging_discharging_kW</i>	The charging/discharging power [kw] being sent to the asset.

```

380 {
381     // 1. compute SOC
382     double SOC = this->charge_kWh / this->energy_capacity_kWh;
383
384     // 2. compute C-rate and corresponding acceleration factor
385     double C_rate = charging_discharging_kW / this->power_capacity_kW;
386
387     double C_acceleration_factor =
388         1 + this->degradation_alpha * pow(C_rate, this->degradation_beta);
389
390     // 3. compute dSOH / dt
391     double B_cal = __getBcal(SOC);
392     double Ea_cal = __getEa_cal(SOC);
393
394     double dSOH_dt = B_cal *
395         exp((-1 * Ea_cal) / (this->gas_constant_JmolK * this->temperature_K));
396
397     dSOH_dt *= dSOH_dt;
398     dSOH_dt *= 1 / (2 * this->SOH);
399     dSOH_dt *= C_acceleration_factor;
400
401     // 4. update state of health
402     this->SOH -= dSOH_dt * dt_hrs;
403
404     return;
405 } /* __modelDegradation() */

```

4.11.3.8 __toggleDepleted()

```

void LiIon::__toggleDepleted (
    void ) [private]

```

Helper method to toggle the is_depleted attribute of [Lilon](#).

```

295 {
296     if (this->is_depleted) {
297         double hysteresis_charge_kWh = this->hysteresis_SOC * this->energy_capacity_kWh;
298
299         if (hysteresis_charge_kWh > this->dynamic_energy_capacity_kWh) {
300             hysteresis_charge_kWh = this->dynamic_energy_capacity_kWh;
301         }
302
303         if (this->charge_kWh >= hysteresis_charge_kWh) {
304             this->is_depleted = false;
305         }
306     }
307
308     else {
309         double min_charge_kWh = this->min_SOC * this->energy_capacity_kWh;
310
311         if (this->charge_kWh <= min_charge_kWh) {
312             this->is_depleted = true;
313         }
314     }
315
316     return;
317 } /* __toggleDepleted() */

```

4.11.3.9 __writeSummary()

```

void LiIon::__writeSummary (
    std::string write_path ) [private], [virtual]

```

Helper method to write summary results for [Lilon](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
-------------------	--

Reimplemented from [Storage](#).

```

479 {
480     // 1. create filestream
481     write_path += "summary_results.md";
482     std::ofstream ofs;
483     ofs.open(write_path, std::ofstream::out);
484
485     // 2. write summary results (markdown)
486     ofs << "# ";
487     ofs << std::to_string(int(ceil(this->power_capacity_kW)));
488     ofs << " kW ";
489     ofs << std::to_string(int(ceil(this->energy_capacity_kWh)));
490     ofs << " kWh LIIION Summary Results\n";
491     ofs << "\n-----\n\n";
492
493     // 2.1. Storage attributes
494     ofs << "## Storage Attributes\n";
495     ofs << "\n";
496     ofs << "Power Capacity: " << this->power_capacity_kW << "kW \n";
497     ofs << "Energy Capacity: " << this->energy_capacity_kWh << "kWh \n";
498     ofs << "\n";
499
500     ofs << "Sunk Cost (N = 0 / Y = 1): " << this->is_sunk << " \n";
501     ofs << "Capital Cost: " << this->capital_cost << " \n";
502     ofs << "Operation and Maintenance Cost: " << this->operation_maintenance_cost_kWh
503         << " per kWh charged/discharged \n";
504     ofs << "Nominal Inflation Rate (annual): " << this->nominal_inflation_annual
505         << " \n";
506     ofs << "Nominal Discount Rate (annual): " << this->nominal_discount_annual
507         << " \n";
508     ofs << "Real Discount Rate (annual): " << this->real_discount_annual << " \n";
509
510     ofs << "\n-----\n\n";
511
512     // 2.2. LiIon attributes
513     ofs << "## LiIon Attributes\n";
514     ofs << "\n";
515
516     ofs << "Charging Efficiency: " << this->charging_efficiency << " \n";
517     ofs << "Discharging Efficiency: " << this->discharging_efficiency << " \n";
518     ofs << "\n";
519
520     ofs << "Initial State of Charge: " << this->init_SOC << " \n";
521     ofs << "Minimum State of Charge: " << this->min_SOC << " \n";
522     ofs << "Hyteresis State of Charge: " << this->hysteresis_SOC << " \n";
523     ofs << "Maximum State of Charge: " << this->max_SOC << " \n";
524     ofs << "\n";
525
526     ofs << "Replacement State of Health: " << this->replace_SOH << " \n";
527     ofs << "\n";
528
529     ofs << "Degradation Acceleration Coeff.: " << this->degradation_alpha << " \n";
530     ofs << "Degradation Acceleration Exp.: " << this->degradation_beta << " \n";
531     ofs << "Degradation Base Pre-Exponential Factor: "
532         << this->degradation_B_hat_cal_0 << " 1/sqrt(hrs) \n";
533     ofs << "Degradation Dimensionless Constant (r_cal): "
534         << this->degradation_r_cal << " \n";
535     ofs << "Degradation Base Activation Energy: "
536         << this->degradation_Ea_cal_0 << " J/mol \n";
537     ofs << "Degradation Pre-Exponential Factor: "
538         << this->degradation_a_cal << " J/mol \n";
539     ofs << "Degradation Dimensionless Constant (s_cal): "
540         << this->degradation_s_cal << " \n";
541     ofs << "Universal Gas Constant: " << this->gas_constant_JmolK
542         << " J/mol.K \n";
543     ofs << "Absolute Environmental Temperature: " << this->temperature_K << " K \n";
544     ofs << "\n";
545
546     ofs << "\n-----\n\n";
547
548     // 2.3. LiIon Results
549     ofs << "## Results\n";
550     ofs << "\n";
551
552     ofs << "Net Present Cost: " << this->net_present_cost << " \n";
553     ofs << "\n";
554
555     ofs << "Total Discharge: " << this->total_discharge_kWh

```

```

556         « " kWh  \n";
557
558     ofs « "Levellized Cost of Energy: " « this->levellized_cost_of_energy_kWh
559         « " per kWh dispatched  \n";
560     ofs « "\n";
561
562     ofs « "Replacements: " « this->n_replacements « "  \n";
563
564     ofs « "\n-----\n\n";
565     ofs.close();
566     return;
567 } /* __writeSummary() */

```

4.11.3.10 __writeTimeSeries()

```

void LiIon::__writeTimeSeries (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    int max_lines = -1 ) [private], [virtual]

```

Helper method to write time series results for [Lilon](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <i>time_vec_hrs</i> attribute of the ElectricalLoad .
<i>max_lines</i>	The maximum number of lines of output to write.

Reimplemented from [Storage](#).

```

598 {
599     // 1. create filestream
600     write_path += "time_series_results.csv";
601     std::ofstream ofs;
602     ofs.open(write_path, std::ofstream::out);
603
604     // 2. write time series results (comma separated value)
605     ofs « "Time (since start of data) [hrs],";
606     ofs « "Charging Power [kW],";
607     ofs « "Discharging Power [kW],";
608     ofs « "Charge (at end of timestep) [kWh],";
609     ofs « "State of Health (at end of timestep) [ ],";
610     ofs « "Capital Cost (actual),";
611     ofs « "Operation and Maintenance Cost (actual),";
612     ofs « "\n";
613
614     for (int i = 0; i < max_lines; i++) {
615         ofs « time_vec_hrs_ptr->at(i) « ",";
616         ofs « this->charging_power_vec_kW[i] « ",";
617         ofs « this->discharging_power_vec_kW[i] « ",";
618         ofs « this->charge_vec_kWh[i] « ",";
619         ofs « this->SOH_vec[i] « ",";
620         ofs « this->capital_cost_vec[i] « ",";
621         ofs « this->operation_maintenance_cost_vec[i] « ",";
622         ofs « "\n";
623     }
624
625     ofs.close();
626     return;
627 } /* __writeTimeSeries() */

```

4.11.3.11 commitCharge()

```

void LiIon::commitCharge (
    int timestep,

```

```
double dt_hrs,
double charge_kW ) [virtual]
```

Method which takes in the charging power for the current timestep and records.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>charging_kW</i>	The charging power [kw] being sent to the asset.

Reimplemented from [Storage](#).

```
881 {
882     // 1. record charging power
883     this->charging_power_vec_kW[timestep] = charging_kW;
884
885     // 2. update charge and record
886     this->charge_kWh += this->charging_efficiency * charging_kW * dt_hrs;
887     this->charge_vec_kWh[timestep] = this->charge_kWh;
888
889     // 3. toggle depleted flag (if applicable)
890     this->__toggleDepleted();
891
892     // 4. model degradation
893     this->__handleDegradation(timestep, dt_hrs, charging_kW);
894
895     // 5. trigger replacement (if applicable)
896     if (this->SOH <= this->replace_SOH) {
897         this->handleReplacement(timestep);
898     }
899
900     // 6. capture operation and maintenance costs (if applicable)
901     if (charging_kW > 0) {
902         this->operation_maintenance_cost_vec[timestep] = charging_kW * dt_hrs *
903             this->operation_maintenance_cost_kWh;
904     }
905
906     this->power_kW = 0;
907     return;
908 } /* commitCharge() */
```

4.11.3.12 commitDischarge()

```
double LiIon::commitDischarge (
    int timestep,
    double dt_hrs,
    double discharging_kW,
    double load_kW ) [virtual]
```

Method which takes in the discharging power for the current timestep and records. Returns the load remaining after discharge.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>discharging_kW</i>	The discharging power [kw] being drawn from the asset.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the discharge is deducted from it.

Reimplemented from [Storage](#).

```

944 {
945     // 1. record discharging power, update total
946     this->discharging_power_vec_kW[timestep] = discharging_kW;
947     this->total_discharge_kWh += discharging_kW * dt_hrs;
948
949     // 2. update charge and record
950     this->charge_kWh -= (discharging_kW * dt_hrs) / this->discharging_efficiency;
951     this->charge_vec_kWh[timestep] = this->charge_kWh;
952
953     // 3. update load
954     load_kW -= discharging_kW;
955
956     // 4. toggle depleted flag (if applicable)
957     this->__toggleDepleted();
958
959     // 5. model degradation
960     this->__handleDegradation(timestep, dt_hrs, discharging_kW);
961
962     // 6. trigger replacement (if applicable)
963     if (this->SOH <= this->replace_SOH) {
964         this->handleReplacement(timestep);
965     }
966
967     // 7. capture operation and maintenance costs (if applicable)
968     if (discharging_kW > 0) {
969         this->operation_maintenance_cost_vec[timestep] = discharging_kW * dt_hrs *
970             this->operation_maintenance_cost_kWh;
971     }
972
973     this->power_kW = 0;
974     return load_kW;
975 } /* commitDischarge() */

```

4.11.3.13 getAcceptablekW()

```

double LiIon::getAcceptablekW (
    double dt_hrs ) [virtual]

```

Method to get the charge power currently acceptable by the asset.

Parameters

<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
---------------	--

Returns

The charging power [kW] currently acceptable by the asset.

Reimplemented from [Storage](#).

```

825 {
826     // 1. get max charge
827     double max_charge_kWh = this->max_SOC * this->energy_capacity_kWh;
828
829     if (max_charge_kWh > this->dynamic_energy_capacity_kWh) {
830         max_charge_kWh = this->dynamic_energy_capacity_kWh;
831     }
832
833     // 2. compute acceptable power
834     // (accounting for the power currently being charged/discharged by the asset)
835     double acceptable_kW =
836         (max_charge_kWh - this->charge_kWh) /
837         (this->charging_efficiency * dt_hrs);

```

```

838
839     acceptable_kW -= this->power_kW;
840
841     if (acceptable_kW <= 0) {
842         return 0;
843     }
844
845     // 3. apply power constraint
846     if (acceptable_kW > this->power_capacity_kW) {
847         acceptable_kW = this->power_capacity_kW;
848     }
849
850     return acceptable_kW;
851 } /* getAcceptablekW( */

```

4.11.3.14 getAvailablekW()

```

double LiIon::getAvailablekW (
    double dt_hrs ) [virtual]

```

Method to get the discharge power currently available from the asset.

Parameters

<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
---------------	--

Returns

The discharging power [kW] currently available from the asset.

Reimplemented from [Storage](#).

```

784 {
785     // 1. get min charge
786     double min_charge_kWh = this->min_SOC * this->energy_capacity_kWh;
787
788     // 2. compute available power
789     // (accounting for the power currently being charged/discharged by the asset)
790     double available_kW =
791         ((this->charge_kWh - min_charge_kWh) * this->discharging_efficiency) /
792         dt_hrs;
793
794     available_kW -= this->power_kW;
795
796     if (available_kW <= 0) {
797         return 0;
798     }
799
800     // 3. apply power constraint
801     if (available_kW > this->power_capacity_kW) {
802         available_kW = this->power_capacity_kW;
803     }
804
805     return available_kW;
806 } /* getAvailablekW( */

```

4.11.3.15 handleReplacement()

```

void LiIon::handleReplacement (
    int timestep ) [virtual]

```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Storage](#).

```

752 {
753     // 1. reset attributes
754     this->dynamic_energy_capacity_kWh = this->energy_capacity_kWh;
755     this->SOH = 1;
756
757     // 2. invoke base class method
758     Storage::handleReplacement(timestep);
759
760     // 3. correct attributes
761     this->charge_kWh = this->init_SOC * this->energy_capacity_kWh;
762     this->is_depleted = false;
763
764     return;
765 } /* __handleReplacement() */

```

4.11.4 Member Data Documentation

4.11.4.1 charging_efficiency

```
double LiIon::charging_efficiency
```

The charging efficiency of the asset.

4.11.4.2 degradation_a_cal

```
double LiIon::degradation_a_cal
```

A pre-exponential factor [J/mol] used in modelling energy capacity degradation.

4.11.4.3 degradation_alpha

```
double LiIon::degradation_alpha
```

A dimensionless acceleration coefficient used in modelling energy capacity degradation.

4.11.4.4 degradation_B_hat_cal_0

```
double LiIon::degradation_B_hat_cal_0
```

A reference (or base) pre-exponential factor [1/sqrt(hrs)] used in modelling energy capacity degradation.

4.11.4.5 degradation_beta

```
double LiIon::degradation_beta
```

A dimensionless acceleration exponent used in modelling energy capacity degradation.

4.11.4.6 degradation_Ea_cal_0

```
double LiIon::degradation_Ea_cal_0
```

A reference (or base) activation energy [J/mol] used in modelling energy capacity degradation.

4.11.4.7 degradation_r_cal

```
double LiIon::degradation_r_cal
```

A dimensionless constant used in modelling energy capacity degradation.

4.11.4.8 degradation_s_cal

```
double LiIon::degradation_s_cal
```

A dimensionless constant used in modelling energy capacity degradation.

4.11.4.9 discharging_efficiency

```
double LiIon::discharging_efficiency
```

The discharging efficiency of the asset.

4.11.4.10 dynamic_energy_capacity_kWh

```
double LiIon::dynamic_energy_capacity_kWh
```

The dynamic (i.e. degrading) energy capacity [kWh] of the asset.

4.11.4.11 gas_constant_JmolK

```
double LiIon::gas_constant_JmolK
```

The universal gas constant [J/mol.K].

4.11.4.12 hysteresis_SOC

```
double LiIon::hysteresis_SOC
```

The state of charge the asset must achieve to toggle is_depleted.

4.11.4.13 init_SOC

```
double LiIon::init_SOC
```

The initial state of charge of the asset.

4.11.4.14 max_SOC

```
double LiIon::max_SOC
```

The maximum state of charge of the asset.

4.11.4.15 min_SOC

```
double LiIon::min_SOC
```

The minimum state of charge of the asset. Will toggle is_depleted when reached.

4.11.4.16 replace_SOH

```
double LiIon::replace_SOH
```

The state of health at which the asset is considered "dead" and must be replaced.

4.11.4.17 SOH

```
double LiIon::SOH
```

The state of health of the asset.

4.11.4.18 SOH_vec

```
std::vector<double> LiIon::SOH_vec
```

A vector of the state of health of the asset at each point in the modelling time series.

4.11.4.19 temperature_K

```
double LiIon::temperature_K
```

The absolute environmental temperature [K] of the lithium ion battery energy storage system.

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

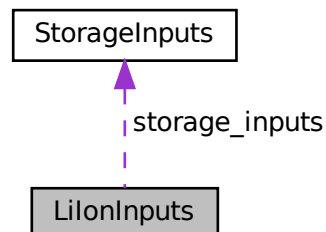
- header/Storage/[Lilon.h](#)
- source/Storage/[Lilon.cpp](#)

4.12 LilonInputs Struct Reference

A structure which bundles the necessary inputs for the [Lilon](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [StorageInputs](#).

```
#include <LiIon.h>
```

Collaboration diagram for LilonInputs:



Public Attributes

- [StorageInputs storage_inputs](#)
An encapsulated [StorageInputs](#) instance.
- double [capital_cost](#) = -1
The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].
- double [operation_maintenance_cost_kWh](#) = -1
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy charged/discharged. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].
- double [init_SOC](#) = 0.5
The initial state of charge of the asset.
- double [min_SOC](#) = 0.15
The minimum state of charge of the asset. Will toggle `is_depleted` when reached.
- double [hysteresis_SOC](#) = 0.5
The state of charge the asset must achieve to toggle `is_depleted`.
- double [max_SOC](#) = 0.9
The maximum state of charge of the asset.
- double [charging_efficiency](#) = 0.9
The charging efficiency of the asset.
- double [discharging_efficiency](#) = 0.9
The discharging efficiency of the asset.
- double [replace_SOH](#) = 0.8
The state of health at which the asset is considered "dead" and must be replaced.
- double [degradation_alpha](#) = 8.935
A dimensionless acceleration coefficient used in modelling energy capacity degradation.
- double [degradation_beta](#) = 1
A dimensionless acceleration exponent used in modelling energy capacity degradation.
- double [degradation_B_hat_cal_0](#) = 5.22226e6
A reference (or base) pre-exponential factor [1/sqrt(hrs)] used in modelling energy capacity degradation.
- double [degradation_r_cal](#) = 0.4361
A dimensionless constant used in modelling energy capacity degradation.
- double [degradation_Ea_cal_0](#) = 5.279e4
A reference (or base) activation energy [J/mol] used in modelling energy capacity degradation.
- double [degradation_a_cal](#) = 100
A pre-exponential factor [J/mol] used in modelling energy capacity degradation.
- double [degradation_s_cal](#) = 2
A dimensionless constant used in modelling energy capacity degradation.
- double [gas_constant_JmolK](#) = 8.31446
The universal gas constant [J/mol.K].
- double [temperature_K](#) = 273 + 20
The absolute environmental temperature [K] of the lithium ion battery energy storage system.

4.12.1 Detailed Description

A structure which bundles the necessary inputs for the [Lilon](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [StorageInputs](#).

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

4.12.2 Member Data Documentation

4.12.2.1 capital_cost

```
double LiIonInputs::capital_cost = -1
```

The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].

4.12.2.2 charging_efficiency

```
double LiIonInputs::charging_efficiency = 0.9
```

The charging efficiency of the asset.

4.12.2.3 degradation_a_cal

```
double LiIonInputs::degradation_a_cal = 100
```

A pre-exponential factor [J/mol] used in modelling energy capacity degradation.

4.12.2.4 degradation_alpha

```
double LiIonInputs::degradation_alpha = 8.935
```

A dimensionless acceleration coefficient used in modelling energy capacity degradation.

4.12.2.5 degradation_B_hat_cal_0

```
double LiIonInputs::degradation_B_hat_cal_0 = 5.22226e6
```

A reference (or base) pre-exponential factor [1/sqrt(hrs)] used in modelling energy capacity degradation.

4.12.2.6 degradation_beta

```
double LiIonInputs::degradation_beta = 1
```

A dimensionless acceleration exponent used in modelling energy capacity degradation.

4.12.2.7 degradation_Ea_cal_0

```
double LiIonInputs::degradation_Ea_cal_0 = 5.279e4
```

A reference (or base) activation energy [J/mol] used in modelling energy capacity degradation.

4.12.2.8 degradation_r_cal

```
double LiIonInputs::degradation_r_cal = 0.4361
```

A dimensionless constant used in modelling energy capacity degradation.

4.12.2.9 degradation_s_cal

```
double LiIonInputs::degradation_s_cal = 2
```

A dimensionless constant used in modelling energy capacity degradation.

4.12.2.10 discharging_efficiency

```
double LiIonInputs::discharging_efficiency = 0.9
```

The discharging efficiency of the asset.

4.12.2.11 gas_constant_JmolK

```
double LiIonInputs::gas_constant_JmolK = 8.31446
```

The universal gas constant [J/mol.K].

4.12.2.12 hysteresis_SOC

```
double LiIonInputs::hysteresis_SOC = 0.5
```

The state of charge the asset must achieve to toggle is_depleted.

4.12.2.13 init_SOC

```
double LiIonInputs::init_SOC = 0.5
```

The initial state of charge of the asset.

4.12.2.14 max_SOC

```
double LiIonInputs::max_SOC = 0.9
```

The maximum state of charge of the asset.

4.12.2.15 min_SOC

```
double LiIonInputs::min_SOC = 0.15
```

The minimum state of charge of the asset. Will toggle is_depleted when reached.

4.12.2.16 operation_maintenance_cost_kWh

```
double LiIonInputs::operation_maintenance_cost_kWh = -1
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy charged/discharged. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].

4.12.2.17 replace_SOH

```
double LiIonInputs::replace_SOH = 0.8
```

The state of health at which the asset is considered "dead" and must be replaced.

4.12.2.18 storage_inputs

```
StorageInputs LiIonInputs::storage_inputs
```

An encapsulated [StorageInputs](#) instance.

4.12.2.19 temperature_K

```
double LiIonInputs::temperature_K = 273 + 20
```

The absolute environmental temperature [K] of the lithium ion battery energy storage system.

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

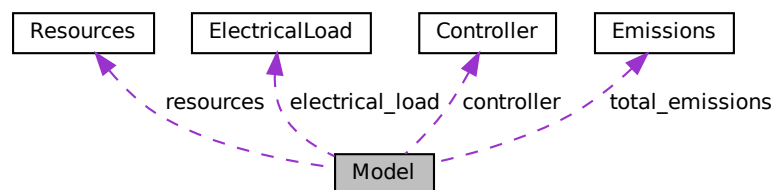
- header/Storage/[Lilon.h](#)

4.13 Model Class Reference

A container class which forms the centre of PGMcpp. The [Model](#) class is intended to serve as the primary user interface with the functionality of PGMcpp, and as such it contains all other classes.

```
#include <Model.h>
```

Collaboration diagram for Model:



Public Member Functions

- [Model](#) (void)
Constructor (dummy) for the [Model](#) class.
- [Model](#) ([ModelInputs](#))
Constructor (intended) for the [Model](#) class.
- void [addDiesel](#) ([DieselInputs](#))
Method to add a [Diesel](#) asset to the [Model](#).
- void [addResource](#) ([RenewableType](#), std::string, int)
A method to add a renewable resource time series to the [Model](#).
- void [addSolar](#) ([SolarInputs](#))
Method to add a [Solar](#) asset to the [Model](#).
- void [addTidal](#) ([TidalInputs](#))
Method to add a [Tidal](#) asset to the [Model](#).
- void [addWave](#) ([WaveInputs](#))
Method to add a [Wave](#) asset to the [Model](#).
- void [addWind](#) ([WindInputs](#))
Method to add a [Wind](#) asset to the [Model](#).
- void [addLilon](#) ([LilonInputs](#))
Method to add a [Lilon](#) asset to the [Model](#).
- void [run](#) (void)
A method to run the [Model](#).
- void [reset](#) (void)
Method which resets the model for use in assessing a new candidate microgrid design. This method only clears the asset pointer vectors and resets select [Model](#) attributes. It leaves the [Controller](#), [ElectricalLoad](#), and [Resources](#) objects of the [Model](#) alone.
- void [clear](#) (void)
Method to clear all attributes of the [Model](#) object.
- void [writeResults](#) (std::string, int=-1)
Method which writes [Model](#) results to an output directory. Also calls out to [writeResults\(\)](#) for each contained asset.
- [~Model](#) (void)
Destructor for the [Model](#) class.

Public Attributes

- double [total_fuel_consumed_L](#)
The total fuel consumed [L] over a model run.
- [Emissions](#) [total_emissions](#)
An [Emissions](#) structure for holding total emissions [kg].
- double [net_present_cost](#)
The net present cost of the [Model](#) (undefined currency).
- double [total_dispatch_discharge_kWh](#)
The total energy dispatched/discharged [kWh] over the [Model](#) run.
- double [levellized_cost_of_energy_kWh](#)
The levellized cost of energy, per unit energy dispatched/discharged, of the [Model](#) [1/kWh] (undefined currency).
- [Controller](#) [controller](#)
[Controller](#) component of [Model](#).
- [ElectricalLoad](#) [electrical_load](#)
[ElectricalLoad](#) component of [Model](#).
- [Resources](#) [resources](#)
[Resources](#) component of [Model](#).

- `std::vector< Combustion * > combustion_ptr_vec`
A vector of pointers to the various [Combustion](#) assets in the [Model](#).
- `std::vector< Renewable * > renewable_ptr_vec`
A vector of pointers to the various [Renewable](#) assets in the [Model](#).
- `std::vector< Storage * > storage_ptr_vec`
A vector of pointers to the various [Storage](#) assets in the [Model](#).

Private Member Functions

- `void __checkInputs (ModelInputs)`
Helper method (private) to check inputs to the [Model](#) constructor.
- `void __computeFuelAndEmissions (void)`
Helper method to compute the total fuel consumption and emissions over the [Model](#) run.
- `void __computeNetPresentCost (void)`
Helper method to compute the overall net present cost, for the [Model](#) run, from the asset-wise net present costs.
- `void __computeLevellizedCostOfEnergy (void)`
Helper method to compute the overall levellized cost of energy, for the [Model](#) run, from the asset-wise levellized costs of energy.
- `void __computeEconomics (void)`
Helper method to compute key economic metrics for the [Model](#) run.
- `void __writeSummary (std::string)`
Helper method to write summary results for [Model](#).
- `void __writeTimeSeries (std::string, int=-1)`
Helper method to write time series results for [Model](#).

4.13.1 Detailed Description

A container class which forms the centre of PGMcpp. The [Model](#) class is intended to serve as the primary user interface with the functionality of PGMcpp, and as such it contains all other classes.

4.13.2 Constructor & Destructor Documentation

4.13.2.1 [Model\(\)](#) [1/2]

```
Model::Model (
    void )
```

Constructor (dummy) for the [Model](#) class.

```
507 {
508     return;
509 } /* Model() */
```

4.13.2.2 [Model\(\)](#) [2/2]

```
Model::Model (
    ModelInputs model_inputs )
```

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

Parameters

<i>model_inputs</i>	A structure of Model constructor inputs.
---------------------	--

```

526 {
527     // 1. check inputs
528     this->__checkInputs(model_inputs);
529
530     // 2. read in electrical load data
531     this->electrical_load.readLoadData(model_inputs.path_2_electrical_load_time_series);
532
533     // 3. set control mode
534     this->controller.setControlMode(model_inputs.control_mode);
535
536     // 4. set public attributes
537     this->total_fuel_consumed_L = 0;
538     this->net_present_cost = 0;
539     this->total_dispatch_discharge_kWh = 0;
540     this->levellized_cost_of_energy_kWh = 0;
541
542     return;
543 } /* Model() */

```

4.13.2.3 ~Model()

```

Model::~~Model (
    void )

```

Destructor for the [Model](#) class.

```

970 {
971     this->clear();
972     return;
973 } /* ~Model() */

```

4.13.3 Member Function Documentation

4.13.3.1 __checkInputs()

```

void Model::__checkInputs (
    ModelInputs model_inputs ) [private]

```

Helper method (private) to check inputs to the [Model](#) constructor.

Parameters

<i>model_inputs</i>	A structure of Model constructor inputs.
---------------------	--

```

40 {
41     // 1. check path_2_electrical_load_time_series
42     if (model_inputs.path_2_electrical_load_time_series.empty()) {
43         std::string error_str = "ERROR: Model() path_2_electrical_load_time_series ";
44         error_str += "cannot be empty";
45
46         #ifdef _WIN32
47             std::cout << error_str << std::endl;
48         #endif
49
50         throw std::invalid_argument(error_str);
51     }

```

```

52
53     return;
54 } /* __checkInputs() */

```

4.13.3.2 __computeEconomics()

```

void Model::__computeEconomics (
    void ) [private]

```

Helper method to compute key economic metrics for the [Model](#) run.

```

216 {
217     this->__computeNetPresentCost();
218     this->__computeLevellizedCostOfEnergy();
219
220     return;
221 } /* __computeEconomics() */

```

4.13.3.3 __computeFuelAndEmissions()

```

void Model::__computeFuelAndEmissions (
    void ) [private]

```

Helper method to compute the total fuel consumption and emissions over the [Model](#) run.

```

70 {
71     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
72         this->combustion_ptr_vec[i]->computeFuelAndEmissions();
73
74         this->total_fuel_consumed_L +=
75             this->combustion_ptr_vec[i]->total_fuel_consumed_L;
76
77         this->total_emissions.CO2_kg +=
78             this->combustion_ptr_vec[i]->total_emissions.CO2_kg;
79
80         this->total_emissions.CO_kg +=
81             this->combustion_ptr_vec[i]->total_emissions.CO_kg;
82
83         this->total_emissions.NOx_kg +=
84             this->combustion_ptr_vec[i]->total_emissions.NOx_kg;
85
86         this->total_emissions.SOx_kg +=
87             this->combustion_ptr_vec[i]->total_emissions.SOx_kg;
88
89         this->total_emissions.CH4_kg +=
90             this->combustion_ptr_vec[i]->total_emissions.CH4_kg;
91
92         this->total_emissions.PM_kg +=
93             this->combustion_ptr_vec[i]->total_emissions.PM_kg;
94     }
95
96     return;
97 } /* __computeFuelAndEmissions() */

```

4.13.3.4 __computeLevellizedCostOfEnergy()

```
void Model::__computeLevellizedCostOfEnergy (
    void ) [private]
```

Helper method to compute the overall levellized cost of energy, for the [Model](#) run, from the asset-wise levellized costs of energy.

```
170 {
171     // 1. account for Combustion economics in levellized cost of energy
172     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
173         this->levellized_cost_of_energy_kWh +=
174             (
175                 this->combustion_ptr_vec[i]->levellized_cost_of_energy_kWh *
176                 this->combustion_ptr_vec[i]->total_dispatch_kWh
177             ) / this->total_dispatch_discharge_kWh;
178     }
179
180     // 2. account for Renewable economics in levellized cost of energy
181     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
182         this->levellized_cost_of_energy_kWh +=
183             (
184                 this->renewable_ptr_vec[i]->levellized_cost_of_energy_kWh *
185                 this->renewable_ptr_vec[i]->total_dispatch_kWh
186             ) / this->total_dispatch_discharge_kWh;
187     }
188
189     // 3. account for Storage economics in levellized cost of energy
190     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
191         /*
192         this->levellized_cost_of_energy_kWh +=
193             (
194                 this->storage_ptr_vec[i]->levellized_cost_of_energy_kWh *
195                 this->storage_ptr_vec[i]->total_discharge_kWh
196             ) / this->total_dispatch_discharge_kWh;
197         */
198     }
199
200     return;
201 } /* __computeLevellizedCostOfEnergy() */
```

4.13.3.5 __computeNetPresentCost()

```
void Model::__computeNetPresentCost (
    void ) [private]
```

Helper method to compute the overall net present cost, for the [Model](#) run, from the asset-wise net present costs.

```
113 {
114     // 1. account for Combustion economics in net present cost
115     // increment total dispatch
116     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
117         this->combustion_ptr_vec[i]->computeEconomics(
118             &(this->electrical_load.time_vec_hrs)
119         );
120
121         this->net_present_cost += this->combustion_ptr_vec[i]->net_present_cost;
122
123         this->total_dispatch_discharge_kWh +=
124             this->combustion_ptr_vec[i]->total_dispatch_kWh;
125     }
126
127     // 2. account for Renewable economics in net present cost,
128     // increment total dispatch
129     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
130         this->renewable_ptr_vec[i]->computeEconomics(
131             &(this->electrical_load.time_vec_hrs)
132         );
133
134         this->net_present_cost += this->renewable_ptr_vec[i]->net_present_cost;
135
136         this->total_dispatch_discharge_kWh +=
137             this->renewable_ptr_vec[i]->total_dispatch_kWh;
138     }
139
140     // 3. account for Storage economics in net present cost
```

```

141 // increment total dispatch
142 for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
143     this->storage_ptr_vec[i]->computeEconomics(
144         &(this->electrical_load.time_vec_hrs)
145     );
146
147     this->net_present_cost += this->storage_ptr_vec[i]->net_present_cost;
148
149     this->total_dispatch_discharge_kWh +=
150         this->storage_ptr_vec[i]->total_discharge_kWh;
151 }
152
153 return;
154 } /* __computeNetPresentCost() */

```

4.13.3.6 __writeSummary()

```

void Model::__writeSummary (
    std::string write_path ) [private]

```

Helper method to write summary results for [Model](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
-------------------	--

```

239 {
240     // 1. create subdirectory
241     write_path += "Model/";
242     std::filesystem::create_directory(write_path);
243
244     // 2. create filestream
245     write_path += "summary_results.md";
246     std::ofstream ofs;
247     ofs.open(write_path, std::ofstream::out);
248
249     // 3. write summary results (markdown)
250     ofs << "# Model Summary Results\n";
251     ofs << "\n-----\n\n";
252
253     // 3.1. ElectricalLoad
254     ofs << "## Electrical Load\n";
255     ofs << "\n";
256     ofs << "Path: " <<
257         this->electrical_load.path_2_electrical_load_time_series << " \n";
258     ofs << "Data Points: " << this->electrical_load.n_points << " \n";
259     ofs << "Years: " << this->electrical_load.n_years << " \n";
260     ofs << "Min: " << this->electrical_load.min_load_kW << " kW \n";
261     ofs << "Mean: " << this->electrical_load.mean_load_kW << " kW \n";
262     ofs << "Max: " << this->electrical_load.max_load_kW << " kW \n";
263     ofs << "\n-----\n\n";
264
265     // 3.2. Controller
266     ofs << "## Controller\n";
267     ofs << "\n";
268     ofs << "Control Mode: " << this->controller.control_string << " \n";
269     ofs << "\n-----\n\n";
270
271     // 3.3. Resources (1D)
272     ofs << "## 1D Renewable Resources\n";
273     ofs << "\n";
274
275     std::map<int, std::string>::iterator string_map_1D_iter =
276         this->resources.string_map_1D.begin();
277     std::map<int, std::string>::iterator path_map_1D_iter =
278         this->resources.path_map_1D.begin();
279
280     while (
281         string_map_1D_iter != this->resources.string_map_1D.end() and
282         path_map_1D_iter != this->resources.path_map_1D.end()
283     ) {
284         ofs << "Resource Key: " << string_map_1D_iter->first << " \n";
285         ofs << "Type: " << string_map_1D_iter->second << " \n";

```

```

286         ofs << "Path: " << path_map_1D_iter->second << " \n";
287         ofs << "\n";
288
289         string_map_1D_iter++;
290         path_map_1D_iter++;
291     }
292
293     ofs << "\n-----\n\n";
294
295     // 3.4. Resources (2D)
296     ofs << "## 2D Renewable Resources\n";
297     ofs << "\n";
298
299     std::map<int, std::string>::iterator string_map_2D_iter =
300         this->resources.string_map_2D.begin();
301     std::map<int, std::string>::iterator path_map_2D_iter =
302         this->resources.path_map_2D.begin();
303
304     while (
305         string_map_2D_iter != this->resources.string_map_2D.end() and
306         path_map_2D_iter != this->resources.path_map_2D.end()
307     ) {
308         ofs << "Resource Key: " << string_map_2D_iter->first << " \n";
309         ofs << "Type: " << string_map_2D_iter->second << " \n";
310         ofs << "Path: " << path_map_2D_iter->second << " \n";
311         ofs << "\n";
312
313         string_map_2D_iter++;
314         path_map_2D_iter++;
315     }
316
317     ofs << "\n-----\n\n";
318
319     // 3.5. Combustion
320     ofs << "## Combustion Assets\n";
321     ofs << "\n";
322
323     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
324         ofs << "Asset Index: " << i << " \n";
325         ofs << "Type: " << this->combustion_ptr_vec[i]->type_str << " \n";
326         ofs << "Capacity: " << this->combustion_ptr_vec[i]->capacity_kW << " kW \n";
327         ofs << "\n";
328     }
329
330     ofs << "\n-----\n\n";
331
332     // 3.6. Renewable
333     ofs << "## Renewable Assets\n";
334     ofs << "\n";
335
336     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
337         ofs << "Asset Index: " << i << " \n";
338         ofs << "Type: " << this->renewable_ptr_vec[i]->type_str << " \n";
339         ofs << "Capacity: " << this->renewable_ptr_vec[i]->capacity_kW << " kW \n";
340         ofs << "\n";
341     }
342
343     ofs << "\n-----\n\n";
344
345     // 3.7. Storage
346     ofs << "## Storage Assets\n";
347     ofs << "\n";
348
349     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
350         //...
351     }
352
353     ofs << "\n-----\n\n";
354
355     // 3.8. Model Results
356     ofs << "## Results\n";
357     ofs << "\n";
358
359     ofs << "Net Present Cost: " << this->net_present_cost << " \n";
360     ofs << "\n";
361
362     ofs << "Total Dispatch + Discharge: " << this->total_dispatch_discharge_kWh
363         << " kWh \n";
364
365     ofs << "Levellized Cost of Energy: " << this->levellized_cost_of_energy_kWh
366         << " per kWh dispatched/discharged \n";
367     ofs << "\n";
368
369     ofs << "Total Fuel Consumed: " << this->total_fuel_consumed_L << " L "
370         << "(Annual Average: " <<
371         this->total_fuel_consumed_L / this->electrical_load.n_years
372         << " L/yr) \n";

```



```

373     ofs << "\n";
374
375     ofs << "Total Carbon Dioxide (CO2) Emissions: " <<
376         this->total_emissions.CO2_kg << " kg "
377         << "(Annual Average: " <<
378             this->total_emissions.CO2_kg / this->electrical_load.n_years
379         << " kg/yr) \n";
380
381     ofs << "Total Carbon Monoxide (CO) Emissions: " <<
382         this->total_emissions.CO_kg << " kg "
383         << "(Annual Average: " <<
384             this->total_emissions.CO_kg / this->electrical_load.n_years
385         << " kg/yr) \n";
386
387     ofs << "Total Nitrogen Oxides (NOx) Emissions: " <<
388         this->total_emissions.NOx_kg << " kg "
389         << "(Annual Average: " <<
390             this->total_emissions.NOx_kg / this->electrical_load.n_years
391         << " kg/yr) \n";
392
393     ofs << "Total Sulfur Oxides (SOx) Emissions: " <<
394         this->total_emissions.SOx_kg << " kg "
395         << "(Annual Average: " <<
396             this->total_emissions.SOx_kg / this->electrical_load.n_years
397         << " kg/yr) \n";
398
399     ofs << "Total Methane (CH4) Emissions: " << this->total_emissions.CH4_kg << " kg "
400         << "(Annual Average: " <<
401             this->total_emissions.CH4_kg / this->electrical_load.n_years
402         << " kg/yr) \n";
403
404     ofs << "Total Particulate Matter (PM) Emissions: " <<
405         this->total_emissions.PM_kg << " kg "
406         << "(Annual Average: " <<
407             this->total_emissions.PM_kg / this->electrical_load.n_years
408         << " kg/yr) \n";
409
410     ofs << "\n-----\n\n";
411
412     ofs.close();
413     return;
414 } /* __writeSummary() */

```

4.13.3.7 __writeTimeSeries()

```

void Model::__writeTimeSeries (
    std::string write_path,
    int max_lines = -1 ) [private]

```

Helper method to write time series results for [Model](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>max_lines</i>	The maximum number of lines of output to write.

```

434 {
435     // 1. create filestream
436     write_path += "Model/time_series_results.csv";
437     std::ofstream ofs;
438     ofs.open(write_path, std::ofstream::out);
439
440     // 2. write time series results header (comma separated value)
441     ofs << "Time (since start of data) [hrs],";
442     ofs << "Electrical Load [kW],";
443     ofs << "Net Load [kW],";
444     ofs << "Missed Load [kW],";
445
446     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
447         ofs << this->renewable_ptr_vec[i]->capacity_kW << " kW "
448             << this->renewable_ptr_vec[i]->type_str << " Dispatch [kW],";
449     }

```

```

450
451     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
452         //...
453     }
454
455     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
456         ofs << this->combustion_ptr_vec[i]->capacity_kW << " kW "
457         << this->combustion_ptr_vec[i]->type_str << " Dispatch [kW], ";
458     }
459
460     ofs << "\n";
461
462     // 3. write time series results values (comma separated value)
463     for (int i = 0; i < max_lines; i++) {
464         // 3.1. load values
465         ofs << this->electrical_load.time_vec_hrs[i] << ", ";
466         ofs << this->electrical_load.load_vec_kW[i] << ", ";
467         ofs << this->controller.net_load_vec_kW[i] << ", ";
468         ofs << this->controller.missed_load_vec_kW[i] << ", ";
469
470         // 3.2. asset-wise dispatch/discharge
471         for (size_t j = 0; j < this->renewable_ptr_vec.size(); j++) {
472             ofs << this->renewable_ptr_vec[j]->dispatch_vec_kW[i] << ", ";
473         }
474
475         for (size_t j = 0; j < this->storage_ptr_vec.size(); j++) {
476             //...
477         }
478
479         for (size_t j = 0; j < this->combustion_ptr_vec.size(); j++) {
480             ofs << this->combustion_ptr_vec[j]->dispatch_vec_kW[i] << ", ";
481         }
482
483         ofs << "\n";
484     }
485
486     ofs.close();
487     return;
488 } /* __writeTimeSeries() */

```

4.13.3.8 addDiesel()

```

void Model::addDiesel (
    DieselInputs diesel_inputs )

```

Method to add a [Diesel](#) asset to the [Model](#).

Parameters

<i>diesel_inputs</i>	A structure of Diesel constructor inputs.
----------------------	---

```

560 {
561     Combustion* diesel_ptr = new Diesel(
562         this->electrical_load.n_points,
563         this->electrical_load.n_years,
564         diesel_inputs
565     );
566
567     this->combustion_ptr_vec.push_back(diesel_ptr);
568
569     return;
570 } /* addDiesel() */

```

4.13.3.9 addLiIon()

```

void Model::addLiIon (
    LiIonInputs liion_inputs )

```

Method to add a [LiIon](#) asset to the [Model](#).

Parameters

<i>liion_inputs</i>	A structure of Lilon constructor inputs.
---------------------	--

```

733 {
734     Storage* liion_ptr = new Lilon(
735         this->electrical_load.n_points,
736         this->electrical_load.n_years,
737         liion_inputs
738     );
739
740     this->storage_ptr_vec.push_back(liion_ptr);
741
742     return;
743 } /* addLiIon() */

```

4.13.3.10 addResource()

```

void Model::addResource (
    RenewableType renewable_type,
    std::string path_2_resource_data,
    int resource_key )

```

A method to add a renewable resource time series to the [Model](#).

Parameters

<i>renewable_type</i>	The type of renewable resource being added to the Model .
<i>path_2_resource_data</i>	A string defining the path (either relative or absolute) to the given resource time series.
<i>resource_key</i>	A key used to index into the Resources object, used to associate Renewable assets with the corresponding resource.

```

599 {
600     resources.addResource (
601         renewable_type,
602         path_2_resource_data,
603         resource_key,
604         &(this->electrical_load)
605     );
606
607     return;
608 } /* addResource() */

```

4.13.3.11 addSolar()

```

void Model::addSolar (
    SolarInputs solar_inputs )

```

Method to add a [Solar](#) asset to the [Model](#).

Parameters

<i>solar_inputs</i>	A structure of Solar constructor inputs.
---------------------	--

```

625 {
626     Renewable* solar_ptr = new Solar(

```

```

627         this->electrical_load.n_points,
628         this->electrical_load.n_years,
629         solar_inputs
630     );
631
632     this->renewable_ptr_vec.push_back(solar_ptr);
633
634     return;
635 } /* addSolar() */

```

4.13.3.12 addTidal()

```

void Model::addTidal (
    TidalInputs tidal_inputs )

```

Method to add a [Tidal](#) asset to the [Model](#).

Parameters

<i>tidal_inputs</i>	A structure of Tidal constructor inputs.
---------------------	--

```

652 {
653     Renewable* tidal_ptr = new Tidal(
654         this->electrical_load.n_points,
655         this->electrical_load.n_years,
656         tidal_inputs
657     );
658
659     this->renewable_ptr_vec.push_back(tidal_ptr);
660
661     return;
662 } /* addTidal() */

```

4.13.3.13 addWave()

```

void Model::addWave (
    WaveInputs wave_inputs )

```

Method to add a [Wave](#) asset to the [Model](#).

Parameters

<i>wave_inputs</i>	A structure of Wave constructor inputs.
--------------------	---

```

679 {
680     Renewable* wave_ptr = new Wave(
681         this->electrical_load.n_points,
682         this->electrical_load.n_years,
683         wave_inputs
684     );
685
686     this->renewable_ptr_vec.push_back(wave_ptr);
687
688     return;
689 } /* addWave() */

```

4.13.3.14 addWind()

```
void Model::addWind (
    WindInputs wind_inputs )
```

Method to add a [Wind](#) asset to the [Model](#).

Parameters

<i>wind_inputs</i>	A structure of Wind constructor inputs.
--------------------	---

```
706 {
707     Renewable* wind_ptr = new Wind(
708         this->electrical_load.n_points,
709         this->electrical_load.n_years,
710         wind_inputs
711     );
712
713     this->renewable_ptr_vec.push_back(wind_ptr);
714
715     return;
716 } /* addWind() */
```

4.13.3.15 clear()

```
void Model::clear (
    void )
```

Method to clear all attributes of the [Model](#) object.

```
849 {
850     // 1. reset
851     this->reset();
852
853     // 2. clear components
854     controller.clear();
855     electrical_load.clear();
856     resources.clear();
857
858     return;
859 } /* clear() */
```

4.13.3.16 reset()

```
void Model::reset (
    void )
```

Method which resets the model for use in assessing a new candidate microgrid design. This method only clears the asset pointer vectors and resets select [Model](#) attributes. It leaves the [Controller](#), [ElectricalLoad](#), and [Resources](#) objects of the [Model](#) alone.

```
800 {
801     // 1. clear combustion_ptr_vec
802     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
803         delete this->combustion_ptr_vec[i];
804     }
805     this->combustion_ptr_vec.clear();
806
807     // 2. clear renewable_ptr_vec
808     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
809         delete this->renewable_ptr_vec[i];
810     }
811     this->renewable_ptr_vec.clear();
812 }
```

```

813     // 3. clear storage_ptr_vec
814     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
815         delete this->storage_ptr_vec[i];
816     }
817     this->storage_ptr_vec.clear();
818
819     // 4. reset attributes
820     this->total_fuel_consumed_L = 0;
821
822     this->total_emissions.CO2_kg = 0;
823     this->total_emissions.CO_kg = 0;
824     this->total_emissions.NOx_kg = 0;
825     this->total_emissions.SOx_kg = 0;
826     this->total_emissions.CH4_kg = 0;
827     this->total_emissions.PM_kg = 0;
828
829     this->net_present_cost = 0;
830     this->total_dispatch_discharge_kWh = 0;
831     this->levellized_cost_of_energy_kWh = 0;
832
833     return;
834 } /* reset() */

```

4.13.3.17 run()

```

void Model::run (
    void )

```

A method to run the [Model](#).

```

758 {
759     // 1. init Controller
760     this->controller.init(
761         &(this->electrical_load),
762         &(this->renewable_ptr_vec),
763         &(this->resources),
764         &(this->combustion_ptr_vec)
765     );
766
767     // 2. apply dispatch control
768     this->controller.applyDispatchControl(
769         &(this->electrical_load),
770         &(this->combustion_ptr_vec),
771         &(this->renewable_ptr_vec),
772         &(this->storage_ptr_vec)
773     );
774
775     // 3. compute total fuel consumption and emissions
776     this->__computeFuelAndEmissions();
777
778     // 4. compute key economic metrics
779     this->__computeEconomics();
780
781     return;
782 } /* run() */

```

4.13.3.18 writeResults()

```

void Model::writeResults (
    std::string write_path,
    int max_lines = -1 )

```

Method which writes [Model](#) results to an output directory. Also calls out to [writeResults\(\)](#) for each contained asset.

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>max_lines</i>	The maximum number of lines of output to write. If <0, then all available lines are written. If =0, then only summary results are written.

```

887 {
888     // 1. handle sentinel
889     if (max_lines < 0) {
890         max_lines = this->electrical_load.n_points;
891     }
892
893     // 2. check for pre-existing, warn (and remove), then create
894     if (write_path.back() != '/') {
895         write_path += '/';
896     }
897
898     if (std::filesystem::is_directory(write_path)) {
899         std::string warning_str = "WARNING: Model::writeResults(): ";
900         warning_str += write_path;
901         warning_str += " already exists, contents will be overwritten!";
902
903         std::cout << warning_str << std::endl;
904
905         std::filesystem::remove_all(write_path);
906     }
907
908     std::filesystem::create_directory(write_path);
909
910     // 3. write summary
911     this->__writeSummary(write_path);
912
913     // 4. write time series
914     if (max_lines > this->electrical_load.n_points) {
915         max_lines = this->electrical_load.n_points;
916     }
917
918     if (max_lines > 0) {
919         this->__writeTimeSeries(write_path, max_lines);
920     }
921
922     // 5. call out to Combustion :: writeResults()
923     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
924         this->combustion_ptr_vec[i]->writeResults(
925             write_path,
926             &(this->electrical_load.time_vec_hrs),
927             i,
928             max_lines
929         );
930     }
931
932     // 6. call out to Renewable :: writeResults()
933     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
934         this->renewable_ptr_vec[i]->writeResults(
935             write_path,
936             &(this->electrical_load.time_vec_hrs),
937             &(this->resources.resource_map_1D),
938             &(this->resources.resource_map_2D),
939             i,
940             max_lines
941         );
942     }
943
944     // 7. call out to Storage :: writeResults()
945     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
946         this->storage_ptr_vec[i]->writeResults(
947             write_path,
948             &(this->electrical_load.time_vec_hrs),
949             i,
950             max_lines
951         );
952     }
953
954     return;
955 } /* writeResults() */

```

4.13.4 Member Data Documentation

4.13.4.1 combustion_ptr_vec

```
std::vector<Combustion*> Model::combustion_ptr_vec
```

A vector of pointers to the various [Combustion](#) assets in the [Model](#).

4.13.4.2 controller

```
Controller Model::controller
```

[Controller](#) component of [Model](#).

4.13.4.3 electrical_load

```
ElectricalLoad Model::electrical_load
```

[ElectricalLoad](#) component of [Model](#).

4.13.4.4 levlized_cost_of_energy_kWh

```
double Model::levlized_cost_of_energy_kWh
```

The levlized cost of energy, per unit energy dispatched/discharged, of the [Model](#) [1/kWh] (undefined currency).

4.13.4.5 net_present_cost

```
double Model::net_present_cost
```

The net present cost of the [Model](#) (undefined currency).

4.13.4.6 renewable_ptr_vec

```
std::vector<Renewable*> Model::renewable_ptr_vec
```

A vector of pointers to the various [Renewable](#) assets in the [Model](#).

4.13.4.7 resources

`Resources` `Model::resources`

`Resources` component of `Model`.

4.13.4.8 storage_ptr_vec

`std::vector<Storage*>` `Model::storage_ptr_vec`

A vector of pointers to the various `Storage` assets in the `Model`.

4.13.4.9 total_dispatch_discharge_kWh

`double` `Model::total_dispatch_discharge_kWh`

The total energy dispatched/discharged [kWh] over the `Model` run.

4.13.4.10 total_emissions

`Emissions` `Model::total_emissions`

An `Emissions` structure for holding total emissions [kg].

4.13.4.11 total_fuel_consumed_L

`double` `Model::total_fuel_consumed_L`

The total fuel consumed [L] over a model run.

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

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

4.14 ModelInputs Struct Reference

A structure which bundles the necessary inputs for the `Model` constructor. Provides default values for every necessary input (except `path_2_electrical_load_time_series`, for which a valid input must be provided).

```
#include <Model.h>
```

Public Attributes

- `std::string path_2_electrical_load_time_series = ""`
A string defining the path (either relative or absolute) to the given electrical load time series.
- `ControlMode control_mode = ControlMode :: LOAD_FOLLOWING`
The control mode to be applied by the [Controller](#) object.

4.14.1 Detailed Description

A structure which bundles the necessary inputs for the [Model](#) constructor. Provides default values for every necessary input (except `path_2_electrical_load_time_series`, for which a valid input must be provided).

4.14.2 Member Data Documentation

4.14.2.1 control_mode

```
ControlMode ModelInputs::control_mode = ControlMode :: LOAD_FOLLOWING
```

The control mode to be applied by the [Controller](#) object.

4.14.2.2 path_2_electrical_load_time_series

```
std::string ModelInputs::path_2_electrical_load_time_series = ""
```

A string defining the path (either relative or absolute) to the given electrical load time series.

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

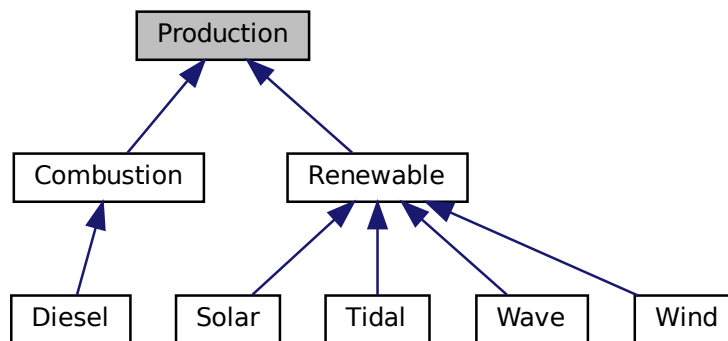
- [header/Model.h](#)

4.15 Production Class Reference

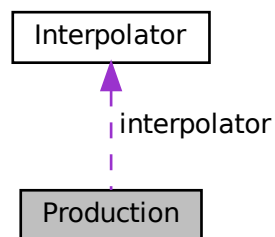
The base class of the [Production](#) hierarchy. This hierarchy contains derived classes which model the production of energy, be it renewable or otherwise.

```
#include <Production.h>
```

Inheritance diagram for Production:



Collaboration diagram for Production:



Public Member Functions

- [Production](#) (void)
Constructor (dummy) for the [Production](#) class.
- [Production](#) (int, double, [ProductionInputs](#))
Constructor (intended) for the [Production](#) class.
- virtual void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.

- double `computeRealDiscountAnnual` (double, double)
Method to compute the real, annual discount rate to be used in computing model economics. This enables application of the discount factor approach.
- virtual void `computeEconomics` (std::vector< double > *)
Helper method to compute key economic metrics for the `Model` run.
- virtual double `commit` (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- virtual `~Production` (void)
Destructor for the `Production` class.

Public Attributes

- `Interpolator interpolator`
`Interpolator` component of `Production`.
- bool `print_flag`
A flag which indicates whether or not object construct/destruction should be verbose.
- bool `is_running`
A boolean which indicates whether or not the asset is running.
- bool `is_sunk`
A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).
- int `n_points`
The number of points in the modelling time series.
- int `n_starts`
The number of times the asset has been started.
- int `n_replacements`
The number of times the asset has been replaced.
- double `n_years`
The number of years being modelled.
- double `running_hours`
The number of hours for which the asset has been operating.
- double `replace_running_hrs`
The number of running hours after which the asset must be replaced.
- double `capacity_kW`
The rated production capacity [kW] of the asset.
- double `nominal_inflation_annual`
The nominal, annual inflation rate to use in computing model economics.
- double `nominal_discount_annual`
The nominal, annual discount rate to use in computing model economics.
- double `real_discount_annual`
The real, annual discount rate used in computing model economics. Is computed from the given nominal inflation and discount rates.
- double `capital_cost`
The capital cost of the asset (undefined currency).
- double `operation_maintenance_cost_kWh`
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced.
- double `net_present_cost`
The net present cost of this asset.
- double `total_dispatch_kWh`

- The total energy dispatched [kWh] over the [Model](#) run.

 - double [levellized_cost_of_energy_kWh](#)

The levellized cost of energy [1/kWh] (undefined currency) of this asset. This metric considers only dispatch.
- std::string [type_str](#)

A string describing the type of the asset.
- std::vector< bool > [is_running_vec](#)

A boolean vector for tracking if the asset is running at a particular point in time.
- std::vector< double > [production_vec_kW](#)

A vector of production [kW] at each point in the modelling time series.
- std::vector< double > [dispatch_vec_kW](#)

A vector of dispatch [kW] at each point in the modelling time series. Dispatch is the amount of production that is sent to the grid to satisfy load.
- std::vector< double > [storage_vec_kW](#)

A vector of storage [kW] at each point in the modelling time series. [Storage](#) is the amount of production that is sent to storage.
- std::vector< double > [curtailment_vec_kW](#)

A vector of curtailment [kW] at each point in the modelling time series. Curtailment is the amount of production that can be neither dispatched nor stored, and is hence curtailed.
- std::vector< double > [capital_cost_vec](#)

A vector of capital costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).
- std::vector< double > [operation_maintenance_cost_vec](#)

A vector of operation and maintenance costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).

Private Member Functions

- void [__checkInputs](#) (int, double, [ProductionInputs](#))

Helper method to check inputs to the [Production](#) constructor.

4.15.1 Detailed Description

The base class of the [Production](#) hierarchy. This hierarchy contains derived classes which model the production of energy, be it renewable or otherwise.

4.15.2 Constructor & Destructor Documentation

4.15.2.1 [Production\(\)](#) [1/2]

```
Production::Production (
    void )
```

Constructor (dummy) for the [Production](#) class.

```
112 {
113     return;
114 } /* Production() */
```

4.15.2.2 Production() [2/2]

```
Production::Production (
    int n_points,
    double n_years,
    ProductionInputs production_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>production_inputs</i>	A structure of Production constructor inputs.

```
143 {
144     // 1. check inputs
145     this->__checkInputs(n_points, n_years, production_inputs);
146
147     // 2. set attributes
148     this->print_flag = production_inputs.print_flag;
149     this->is_running = false;
150     this->is_sunk = production_inputs.is_sunk;
151
152     this->n_points = n_points;
153     this->n_starts = 0;
154     this->n_replacements = 0;
155
156     this->n_years = n_years;
157
158     this->running_hours = 0;
159     this->replace_running_hrs = production_inputs.replace_running_hrs;
160
161     this->capacity_kW = production_inputs.capacity_kW;
162
163     this->nominal_inflation_annual = production_inputs.nominal_inflation_annual;
164     this->nominal_discount_annual = production_inputs.nominal_discount_annual;
165
166     this->real_discount_annual = this->computeRealDiscountAnnual (
167         production_inputs.nominal_inflation_annual,
168         production_inputs.nominal_discount_annual
169     );
170
171     this->capital_cost = 0;
172     this->operation_maintenance_cost_kWh = 0;
173     this->net_present_cost = 0;
174     this->total_dispatch_kWh = 0;
175     this->levellized_cost_of_energy_kWh = 0;
176
177     this->is_running_vec.resize(this->n_points, 0);
178
179     this->production_vec_kW.resize(this->n_points, 0);
180     this->dispatch_vec_kW.resize(this->n_points, 0);
181     this->storage_vec_kW.resize(this->n_points, 0);
182     this->curtailment_vec_kW.resize(this->n_points, 0);
183
184     this->capital_cost_vec.resize(this->n_points, 0);
185     this->operation_maintenance_cost_vec.resize(this->n_points, 0);
186
187     // 3. construction print
188     if (this->print_flag) {
189         std::cout << "Production object constructed at " << this << std::endl;
190     }
191
192     return;
193 } /* Production() */
```

4.15.2.3 ~Production()

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

Destructor for the [Production](#) class.

```

411 {
412     // 1. destruction print
413     if (this->print_flag) {
414         std::cout << "Production object at " << this << " destroyed" << std::endl;
415     }
416
417     return;
418 } /* ~Production() */

```

4.15.3 Member Function Documentation

4.15.3.1 __checkInputs()

```

void Production::__checkInputs (
    int n_points,
    double n_years,
    ProductionInputs production_inputs ) [private]

```

Helper method to check inputs to the [Production](#) constructor.

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>production_inputs</i>	A structure of Production constructor inputs.

```

45 {
46     // 1. check n_points
47     if (n_points <= 0) {
48         std::string error_str = "ERROR: Production(): n_points must be > 0";
49
50         #ifdef _WIN32
51             std::cout << error_str << std::endl;
52         #endif
53
54         throw std::invalid_argument(error_str);
55     }
56
57     // 2. check n_years
58     if (n_years <= 0) {
59         std::string error_str = "ERROR: Production(): n_years must be > 0";
60
61         #ifdef _WIN32
62             std::cout << error_str << std::endl;
63         #endif
64
65         throw std::invalid_argument(error_str);
66     }
67
68     // 3. check capacity_kW
69     if (production_inputs.capacity_kW <= 0) {
70         std::string error_str = "ERROR: Production(): ";
71         error_str += "ProductionInputs::capacity_kW must be > 0";
72
73         #ifdef _WIN32
74             std::cout << error_str << std::endl;
75         #endif
76
77         throw std::invalid_argument(error_str);
78     }
79
80     // 4. check replace_running_hrs
81     if (production_inputs.replace_running_hrs <= 0) {
82         std::string error_str = "ERROR: Production(): ";
83         error_str += "ProductionInputs::replace_running_hrs must be > 0";
84
85         #ifdef _WIN32
86             std::cout << error_str << std::endl;
87         #endif

```

```

88
89         throw std::invalid_argument(error_str);
90     }
91
92     return;
93 } /* __checkInputs() */

```

4.15.3.2 commit()

```

double Production::commit (
    int timestep,
    double dt_hrs,
    double production_kW,
    double load_kW ) [virtual]

```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented in [Wind](#), [Wave](#), [Tidal](#), [Solar](#), [Renewable](#), [Diesel](#), and [Combustion](#).

```

352 {
353     // 1. record production
354     this->production_vec_kW[timestep] = production_kW;
355
356     // 2. compute and record dispatch and curtailment
357     double dispatch_kW = 0;
358     double curtailment_kW = 0;
359
360     if (production_kW > load_kW) {
361         dispatch_kW = load_kW;
362         curtailment_kW = production_kW - dispatch_kW;
363     }
364
365     else {
366         dispatch_kW = production_kW;
367     }
368
369     this->dispatch_vec_kW[timestep] = dispatch_kW;
370     this->total_dispatch_kWh += dispatch_kW * dt_hrs;
371     this->curtailment_vec_kW[timestep] = curtailment_kW;
372
373     // 3. update load
374     load_kW -= dispatch_kW;
375
376     // 4. update and log running attributes
377     if (this->is_running) {
378         // 4.1. log running state, running hours
379         this->is_running_vec[timestep] = this->is_running;
380         this->running_hours += dt_hrs;
381
382         // 4.2. incur operation and maintenance costs
383         double produced_kWh = production_kW * dt_hrs;
384
385         double operation_maintenance_cost =
386             this->operation_maintenance_cost_kWh + produced_kWh;

```



```

387         this->operation_maintenance_cost_vec[timestep] = operation_maintenance_cost;
388     }
389
390     // 5. trigger replacement, if applicable
391     if (this->running_hours >= (this->n_replacements + 1) * this->replace_running_hrs) {
392         this->handleReplacement(timestep);
393     }
394
395     return load_kW;
396 } /* commit() */

```

4.15.3.3 computeEconomics()

```

void Production::computeEconomics (
    std::vector< double > * time_vec_hrs_ptr ) [virtual]

```

Helper method to compute key economic metrics for the [Model](#) run.

Ref: [HOMER \[2023b\]](#)

Ref: [HOMER \[2023g\]](#)

Ref: [HOMER \[2023i\]](#)

Ref: [HOMER \[2023a\]](#)

Parameters

<i>time_vec_hrs_ptr</i>	A pointer to the <i>time_vec_hrs</i> attribute of the ElectricalLoad .
-------------------------	--

1. compute levelized cost of energy (per unit dispatched)

Reimplemented in [Renewable](#), and [Combustion](#).

```

281 {
282     // 1. compute net present cost
283     double t_hrs = 0;
284     double real_discount_scalar = 0;
285
286     for (int i = 0; i < this->n_points; i++) {
287         t_hrs = time_vec_hrs_ptr->at(i);
288
289         real_discount_scalar = 1.0 / pow(
290             1 + this->real_discount_annual,
291             t_hrs / 8760
292         );
293
294         this->net_present_cost += real_discount_scalar * this->capital_cost_vec[i];
295
296         this->net_present_cost +=
297             real_discount_scalar * this->operation_maintenance_cost_vec[i];
298     }
299
300     // assuming 8,760 hours per year
301     double n_years = time_vec_hrs_ptr->at(this->n_points - 1) / 8760;
302
303     double capital_recovery_factor =
304         (this->real_discount_annual * pow(1 + this->real_discount_annual, n_years)) /
305         (pow(1 + this->real_discount_annual, n_years) - 1);
306
307     double total_annualized_cost = capital_recovery_factor *
308         this->net_present_cost;
309
310     this->levelized_cost_of_energy_kWh =
311         (n_years * total_annualized_cost) /
312         this->total_dispatch_kWh;
313
314     return;
315 } /* computeEconomics() */

```

4.15.3.4 computeRealDiscountAnnual()

```
double Production::computeRealDiscountAnnual (
    double nominal_inflation_annual,
    double nominal_discount_annual )
```

Method to compute the real, annual discount rate to be used in computing model economics. This enables application of the discount factor approach.

Ref: [HOMER \[2023h\]](#)

Ref: [HOMER \[2023b\]](#)

Parameters

<i>nominal_inflation_annual</i>	The nominal, annual inflation rate to use in computing model economics.
<i>nominal_discount_annual</i>	The nominal, annual discount rate to use in computing model economics.

Returns

The real, annual discount rate to use in computing model economics.

```
254 {
255     double real_discount_annual = nominal_discount_annual - nominal_inflation_annual;
256     real_discount_annual /= 1 + nominal_inflation_annual;
257
258     return real_discount_annual;
259 } /* __computeRealDiscountAnnual() */
```

4.15.3.5 handleReplacement()

```
void Production::handleReplacement (
    int timestep ) [virtual]
```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented in [Wind](#), [Wave](#), [Tidal](#), [Solar](#), [Renewable](#), [Diesel](#), and [Combustion](#).

```
211 {
212     // 1. reset attributes
213     this->is_running = false;
214
215     // 2. log replacement
216     this->n_replacements++;
217
218     // 3. incur capital cost in timestep
219     this->capital_cost_vec[timestep] = this->capital_cost;
220
221     return;
222 } /* __handleReplacement() */
```

4.15.4 Member Data Documentation

4.15.4.1 capacity_kW

```
double Production::capacity_kW
```

The rated production capacity [kW] of the asset.

4.15.4.2 capital_cost

```
double Production::capital_cost
```

The capital cost of the asset (undefined currency).

4.15.4.3 capital_cost_vec

```
std::vector<double> Production::capital_cost_vec
```

A vector of capital costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).

4.15.4.4 curtailment_vec_kW

```
std::vector<double> Production::curtailment_vec_kW
```

A vector of curtailment [kW] at each point in the modelling time series. Curtailment is the amount of production that can be neither dispatched nor stored, and is hence curtailed.

4.15.4.5 dispatch_vec_kW

```
std::vector<double> Production::dispatch_vec_kW
```

A vector of dispatch [kW] at each point in the modelling time series. Dispatch is the amount of production that is sent to the grid to satisfy load.

4.15.4.6 interpolator

```
Interpolator Production::interpolator
```

[Interpolator](#) component of [Production](#).

4.15.4.7 is_running

```
bool Production::is_running
```

A boolean which indicates whether or not the asset is running.

4.15.4.8 is_running_vec

```
std::vector<bool> Production::is_running_vec
```

A boolean vector for tracking if the asset is running at a particular point in time.

4.15.4.9 is_sunk

```
bool Production::is_sunk
```

A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).

4.15.4.10 levellized_cost_of_energy_kWh

```
double Production::levellized_cost_of_energy_kWh
```

The levellized cost of energy [1/kWh] (undefined currency) of this asset. This metric considers only dispatch.

4.15.4.11 n_points

```
int Production::n_points
```

The number of points in the modelling time series.

4.15.4.12 n_replacements

```
int Production::n_replacements
```

The number of times the asset has been replaced.

4.15.4.13 n_starts

```
int Production::n_starts
```

The number of times the asset has been started.

4.15.4.14 n_years

```
double Production::n_years
```

The number of years being modelled.

4.15.4.15 net_present_cost

```
double Production::net_present_cost
```

The net present cost of this asset.

4.15.4.16 nominal_discount_annual

```
double Production::nominal_discount_annual
```

The nominal, annual discount rate to use in computing model economics.

4.15.4.17 nominal_inflation_annual

```
double Production::nominal_inflation_annual
```

The nominal, annual inflation rate to use in computing model economics.

4.15.4.18 operation_maintenance_cost_kWh

```
double Production::operation_maintenance_cost_kWh
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced.

4.15.4.19 operation_maintenance_cost_vec

```
std::vector<double> Production::operation_maintenance_cost_vec
```

A vector of operation and maintenance costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).

4.15.4.20 print_flag

```
bool Production::print_flag
```

A flag which indicates whether or not object construct/destruction should be verbose.

4.15.4.21 production_vec_kW

```
std::vector<double> Production::production_vec_kW
```

A vector of production [kW] at each point in the modelling time series.

4.15.4.22 real_discount_annual

```
double Production::real_discount_annual
```

The real, annual discount rate used in computing model economics. Is computed from the given nominal inflation and discount rates.

4.15.4.23 replace_running_hrs

```
double Production::replace_running_hrs
```

The number of running hours after which the asset must be replaced.

4.15.4.24 running_hours

```
double Production::running_hours
```

The number of hours for which the asset has been operating.

4.15.4.25 storage_vec_kW

```
std::vector<double> Production::storage_vec_kW
```

A vector of storage [kW] at each point in the modelling time series. [Storage](#) is the amount of production that is sent to storage.

4.15.4.26 total_dispatch_kWh

```
double Production::total_dispatch_kWh
```

The total energy dispatched [kWh] over the [Model](#) run.

4.15.4.27 type_str

```
std::string Production::type_str
```

A string describing the type of the asset.

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

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

4.16 ProductionInputs Struct Reference

A structure which bundles the necessary inputs for the [Production](#) constructor. Provides default values for every necessary input.

```
#include <Production.h>
```

Public Attributes

- bool [print_flag](#) = false
A flag which indicates whether or not object construct/destruction should be verbose.
- bool [is_sunk](#) = false
A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).
- double [capacity_kW](#) = 100
The rated production capacity [kW] of the asset.
- double [nominal_inflation_annual](#) = 0.02
The nominal, annual inflation rate to use in computing model economics.
- double [nominal_discount_annual](#) = 0.04
The nominal, annual discount rate to use in computing model economics.
- double [replace_running_hrs](#) = 90000
The number of running hours after which the asset must be replaced.

4.16.1 Detailed Description

A structure which bundles the necessary inputs for the [Production](#) constructor. Provides default values for every necessary input.

4.16.2 Member Data Documentation

4.16.2.1 capacity_kW

```
double ProductionInputs::capacity_kW = 100
```

The rated production capacity [kW] of the asset.

4.16.2.2 is_sunk

```
bool ProductionInputs::is_sunk = false
```

A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).

4.16.2.3 nominal_discount_annual

```
double ProductionInputs::nominal_discount_annual = 0.04
```

The nominal, annual discount rate to use in computing model economics.

4.16.2.4 nominal_inflation_annual

```
double ProductionInputs::nominal_inflation_annual = 0.02
```

The nominal, annual inflation rate to use in computing model economics.

4.16.2.5 print_flag

```
bool ProductionInputs::print_flag = false
```

A flag which indicates whether or not object construct/destruction should be verbose.

4.16.2.6 replace_running_hrs

```
double ProductionInputs::replace_running_hrs = 90000
```

The number of running hours after which the asset must be replaced.

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

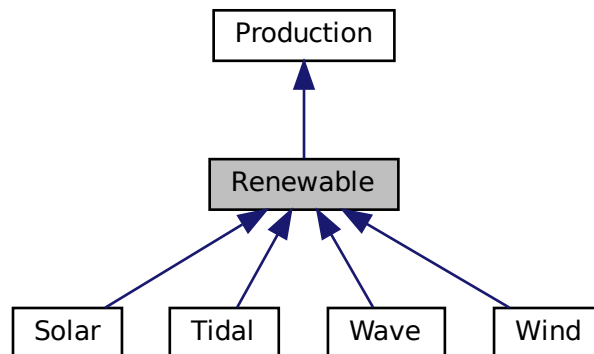
- header/Production/[Production.h](#)

4.17 Renewable Class Reference

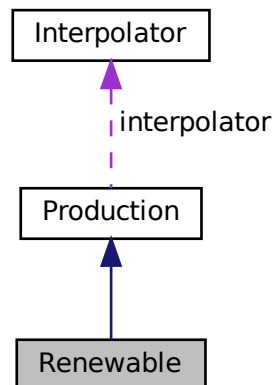
The root of the [Renewable](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the renewable production of energy.

```
#include <Renewable.h>
```

Inheritance diagram for Renewable:



Collaboration diagram for Renewable:



Public Member Functions

- [Renewable](#) (void)
Constructor (dummy) for the [Renewable](#) class.
- [Renewable](#) (int, double, [RenewableInputs](#))
Constructor (intended) for the [Renewable](#) class.
- virtual void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- void [computeEconomics](#) (std::vector< double > *)
Helper method to compute key economic metrics for the [Model](#) run.
- virtual double [computeProductionkW](#) (int, double, double)
- virtual double [computeProductionkW](#) (int, double, double, double)
- virtual double [commit](#) (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- void [writeResults](#) (std::string, std::vector< double > *, std::map< int, std::vector< double >> *, std::map< int, std::vector< std::vector< double >>> *, int, int=-1)
Method which writes [Renewable](#) results to an output directory.
- virtual [~Renewable](#) (void)
Destructor for the [Renewable](#) class.

Public Attributes

- [RenewableType](#) type
The type ([RenewableType](#)) of the asset.
- int [resource_key](#)
A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.

Private Member Functions

- void `__checkInputs` ([RenewableInputs](#))
Helper method to check inputs to the [Renewable](#) constructor.
- void `__handleStartStop` (int, double, double)
Helper method to handle the starting/stopping of the renewable asset.
- virtual void `__writeSummary` (std::string)
- virtual void `__writeTimeSeries` (std::string, std::vector< double > *, std::map< int, std::vector< double >> *, std::map< int, std::vector< std::vector< double >>> *, int=-1)

4.17.1 Detailed Description

The root of the [Renewable](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the renewable production of energy.

4.17.2 Constructor & Destructor Documentation

4.17.2.1 `Renewable()` [1/2]

```
Renewable::Renewable (
    void )
```

Constructor (dummy) for the [Renewable](#) class.

```
92 {
93     //...
94
95     return;
96 } /* Renewable() */
```

4.17.2.2 `Renewable()` [2/2]

```
Renewable::Renewable (
    int n_points,
    double n_years,
    RenewableInputs renewable_inputs )
```

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

Parameters

<code>n_points</code>	The number of points in the modelling time series.
<code>n_years</code>	The number of years being modelled.
<code>renewable_inputs</code>	A structure of Renewable constructor inputs.

```
124 :
125 Production(
126     n_points,
```

```

127     n_years,
128     renewable_inputs.production_inputs
129 )
130 {
131     // 1. check inputs
132     this->__checkInputs(renewable_inputs);
133
134     // 2. set attributes
135     //...
136
137     // 3. construction print
138     if (this->print_flag) {
139         std::cout << "Renewable object constructed at " << this << std::endl;
140     }
141
142     return;
143 } /* Renewable() */

```

4.17.2.3 ~Renewable()

```

Renewable::~Renewable (
    void ) [virtual]

```

Destructor for the [Renewable](#) class.

```

346 {
347     // 1. destruction print
348     if (this->print_flag) {
349         std::cout << "Renewable object at " << this << " destroyed" << std::endl;
350     }
351
352     return;
353 } /* ~Renewable() */

```

4.17.3 Member Function Documentation

4.17.3.1 __checkInputs()

```

void Renewable::__checkInputs (
    RenewableInputs renewable_inputs ) [private]

```

Helper method to check inputs to the [Renewable](#) constructor.

```

37 {
38     //...
39
40     return;
41 } /* __checkInputs() */

```

4.17.3.2 __handleStartStop()

```
void Renewable::__handleStartStop (
    int timestep,
    double dt_hrs,
    double production_kW ) [private]
```

Helper method to handle the starting/stopping of the renewable asset.

```
56 {
57     if (this->is_running) {
58         // handle stopping
59         if (production_kW <= 0) {
60             this->is_running = false;
61         }
62     }
63
64     else {
65         // handle starting
66         if (production_kW > 0) {
67             this->is_running = true;
68             this->n_starts++;
69         }
70     }
71
72     return;
73 } /* __handleStartStop() */
```

4.17.3.3 __writeSummary()

```
virtual void Renewable::__writeSummary (
    std::string ) [inline], [private], [virtual]
```

Reimplemented in [Wind](#), [Wave](#), [Tidal](#), and [Solar](#).

```
72 {return;}
```

4.17.3.4 __writeTimeSeries()

```
virtual void Renewable::__writeTimeSeries (
    std::string ,
    std::vector< double > * ,
    std::map< int, std::vector< double >> * ,
    std::map< int, std::vector< std::vector< double >>> * ,
    int = -1 ) [inline], [private], [virtual]
```

Reimplemented in [Wind](#), [Wave](#), [Tidal](#), and [Solar](#).

```
79 {return;}
```

4.17.3.5 commit()

```
double Renewable::commit (
    int timestep,
    double dt_hrs,
    double production_kW,
    double load_kW ) [virtual]
```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented from [Production](#).

Reimplemented in [Wind](#), [Wave](#), [Tidal](#), and [Solar](#).

```

227 {
228     // 1. handle start/stop
229     this->__handleStartStop(timestep, dt_hrs, production_kW);
230
231     // 2. invoke base class method
232     load_kW = Production::commit(
233         timestep,
234         dt_hrs,
235         production_kW,
236         load_kW
237     );
238
239
240     //...
241
242     return load_kW;
243 } /* commit() */

```

4.17.3.6 computeEconomics()

```

void Renewable::computeEconomics (
    std::vector< double > * time_vec_hrs_ptr ) [virtual]

```

Helper method to compute key economic metrics for the [Model](#) run.

Parameters

<i>time_vec_hrs_ptr</i>	A pointer to the <i>time_vec_hrs</i> attribute of the ElectricalLoad .
-------------------------	--

Reimplemented from [Production](#).

```

186 {
187     // 1. invoke base class method
188     Production::computeEconomics(time_vec_hrs_ptr);
189
190     return;
191 } /* computeEconomics() */

```

4.17.3.7 computeProductionkW() [1/2]

```

virtual double Renewable::computeProductionkW (
    int ,

```

```
double ,
double ) [inline], [virtual]
```

Reimplemented in [Wind](#), [Tidal](#), and [Solar](#).

```
96 {return 0;}
```

4.17.3.8 computeProductionkW() [2/2]

```
virtual double Renewable::computeProductionkW (
    int ,
    double ,
    double ,
    double ) [inline], [virtual]
```

Reimplemented in [Wave](#).

```
97 {return 0;}
```

4.17.3.9 handleReplacement()

```
void Renewable::handleReplacement (
    int timestep ) [virtual]
```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Production](#).

Reimplemented in [Wind](#), [Wave](#), [Tidal](#), and [Solar](#).

```
161 {
162     // 1. reset attributes
163     //...
164
165     // 2. invoke base class method
166     Production::handleReplacement(timestep);
167
168     return;
169 } /* __handleReplacement() */
```

4.17.3.10 writeResults()

```
void Renewable::writeResults (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    std::map< int, std::vector< double >> * resource_map_1D_ptr,
    std::map< int, std::vector< std::vector< double >>> * resource_map_2D_ptr,
    int renewable_index,
    int max_lines = -1 )
```

Method which writes [Renewable](#) results to an output directory.

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <i>time_vec_hrs</i> attribute of the ElectricalLoad .
<i>resource_map_1D_ptr</i>	A pointer to the 1D map of Resources .
<i>resource_map_2D_ptr</i>	A pointer to the 2D map of Resources .
<i>renewable_index</i>	An integer which corresponds to the index of the Renewable asset in the Model .
<i>max_lines</i>	The maximum number of lines of output to write. If <0 , then all available lines are written. If $=0$, then only summary results are written.

```

287 {
288     // 1. handle sentinel
289     if (max_lines < 0) {
290         max_lines = this->n_points;
291     }
292
293     // 2. create subdirectories
294     write_path += "Production/";
295     if (not std::filesystem::is_directory(write_path)) {
296         std::filesystem::create_directory(write_path);
297     }
298
299     write_path += "Renewable/";
300     if (not std::filesystem::is_directory(write_path)) {
301         std::filesystem::create_directory(write_path);
302     }
303
304     write_path += this->type_str;
305     write_path += "_";
306     write_path += std::to_string(int(ceil(this->capacity_kw)));
307     write_path += "kW_idx";
308     write_path += std::to_string(renewable_index);
309     write_path += "/";
310     std::filesystem::create_directory(write_path);
311
312     // 3. write summary
313     this->__writeSummary(write_path);
314
315     // 4. write time series
316     if (max_lines > this->n_points) {
317         max_lines = this->n_points;
318     }
319
320     if (max_lines > 0) {
321         this->__writeTimeSeries(
322             write_path,
323             time_vec_hrs_ptr,
324             resource_map_1D_ptr,
325             resource_map_2D_ptr,
326             max_lines
327         );
328     }
329
330     return;
331 } /* writeResults() */

```

4.17.4 Member Data Documentation

4.17.4.1 resource_key

```
int Renewable::resource_key
```

A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.

4.17.4.2 type

`RenewableType` `Renewable::type`

The type (`RenewableType`) of the asset.

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

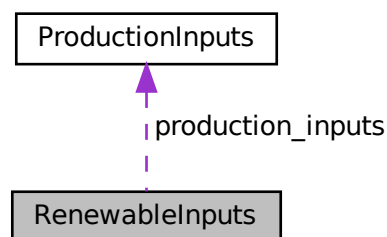
- `header/Production/Renewable/Renewable.h`
- `source/Production/Renewable/Renewable.cpp`

4.18 RenewableInputs Struct Reference

A structure which bundles the necessary inputs for the `Renewable` constructor. Provides default values for every necessary input. Note that this structure encapsulates `ProductionInputs`.

```
#include <Renewable.h>
```

Collaboration diagram for `RenewableInputs`:



Public Attributes

- `ProductionInputs production_inputs`
An encapsulated `ProductionInputs` instance.

4.18.1 Detailed Description

A structure which bundles the necessary inputs for the `Renewable` constructor. Provides default values for every necessary input. Note that this structure encapsulates `ProductionInputs`.

4.18.2 Member Data Documentation

4.18.2.1 production_inputs

`ProductionInputs RenewableInputs::production_inputs`

An encapsulated `ProductionInputs` instance.

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

- header/Production/Renewable/[Renewable.h](#)

4.19 Resources Class Reference

A class which contains renewable resource data. Intended to serve as a component class of `Model`.

```
#include <Resources.h>
```

Public Member Functions

- [Resources](#) (void)
Constructor for the [Resources](#) class.
- void [addResource](#) ([RenewableType](#), std::string, int, [ElectricalLoad](#) *)
A method to add a renewable resource time series to [Resources](#). Checks if given resource key is already in use. The associated helper methods also check against [ElectricalLoad](#) to ensure that all added time series align with the electrical load time series (both in terms of length and which points in time are included).
- void [clear](#) (void)
Method to clear all attributes of the [Resources](#) object.
- [~Resources](#) (void)
Destructor for the [Resources](#) class.

Public Attributes

- std::map< int, std::vector< double > > [resource_map_1D](#)
A map <int, vector<double>> of given 1D renewable resource time series.
- std::map< int, std::string > [string_map_1D](#)
A map <int, string> of descriptors for the type of the given 1D renewable resource time series.
- std::map< int, std::string > [path_map_1D](#)
A map <int, string> of the paths (either relative or absolute) to given 1D renewable resource time series.
- std::map< int, std::vector< std::vector< double > > > [resource_map_2D](#)
A map <int, vector<vector<double>>> of given 2D renewable resource time series.
- std::map< int, std::string > [string_map_2D](#)
A map <int, string> of descriptors for the type of the given 2D renewable resource time series.
- std::map< int, std::string > [path_map_2D](#)
A map <int, string> of the paths (either relative or absolute) to given 2D renewable resource time series.

Private Member Functions

- void `__checkResourceKey1D` (int, [RenewableType](#))
Helper method to check if given resource key (1D) is already in use.
- void `__checkResourceKey2D` (int, [RenewableType](#))
Helper method to check if given resource key (2D) is already in use.
- void `__checkTimePoint` (double, double, std::string, [ElectricalLoad](#) *)
Helper method to check received time point against expected time point.
- void `__throwLengthError` (std::string, [ElectricalLoad](#) *)
Helper method to throw data length error.
- void `__readSolarResource` (std::string, int, [ElectricalLoad](#) *)
Helper method to handle reading a solar resource time series into [Resources](#).
- void `__readTidalResource` (std::string, int, [ElectricalLoad](#) *)
Helper method to handle reading a tidal resource time series into [Resources](#).
- void `__readWaveResource` (std::string, int, [ElectricalLoad](#) *)
Helper method to handle reading a wave resource time series into [Resources](#).
- void `__readWindResource` (std::string, int, [ElectricalLoad](#) *)
Helper method to handle reading a wind resource time series into [Resources](#).

4.19.1 Detailed Description

A class which contains renewable resource data. Intended to serve as a component class of [Model](#).

4.19.2 Constructor & Destructor Documentation

4.19.2.1 Resources()

```
Resources::Resources (
    void )
```

Constructor for the [Resources](#) class.

```
577 {
578     return;
579 } /* Resources() */
```

4.19.2.2 ~Resources()

```
Resources::~Resources (
    void )
```

Destructor for the [Resources](#) class.

```
721 {
722     this->clear();
723     return;
724 } /* ~Resources() */
```

4.19.3 Member Function Documentation

4.19.3.1 __checkResourceKey1D()

```
void Resources::__checkResourceKey1D (
    int resource_key,
    RenewableType renewable_type ) [private]
```

Helper method to check if given resource key (1D) is already in use.

Parameters

<i>resource_key</i>	The key associated with the given renewable resource.
---------------------	---

```
45 {
46     if (this->resource_map_1D.count(resource_key) > 0) {
47         std::string error_str = "ERROR: Resources::addResource(";
48
49         switch (renewable_type) {
50             case (RenewableType :: SOLAR): {
51                 error_str += "SOLAR): ";
52
53                 break;
54             }
55
56             case (RenewableType :: TIDAL): {
57                 error_str += "TIDAL): ";
58
59                 break;
60             }
61
62             case (RenewableType :: WIND): {
63                 error_str += "WIND): ";
64
65                 break;
66             }
67
68             default: {
69                 error_str += "UNDEFINED_TYPE): ";
70
71                 break;
72             }
73         }
74
75         error_str += "resource key (1D) ";
76         error_str += std::to_string(resource_key);
77         error_str += " is already in use";
78
79         #ifdef _WIN32
80             std::cout << error_str << std::endl;
81         #endif
82
83         throw std::invalid_argument(error_str);
84     }
85
86     return;
87 } /* __checkResourceKey1D() */
```

4.19.3.2 __checkResourceKey2D()

```
void Resources::__checkResourceKey2D (
    int resource_key,
    RenewableType renewable_type ) [private]
```

Helper method to check if given resource key (2D) is already in use.

Parameters

<i>resource_key</i>	The key associated with the given renewable resource.
---------------------	---

```

109 {
110     if (this->resource_map_2D.count(resource_key) > 0) {
111         std::string error_str = "ERROR:  Resources::addResource(";
112
113         switch (renewable_type) {
114             case (RenewableType :: WAVE): {
115                 error_str += "WAVE):  ";
116
117                 break;
118             }
119
120             default: {
121                 error_str += "UNDEFINED_TYPE):  ";
122
123                 break;
124             }
125         }
126
127         error_str += "resource key (2D) ";
128         error_str += std::to_string(resource_key);
129         error_str += " is already in use";
130
131         #ifdef _WIN32
132             std::cout << error_str << std::endl;
133         #endif
134
135         throw std::invalid_argument(error_str);
136     }
137
138     return;
139 } /* __checkResourceKey2D() */

```

4.19.3.3 __checkTimePoint()

```

void Resources::__checkTimePoint (
    double time_received_hrs,
    double time_expected_hrs,
    std::string path_2_resource_data,
    ElectricalLoad * electrical_load_ptr ) [private]

```

Helper method to check received time point against expected time point.

Parameters

<i>time_received_hrs</i>	The point in time received from the given data.
<i>time_expected_hrs</i>	The point in time expected (this comes from the electrical load time series).
<i>path_2_resource_data</i>	The path (either relative or absolute) to the given resource time series.
<i>electrical_load_ptr</i>	A pointer to the Model's ElectricalLoad object.

```

173 {
174     if (time_received_hrs != time_expected_hrs) {
175         std::string error_str = "ERROR:  Resources::addResource():  ";
176         error_str += "the given resource time series at ";
177         error_str += path_2_resource_data;
178         error_str += " does not align with the ";
179         error_str += "previously given electrical load time series at ";
180         error_str += electrical_load_ptr->path_2_electrical_load_time_series;
181
182         #ifdef _WIN32
183             std::cout << error_str << std::endl;
184         #endif
185
186         throw std::runtime_error(error_str);
187     }
188 }

```

```

189     return;
190 } /* __checkTimePoint() */

```

4.19.3.4 __readSolarResource()

```

void Resources::__readSolarResource (
    std::string path_2_resource_data,
    int resource_key,
    ElectricalLoad * electrical_load_ptr ) [private]

```

Helper method to handle reading a solar resource time series into [Resources](#).

Parameters

<i>path_2_resource_data</i>	The path (either relative or absolute) to the given resource time series.
<i>resource_key</i>	The key associated with the given renewable resource.
<i>electrical_load_ptr</i>	A pointer to the Model's ElectricalLoad object.

```

257 {
258     // 1. init CSV reader, record path and type
259     io::CSVReader<2> CSV(path_2_resource_data);
260
261     CSV.read_header(
262         io::ignore_extra_column,
263         "Time (since start of data) [hrs]",
264         "Solar GHI [kW/m2]"
265     );
266
267     this->path_map_1D.insert(
268         std::pair<int, std::string>(resource_key, path_2_resource_data)
269     );
270
271     this->string_map_1D.insert(std::pair<int, std::string>(resource_key, "SOLAR"));
272
273     // 2. init map element
274     this->resource_map_1D.insert(
275         std::pair<int, std::vector<double>>(resource_key, {})
276     );
277     this->resource_map_1D[resource_key].resize(electrical_load_ptr->n_points, 0);
278
279
280     // 3. read in resource data, check against time series (point-wise and length)
281     int n_points = 0;
282     double time_hrs = 0;
283     double time_expected_hrs = 0;
284     double solar_resource_kWm2 = 0;
285
286     while (CSV.read_row(time_hrs, solar_resource_kWm2)) {
287         if (n_points > electrical_load_ptr->n_points) {
288             this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
289         }
290
291         time_expected_hrs = electrical_load_ptr->time_vec_hrs[n_points];
292         this->__checkTimePoint(
293             time_hrs,
294             time_expected_hrs,
295             path_2_resource_data,
296             electrical_load_ptr
297         );
298
299         this->resource_map_1D[resource_key][n_points] = solar_resource_kWm2;
300
301         n_points++;
302     }
303
304     // 4. check data length
305     if (n_points != electrical_load_ptr->n_points) {
306         this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
307     }
308
309     return;
310 } /* __readSolarResource() */

```

4.19.3.5 __readTidalResource()

```
void Resources::__readTidalResource (
    std::string path_2_resource_data,
    int resource_key,
    ElectricalLoad * electrical_load_ptr ) [private]
```

Helper method to handle reading a tidal resource time series into [Resources](#).

Parameters

<i>path_2_resource_data</i>	The path (either relative or absolute) to the given resource time series.
<i>resource_key</i>	The key associated with the given renewable resource.
<i>electrical_load_ptr</i>	A pointer to the Model's ElectricalLoad object.

```
339 {
340     // 1. init CSV reader, record path and type
341     io::CSVReader<2> CSV(path_2_resource_data);
342
343     CSV.read_header(
344         io::ignore_extra_column,
345         "Time (since start of data) [hrs]",
346         "Tidal Speed (hub depth) [m/s]"
347     );
348
349     this->path_map_1D.insert(
350         std::pair<int, std::string>(resource_key, path_2_resource_data)
351     );
352
353     this->string_map_1D.insert(std::pair<int, std::string>(resource_key, "TIDAL"));
354
355     // 2. init map element
356     this->resource_map_1D.insert(
357         std::pair<int, std::vector<double>>(resource_key, {})
358     );
359     this->resource_map_1D[resource_key].resize(electrical_load_ptr->n_points, 0);
360
361     // 3. read in resource data, check against time series (point-wise and length)
362     int n_points = 0;
363     double time_hrs = 0;
364     double time_expected_hrs = 0;
365     double tidal_resource_ms = 0;
366
367     while (CSV.read_row(time_hrs, tidal_resource_ms)) {
368         if (n_points > electrical_load_ptr->n_points) {
369             this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
370         }
371
372         time_expected_hrs = electrical_load_ptr->time_vec_hrs[n_points];
373         this->__checkTimePoint(
374             time_hrs,
375             time_expected_hrs,
376             path_2_resource_data,
377             electrical_load_ptr
378         );
379
380         this->resource_map_1D[resource_key][n_points] = tidal_resource_ms;
381         n_points++;
382     }
383
384     // 4. check data length
385     if (n_points != electrical_load_ptr->n_points) {
386         this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
387     }
388
389     return;
390 }
391
392 } /* __readTidalResource() */
```

4.19.3.6 __readWaveResource()

```
void Resources::__readWaveResource (
    std::string path_2_resource_data,
    int resource_key,
    ElectricalLoad * electrical_load_ptr ) [private]
```

Helper method to handle reading a wave resource time series into [Resources](#).

Parameters

<i>path_2_resource_data</i>	The path (either relative or absolute) to the given resource time series.
<i>resource_key</i>	The key associated with the given renewable resource.
<i>electrical_load_ptr</i>	A pointer to the Model's ElectricalLoad object.

```
421 {
422     // 1. init CSV reader, record path and type
423     io::CSVReader<3> CSV(path_2_resource_data);
424
425     CSV.read_header(
426         io::ignore_extra_column,
427         "Time (since start of data) [hrs]",
428         "Significant Wave Height [m]",
429         "Energy Period [s]"
430     );
431
432     this->path_map_2D.insert(
433         std::pair<int, std::string>(resource_key, path_2_resource_data)
434     );
435
436     this->string_map_2D.insert(std::pair<int, std::string>(resource_key, "WAVE"));
437
438     // 2. init map element
439     this->resource_map_2D.insert(
440         std::pair<int, std::vector<std::vector<double>>>(resource_key, {})
441     );
442     this->resource_map_2D[resource_key].resize(electrical_load_ptr->n_points, {0, 0});
443
444     // 3. read in resource data, check against time series (point-wise and length)
445     int n_points = 0;
446     double time_hrs = 0;
447     double time_expected_hrs = 0;
448     double significant_wave_height_m = 0;
449     double energy_period_s = 0;
450
451     while (CSV.read_row(time_hrs, significant_wave_height_m, energy_period_s)) {
452         if (n_points > electrical_load_ptr->n_points) {
453             this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
454         }
455
456         time_expected_hrs = electrical_load_ptr->time_vec_hrs[n_points];
457         this->__checkTimePoint(
458             time_hrs,
459             time_expected_hrs,
460             path_2_resource_data,
461             electrical_load_ptr
462         );
463
464         this->resource_map_2D[resource_key][n_points][0] = significant_wave_height_m;
465         this->resource_map_2D[resource_key][n_points][1] = energy_period_s;
466
467         n_points++;
468     }
469
470     // 4. check data length
471     if (n_points != electrical_load_ptr->n_points) {
472         this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
473     }
474
475     return;
476 }
477 /* __readWaveResource() */
```


4.19.3.7 __readWindResource()

```
void Resources::__readWindResource (
    std::string path_2_resource_data,
    int resource_key,
    ElectricalLoad * electrical_load_ptr ) [private]
```

Helper method to handle reading a wind resource time series into [Resources](#).

Parameters

<i>path_2_resource_data</i>	The path (either relative or absolute) to the given resource time series.
<i>resource_key</i>	The key associated with the given renewable resource.
<i>electrical_load_ptr</i>	A pointer to the Model's ElectricalLoad object.

```
506 {
507     // 1. init CSV reader, record path and type
508     io::CSVReader<2> CSV(path_2_resource_data);
509
510     CSV.read_header(
511         io::ignore_extra_column,
512         "Time (since start of data) [hrs]",
513         "Wind Speed (hub height) [m/s]"
514     );
515
516     this->path_map_1D.insert(
517         std::pair<int, std::string>(resource_key, path_2_resource_data)
518     );
519
520     this->string_map_1D.insert(std::pair<int, std::string>(resource_key, "WIND"));
521
522     // 2. init map element
523     this->resource_map_1D.insert(
524         std::pair<int, std::vector<double>>(resource_key, {})
525     );
526     this->resource_map_1D[resource_key].resize(electrical_load_ptr->n_points, 0);
527
528
529     // 3. read in resource data, check against time series (point-wise and length)
530     int n_points = 0;
531     double time_hrs = 0;
532     double time_expected_hrs = 0;
533     double wind_resource_ms = 0;
534
535     while (CSV.read_row(time_hrs, wind_resource_ms)) {
536         if (n_points > electrical_load_ptr->n_points) {
537             this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
538         }
539
540         time_expected_hrs = electrical_load_ptr->time_vec_hrs[n_points];
541         this->__checkTimePoint(
542             time_hrs,
543             time_expected_hrs,
544             path_2_resource_data,
545             electrical_load_ptr
546         );
547
548         this->resource_map_1D[resource_key][n_points] = wind_resource_ms;
549
550         n_points++;
551     }
552
553     // 4. check data length
554     if (n_points != electrical_load_ptr->n_points) {
555         this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
556     }
557
558     return;
559 } /* __readWindResource() */
```

4.19.3.8 __throwLengthError()

```
void Resources::__throwLengthError (
```

```
std::string path_2_resource_data,
ElectricalLoad * electrical_load_ptr ) [private]
```

Helper method to throw data length error.

Parameters

<i>path_2_resource_data</i>	The path (either relative or absolute) to the given resource time series.
<i>electrical_load_ptr</i>	A pointer to the Model's ElectricalLoad object.

```
215 {
216     std::string error_str = "ERROR: Resources::addResource(): ";
217     error_str += "the given resource time series at ";
218     error_str += path_2_resource_data;
219     error_str += " is not the same length as the previously given electrical";
220     error_str += " load time series at ";
221     error_str += electrical_load_ptr->path_2_electrical_load_time_series;
222
223     #ifdef _WIN32
224         std::cout << error_str << std::endl;
225     #endif
226
227     throw std::runtime_error(error_str);
228
229     return;
230 } /* __throwLengthError() */
```

4.19.3.9 addResource()

```
void Resources::addResource (
    RenewableType renewable_type,
    std::string path_2_resource_data,
    int resource_key,
    ElectricalLoad * electrical_load_ptr )
```

A method to add a renewable resource time series to [Resources](#). Checks if given resource key is already in use. The associated helper methods also check against [ElectricalLoad](#) to ensure that all added time series align with the electrical load time series (both in terms of length and which points in time are included).

Parameters

<i>renewable_type</i>	The type of renewable resource being added to Resources .
<i>path_2_resource_data</i>	A string defining the path (either relative or absolute) to the given resource time series.
<i>resource_key</i>	A key used to index into the Resources object, used to associate Renewable assets with the corresponding resource.
<i>electrical_load_ptr</i>	A pointer to the Model's ElectricalLoad object.

```
616 {
617     switch (renewable_type) {
618         case (RenewableType :: SOLAR): {
619             this->__checkResourceKeyID(resource_key, renewable_type);
620
621             this->__readSolarResource(
622                 path_2_resource_data,
623                 resource_key,
624                 electrical_load_ptr
625             );
626
627             break;
628         }
629
630         case (RenewableType :: TIDAL): {
631             this->__checkResourceKeyID(resource_key, renewable_type);
```

```

632
633         this->__readTidalResource(
634             path_2_resource_data,
635             resource_key,
636             electrical_load_ptr
637         );
638
639         break;
640     }
641
642     case (RenewableType :: WAVE): {
643         this->__checkResourceKey2D(resource_key, renewable_type);
644
645         this->__readWaveResource(
646             path_2_resource_data,
647             resource_key,
648             electrical_load_ptr
649         );
650
651         break;
652     }
653
654     case (RenewableType :: WIND): {
655         this->__checkResourceKey1D(resource_key, renewable_type);
656
657         this->__readWindResource(
658             path_2_resource_data,
659             resource_key,
660             electrical_load_ptr
661         );
662
663         break;
664     }
665
666     default: {
667         std::string error_str = "ERROR: Resources :: addResource(: ";
668         error_str += "renewable type ";
669         error_str += std::to_string(renewable_type);
670         error_str += " not recognized";
671
672         #ifdef _WIN32
673             std::cout << error_str << std::endl;
674         #endif
675
676         throw std::runtime_error(error_str);
677
678         break;
679     }
680 }
681
682 return;
683 } /* addResource() */

```

4.19.3.10 clear()

```

void Resources::clear (
    void )

```

Method to clear all attributes of the [Resources](#) object.

```

697 {
698     this->resource_map_1D.clear();
699     this->string_map_1D.clear();
700     this->path_map_1D.clear();
701
702     this->resource_map_2D.clear();
703     this->string_map_2D.clear();
704     this->path_map_2D.clear();
705
706     return;
707 } /* clear() */

```

4.19.4 Member Data Documentation

4.19.4.1 path_map_1D

```
std::map<int, std::string> Resources::path_map_1D
```

A map <int, string> of the paths (either relative or absolute) to given 1D renewable resource time series.

4.19.4.2 path_map_2D

```
std::map<int, std::string> Resources::path_map_2D
```

A map <int, string> of the paths (either relative or absolute) to given 2D renewable resource time series.

4.19.4.3 resource_map_1D

```
std::map<int, std::vector<double> > Resources::resource_map_1D
```

A map <int, vector<double>> of given 1D renewable resource time series.

4.19.4.4 resource_map_2D

```
std::map<int, std::vector<std::vector<double> > > Resources::resource_map_2D
```

A map <int, vector<vector<double>>> of given 2D renewable resource time series.

4.19.4.5 string_map_1D

```
std::map<int, std::string> Resources::string_map_1D
```

A map <int, string> of descriptors for the type of the given 1D renewable resource time series.

4.19.4.6 string_map_2D

```
std::map<int, std::string> Resources::string_map_2D
```

A map <int, string> of descriptors for the type of the given 2D renewable resource time series.

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

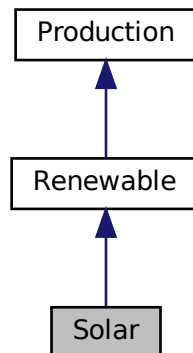
- header/[Resources.h](#)
- source/[Resources.cpp](#)

4.20 Solar Class Reference

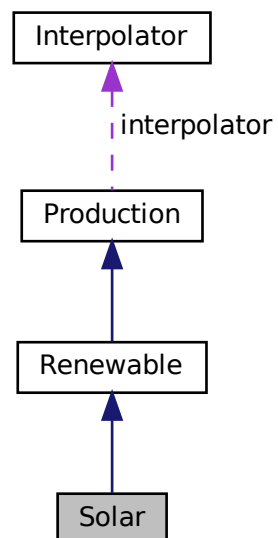
A derived class of the [Renewable](#) branch of [Production](#) which models solar production.

```
#include <Solar.h>
```

Inheritance diagram for Solar:



Collaboration diagram for Solar:



Public Member Functions

- [Solar](#) (void)
Constructor (dummy) for the [Solar](#) class.
- [Solar](#) (int, double, [SolarInputs](#))
Constructor (intended) for the [Solar](#) class.
- void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- double [computeProductionkW](#) (int, double, double)
Method which takes in the solar resource at a particular point in time, and then returns the solar PV production at that point in time.
- double [commit](#) (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- [~Solar](#) (void)
Destructor for the [Solar](#) class.

Public Attributes

- double [derating](#)
The derating of the solar PV array (i.e., shadowing, soiling, etc.).

Private Member Functions

- void [__checkInputs](#) ([SolarInputs](#))
Helper method to check inputs to the [Solar](#) constructor.
- double [__getGenericCapitalCost](#) (void)
Helper method to generate a generic solar PV array capital cost.
- double [__getGenericOpMaintCost](#) (void)
Helper method to generate a generic solar PV array operation and maintenance cost. This is a cost incurred per unit energy produced.
- void [__writeSummary](#) (std::string)
Helper method to write summary results for [Solar](#).
- void [__writeTimeSeries](#) (std::string, std::vector< double > *, std::map< int, std::vector< double >> *, std::map< int, std::vector< std::vector< double >>> *, int=-1)
Helper method to write time series results for [Solar](#).

4.20.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models solar production.

4.20.2 Constructor & Destructor Documentation

4.20.2.1 Solar() [1/2]

```
Solar::Solar (
    void )
```

Constructor (dummy) for the [Solar](#) class.

```
281 {
282     //...
283
284     return;
285 } /* Solar() */
```

4.20.2.2 Solar() [2/2]

```
Solar::Solar (
    int n_points,
    double n_years,
    SolarInputs solar_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>solar_inputs</i>	A structure of Solar constructor inputs.

```
313 :
314 Renewable(
315     n_points,
316     n_years,
317     solar_inputs.renewable_inputs
318 )
319 {
320     // 1. check inputs
321     this->__checkInputs(solar_inputs);
322
323     // 2. set attributes
324     this->type = RenewableType :: SOLAR;
325     this->type_str = "SOLAR";
326
327     this->resource_key = solar_inputs.resource_key;
328
329     this->derating = solar_inputs.derating;
330
331     if (solar_inputs.capital_cost < 0) {
332         this->capital_cost = this->__getGenericCapitalCost();
333     }
334
335     if (solar_inputs.operation_maintenance_cost_kWh < 0) {
336         this->operation_maintenance_cost_kWh = this->__getGenericOpMaintCost();
337     }
338
339     if (not this->is_sunk) {
340         this->capital_cost_vec[0] = this->capital_cost;
341     }
342
343     // 3. construction print
344     if (this->print_flag) {
345         std::cout << "Solar object constructed at " << this << std::endl;
346     }
347
348     return;
349 } /* Renewable() */
```

4.20.2.3 ~Solar()

```
Solar::~~Solar (
    void )
```

Destructor for the [Solar](#) class.

```
488 {
489     // 1. destruction print
490     if (this->print_flag) {
491         std::cout << "Solar object at " << this << " destroyed" << std::endl;
492     }
493
494     return;
495 } /* ~Solar() */
```

4.20.3 Member Function Documentation

4.20.3.1 __checkInputs()

```
void Solar::__checkInputs (
    SolarInputs solar_inputs ) [private]
```

Helper method to check inputs to the [Solar](#) constructor.

```
37 {
38     // 1. check derating
39     if (
40         solar_inputs.derating < 0 or
41         solar_inputs.derating > 1
42     ) {
43         std::string error_str = "ERROR: Solar(): ";
44         error_str += "SolarInputs::derating must be in the closed interval [0, 1]";
45
46         #ifdef _WIN32
47             std::cout << error_str << std::endl;
48         #endif
49
50         throw std::invalid_argument(error_str);
51     }
52
53     return;
54 } /* __checkInputs() */
```

4.20.3.2 __getGenericCapitalCost()

```
double Solar::__getGenericCapitalCost (
    void ) [private]
```

Helper method to generate a generic solar PV array capital cost.

This model was obtained by way of surveying an assortment of published solar PV costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars [CAD].

Returns

A generic capital cost for the solar PV array [CAD].

```
76 {
77     double capital_cost_per_kW = 1000 * pow(this->capacity_kW, -0.15) + 3000;
78
79     return capital_cost_per_kW * this->capacity_kW;
80 } /* __getGenericCapitalCost() */
```


4.20.3.3 `__getGenericOpMaintCost()`

```
double Solar::__getGenericOpMaintCost (
    void ) [private]
```

Helper method to generate a generic solar PV array operation and maintenance cost. This is a cost incurred per unit energy produced.

This model was obtained by way of surveying an assortment of published solar PV costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars [CAD/kWh].

Returns

A generic operation and maintenance cost, per unit energy produced, for the solar PV array [CAD/kWh].

```
103 {
104     return 0.01;
105 } /* __getGenericOpMaintCost() */
```

4.20.3.4 `__writeSummary()`

```
void Solar::__writeSummary (
    std::string write_path ) [private], [virtual]
```

Helper method to write summary results for [Solar](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
-------------------	--

Reimplemented from [Renewable](#).

```
123 {
124     // 1. create filestream
125     write_path += "summary_results.md";
126     std::ofstream ofs;
127     ofs.open(write_path, std::ofstream::out);
128
129     // 2. write summary results (markdown)
130     ofs << "# ";
131     ofs << std::to_string(int(ceil(this->capacity_kW)));
132     ofs << " kW SOLAR Summary Results\n";
133     ofs << "\n-----\n\n";
134
135     // 2.1. Production attributes
136     ofs << "## Production Attributes\n";
137     ofs << "\n";
138
139     ofs << "Capacity: " << this->capacity_kW << "kW \n";
140     ofs << "\n";
141
142     ofs << "Sunk Cost (N = 0 / Y = 1): " << this->is_sunk << " \n";
143     ofs << "Capital Cost: " << this->capital_cost << " \n";
144     ofs << "Operation and Maintenance Cost: " << this->operation_maintenance_cost_kWh
145         << " per kWh produced \n";
146     ofs << "Nominal Inflation Rate (annual): " << this->nominal_inflation_annual
147         << " \n";
148     ofs << "Nominal Discount Rate (annual): " << this->nominal_discount_annual
149         << " \n";
150     ofs << "Real Discount Rate (annual): " << this->real_discount_annual << " \n";
151     ofs << "\n";
152
153     ofs << "Replacement Running Hours: " << this->replace_running_hrs << " \n";
154     ofs << "\n-----\n\n";
```

```

155
156 // 2.2. Renewable attributes
157 ofs << "## Renewable Attributes\n";
158 ofs << "\n";
159
160 ofs << "Resource Key (1D): " << this->resource_key << " \n";
161
162 ofs << "\n-----\n\n";
163
164 // 2.3. Solar attributes
165 ofs << "## Solar Attributes\n";
166 ofs << "\n";
167
168 ofs << "Derating Factor: " << this->derating << " \n";
169
170 ofs << "\n-----\n\n";
171
172 // 2.4. Solar Results
173 ofs << "## Results\n";
174 ofs << "\n";
175
176 ofs << "Net Present Cost: " << this->net_present_cost << " \n";
177 ofs << "\n";
178
179 ofs << "Total Dispatch: " << this->total_dispatch_kWh
180     << " kWh \n";
181
182 ofs << "Levellized Cost of Energy: " << this->levellized_cost_of_energy_kWh
183     << " per kWh dispatched \n";
184 ofs << "\n";
185
186 ofs << "Running Hours: " << this->running_hours << " \n";
187 ofs << "Replacements: " << this->n_replacements << " \n";
188
189 ofs << "\n-----\n\n";
190
191 ofs.close();
192 return;
193 } /* __writeSummary() */

```

4.20.3.5 __writeTimeSeries()

```

void Solar::__writeTimeSeries (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    std::map< int, std::vector< double >> * resource_map_1D_ptr,
    std::map< int, std::vector< std::vector< double >>> * resource_map_2D_ptr,
    int max_lines = -1 ) [private], [virtual]

```

Helper method to write time series results for [Solar](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <code>time_vec_hrs</code> attribute of the ElectricalLoad .
<i>resource_map_1D_ptr</i>	A pointer to the 1D map of Resources .
<i>resource_map_2D_ptr</i>	A pointer to the 2D map of Resources .
<i>max_lines</i>	The maximum number of lines of output to write.

Reimplemented from [Renewable](#).

```

231 {
232 // 1. create filestream
233 write_path += "time_series_results.csv";
234 std::ofstream ofs;
235 ofs.open(write_path, std::ofstream::out);
236

```

```

237 // 2. write time series results (comma separated value)
238 ofs << "Time (since start of data) [hrs],";
239 ofs << "Solar Resource [kW/m2],";
240 ofs << "Production [kW],";
241 ofs << "Dispatch [kW],";
242 ofs << "Storage [kW],";
243 ofs << "Curtailment [kW],";
244 ofs << "Capital Cost (actual),";
245 ofs << "Operation and Maintenance Cost (actual),";
246 ofs << "\n";
247
248 for (int i = 0; i < max_lines; i++) {
249     ofs << time_vec_hrs_ptr->at(i) << ",";
250     ofs << resource_map_1D_ptr->at(this->resource_key)[i] << ",";
251     ofs << this->production_vec_kW[i] << ",";
252     ofs << this->dispatch_vec_kW[i] << ",";
253     ofs << this->storage_vec_kW[i] << ",";
254     ofs << this->curtailment_vec_kW[i] << ",";
255     ofs << this->capital_cost_vec[i] << ",";
256     ofs << this->operation_maintenance_cost_vec[i] << ",";
257     ofs << "\n";
258 }
259
260 ofs.close();
261 return;
262 } /* __writeTimeSeries() */

```

4.20.3.6 commit()

```

double Solar::commit (
    int timestep,
    double dt_hrs,
    double production_kW,
    double load_kW ) [virtual]

```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented from [Renewable](#).

```

460 {
461     // 1. invoke base class method
462     load_kW = Renewable::commit(
463         timestep,
464         dt_hrs,
465         production_kW,
466         load_kW
467     );
468
469     //...
470
471     return load_kW;
472 } /* commit() */

```

4.20.3.7 computeProductionkW()

```
double Solar::computeProductionkW (
    int timestep,
    double dt_hrs,
    double solar_resource_kWm2 ) [virtual]
```

Method which takes in the solar resource at a particular point in time, and then returns the solar PV production at that point in time.

Ref: [HOMER \[2023f\]](#)

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>solar_resource_kWm2</i>	Solar resource (i.e. irradiance) [kW/m2].

Returns

The production [kW] of the solar PV array.

Reimplemented from [Renewable](#).

```
409 {
410     // check if no resource
411     if (solar_resource_kWm2 <= 0) {
412         return 0;
413     }
414
415     // compute production
416     double production_kW = this->derating * solar_resource_kWm2 * this->capacity_kW;
417
418     // cap production at capacity
419     if (production_kW > this->capacity_kW) {
420         production_kW = this->capacity_kW;
421     }
422
423     return production_kW;
424 } /* computeProductionkW() */
```

4.20.3.8 handleReplacement()

```
void Solar::handleReplacement (
    int timestep ) [virtual]
```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Renewable](#).

```
367 {
368     // 1. reset attributes
369     //...
```

```

370
371 // 2. invoke base class method
372 Renewable :: handleReplacement(timestep);
373
374 return;
375 } /* __handleReplacement() */

```

4.20.4 Member Data Documentation

4.20.4.1 derating

```
double Solar::derating
```

The derating of the solar PV array (i.e., shadowing, soiling, etc.).

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

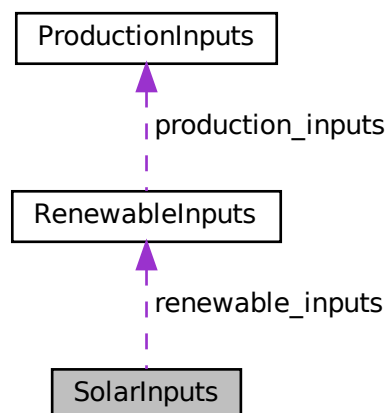
- header/Production/Renewable/[Solar.h](#)
- source/Production/Renewable/[Solar.cpp](#)

4.21 SolarInputs Struct Reference

A structure which bundles the necessary inputs for the [Solar](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

```
#include <Solar.h>
```

Collaboration diagram for SolarInputs:



Public Attributes

- [RenewableInputs](#) `renewable_inputs`
An encapsulated [RenewableInputs](#) instance.
- `int resource_key = 0`
A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.
- `double capital_cost = -1`
The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].
- `double operation_maintenance_cost_kWh = -1`
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].
- `double derating = 0.8`
The derating of the solar PV array (i.e., shadowing, soiling, etc.).

4.21.1 Detailed Description

A structure which bundles the necessary inputs for the [Solar](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

4.21.2 Member Data Documentation

4.21.2.1 capital_cost

```
double SolarInputs::capital_cost = -1
```

The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].

4.21.2.2 derating

```
double SolarInputs::derating = 0.8
```

The derating of the solar PV array (i.e., shadowing, soiling, etc.).

4.21.2.3 operation_maintenance_cost_kWh

```
double SolarInputs::operation_maintenance_cost_kWh = -1
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].

4.21.2.4 renewable_inputs

```
RenewableInputs SolarInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.21.2.5 resource_key

```
int SolarInputs::resource_key = 0
```

A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.

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

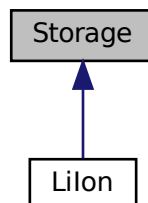
- header/Production/Renewable/[Solar.h](#)

4.22 Storage Class Reference

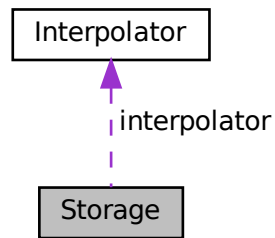
The base class of the [Storage](#) hierarchy. This hierarchy contains derived classes which model the storage of energy.

```
#include <Storage.h>
```

Inheritance diagram for Storage:



Collaboration diagram for Storage:



Public Member Functions

- [Storage](#) (void)
Constructor (dummy) for the [Storage](#) class.
- [Storage](#) (int, double, [StorageInputs](#))
Constructor (intended) for the [Storage](#) class.
- virtual void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- void [computeEconomics](#) (std::vector< double > *)
Helper method to compute key economic metrics for the [Model](#) run.
- virtual double [getAvailablekW](#) (double)
- virtual double [getAcceptablekW](#) (double)
- virtual void [commitCharge](#) (int, double, double)
- virtual double [commitDischarge](#) (int, double, double, double)
- void [writeResults](#) (std::string, std::vector< double > *, int, int=-1)
Method which writes [Storage](#) results to an output directory.
- virtual [~Storage](#) (void)
Destructor for the [Storage](#) class.

Public Attributes

- [StorageType](#) type
The type ([StorageType](#)) of the asset.
- [Interpolator](#) interpolator
[Interpolator](#) component of [Storage](#).
- bool [print_flag](#)
A flag which indicates whether or not object construct/destruction should be verbose.
- bool [is_depleted](#)
A boolean which indicates whether or not the asset is currently considered depleted.
- bool [is_sunk](#)
A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).
- int [n_points](#)
The number of points in the modelling time series.

- int [n_replacements](#)
The number of times the asset has been replaced.
- double [n_years](#)
The number of years being modelled.
- double [power_capacity_kW](#)
The rated power capacity [kW] of the asset.
- double [energy_capacity_kWh](#)
The rated energy capacity [kWh] of the asset.
- double [charge_kWh](#)
The energy [kWh] stored in the asset.
- double [power_kW](#)
The power [kW] currently being charged/discharged by the asset.
- double [nominal_inflation_annual](#)
The nominal, annual inflation rate to use in computing model economics.
- double [nominal_discount_annual](#)
The nominal, annual discount rate to use in computing model economics.
- double [real_discount_annual](#)
The real, annual discount rate used in computing model economics. Is computed from the given nominal inflation and discount rates.
- double [capital_cost](#)
The capital cost of the asset (undefined currency).
- double [operation_maintenance_cost_kWh](#)
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy charged/discharged.
- double [net_present_cost](#)
The net present cost of this asset.
- double [total_discharge_kWh](#)
The total energy discharged [kWh] over the [Model](#) run.
- double [levellized_cost_of_energy_kWh](#)
The levellized cost of energy [1/kWh] (undefined currency) of this asset. This metric considers only discharge.
- std::string [type_str](#)
A string describing the type of the asset.
- std::vector< double > [charge_vec_kWh](#)
A vector of the charge state [kWh] at each point in the modelling time series.
- std::vector< double > [charging_power_vec_kW](#)
A vector of the charging power [kW] at each point in the modelling time series.
- std::vector< double > [discharging_power_vec_kW](#)
A vector of the discharging power [kW] at each point in the modelling time series.
- std::vector< double > [capital_cost_vec](#)
A vector of capital costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).
- std::vector< double > [operation_maintenance_cost_vec](#)
A vector of operation and maintenance costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).

Private Member Functions

- void [__checkInputs](#) (int, double, [StorageInputs](#))
Helper method to check inputs to the [Storage](#) constructor.
- double [__computeRealDiscountAnnual](#) (double, double)
Helper method to compute the real, annual discount rate to be used in computing model economics. This enables application of the discount factor approach.
- virtual void [__writeSummary](#) (std::string)
- virtual void [__writeTimeSeries](#) (std::string, std::vector< double > *, int=-1)

4.22.1 Detailed Description

The base class of the [Storage](#) hierarchy. This hierarchy contains derived classes which model the storage of energy.

4.22.2 Constructor & Destructor Documentation

4.22.2.1 Storage() [1/2]

```
Storage::Storage (
    void )
```

Constructor (dummy) for the [Storage](#) class.

```
151 {
152     return;
153 } /* Storage() */
```

4.22.2.2 Storage() [2/2]

```
Storage::Storage (
    int n_points,
    double n_years,
    StorageInputs storage_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>storage_inputs</i>	A structure of Storage constructor inputs.

```
182 {
183     // 1. check inputs
184     this->__checkInputs(n_points, n_years, storage_inputs);
185
186     // 2. set attributes
187     this->print_flag = storage_inputs.print_flag;
188     this->is_depleted = false;
189     this->is_sunk = storage_inputs.is_sunk;
190
191     this->n_points = n_points;
192     this->n_replacements = 0;
193
194     this->n_years = n_years;
195
196     this->power_capacity_kW = storage_inputs.power_capacity_kW;
197     this->energy_capacity_kWh = storage_inputs.energy_capacity_kWh;
198
199     this->charge_kWh = 0;
200     this->power_kW = 0;
201
202     this->nominal_inflation_annual = storage_inputs.nominal_inflation_annual;
203     this->nominal_discount_annual = storage_inputs.nominal_discount_annual;
204
205     this->real_discount_annual = this->__computeRealDiscountAnnual(
206         storage_inputs.nominal_inflation_annual,
```

```

207     storage_inputs.nominal_discount_annual
208 );
209
210 this->capital_cost = 0;
211 this->operation_maintenance_cost_kWh = 0;
212 this->net_present_cost = 0;
213 this->total_discharge_kWh = 0;
214 this->levellized_cost_of_energy_kWh = 0;
215
216 this->charge_vec_kWh.resize(this->n_points, 0);
217 this->charging_power_vec_kW.resize(this->n_points, 0);
218 this->discharging_power_vec_kW.resize(this->n_points, 0);
219
220 this->capital_cost_vec.resize(this->n_points, 0);
221 this->operation_maintenance_cost_vec.resize(this->n_points, 0);
222
223 // 3. construction print
224 if (this->print_flag) {
225     std::cout << "Storage object constructed at " << this << std::endl;
226 }
227
228 return;
229 } /* Storage() */

```

4.22.2.3 ~Storage()

```

Storage::~Storage (
    void ) [virtual]

```

Destructor for the [Storage](#) class.

```

408 {
409     // 1. destruction print
410     if (this->print_flag) {
411         std::cout << "Storage object at " << this << " destroyed" << std::endl;
412     }
413
414     return;
415 } /* ~Storage() */

```

4.22.3 Member Function Documentation

4.22.3.1 __checkInputs()

```

void Storage::__checkInputs (
    int n_points,
    double n_years,
    StorageInputs storage_inputs ) [private]

```

Helper method to check inputs to the [Storage](#) constructor.

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>storage_inputs</i>	A structure of Storage constructor inputs.

```

45 {
46     // 1. check n_points
47     if (n_points <= 0) {
48         std::string error_str = "ERROR: Storage(): n_points must be > 0";

```

```

49
50     #ifdef _WIN32
51         std::cout << error_str << std::endl;
52     #endif
53
54     throw std::invalid_argument(error_str);
55 }
56
57 // 2. check n_years
58 if (n_years <= 0) {
59     std::string error_str = "ERROR: Storage(): n_years must be > 0";
60
61     #ifdef _WIN32
62         std::cout << error_str << std::endl;
63     #endif
64
65     throw std::invalid_argument(error_str);
66 }
67
68 // 3. check power_capacity_kW
69 if (storage_inputs.power_capacity_kW <= 0) {
70     std::string error_str = "ERROR: Storage(): ";
71     error_str += "StorageInputs::power_capacity_kW must be > 0";
72
73     #ifdef _WIN32
74         std::cout << error_str << std::endl;
75     #endif
76
77     throw std::invalid_argument(error_str);
78 }
79
80 // 4. check energy_capacity_kWh
81 if (storage_inputs.energy_capacity_kWh <= 0) {
82     std::string error_str = "ERROR: Storage(): ";
83     error_str += "StorageInputs::energy_capacity_kWh must be > 0";
84
85     #ifdef _WIN32
86         std::cout << error_str << std::endl;
87     #endif
88
89     throw std::invalid_argument(error_str);
90 }
91
92 return;
93 } /* __checkInputs() */

```

4.22.3.2 __computeRealDiscountAnnual()

```

double Storage::__computeRealDiscountAnnual (
    double nominal_inflation_annual,
    double nominal_discount_annual ) [private]

```

Helper method to compute the real, annual discount rate to be used in computing model economics. This enables application of the discount factor approach.

Ref: [HOMER \[2023h\]](#)

Ref: [HOMER \[2023b\]](#)

Parameters

<i>nominal_inflation_annual</i>	The nominal, annual inflation rate to use in computing model economics.
<i>nominal_discount_annual</i>	The nominal, annual discount rate to use in computing model economics.

Returns

The real, annual discount rate to use in computing model economics.

```
127 {  
128     double real_discount_annual = nominal_discount_annual - nominal_inflation_annual;  
129     real_discount_annual /= 1 + nominal_inflation_annual;  
130  
131     return real_discount_annual;  
132 } /* __computeRealDiscountAnnual() */
```

4.22.3.3 __writeSummary()

```
virtual void Storage::__writeSummary (  
    std::string ) [inline], [private], [virtual]
```

Reimplemented in [Lilon](#).

```
79 {return;}
```

4.22.3.4 __writeTimeSeries()

```
virtual void Storage::__writeTimeSeries (  
    std::string ,  
    std::vector< double > * ,  
    int = -1 ) [inline], [private], [virtual]
```

Reimplemented in [Lilon](#).

```
80 {return;}
```

4.22.3.5 commitCharge()

```
virtual void Storage::commitCharge (  
    int ,  
    double ,  
    double ) [inline], [virtual]
```

Reimplemented in [Lilon](#).

```
134 {return;}
```

4.22.3.6 commitDischarge()

```
virtual double Storage::commitDischarge (  
    int ,  
    double ,  
    double ,  
    double ) [inline], [virtual]
```

Reimplemented in [Lilon](#).

```
135 {return 0;}
```

4.22.3.7 computeEconomics()

```
void Storage::computeEconomics (
    std::vector< double > * time_vec_hrs_ptr )
```

Helper method to compute key economic metrics for the [Model](#) run.

Ref: [HOMER \[2023b\]](#)

Ref: [HOMER \[2023g\]](#)

Ref: [HOMER \[2023i\]](#)

Ref: [HOMER \[2023a\]](#)

Parameters

<i>time_vec_hrs_ptr</i>	A pointer to the <code>time_vec_hrs</code> attribute of the ElectricalLoad .
-------------------------	--

1. compute levellized cost of energy (per unit discharged)

```
282 {
283     // 1. compute net present cost
284     double t_hrs = 0;
285     double real_discount_scalar = 0;
286
287     for (int i = 0; i < this->n_points; i++) {
288         t_hrs = time_vec_hrs_ptr->at(i);
289
290         real_discount_scalar = 1.0 / pow(
291             1 + this->real_discount_annual,
292             t_hrs / 8760
293         );
294
295         this->net_present_cost += real_discount_scalar * this->capital_cost_vec[i];
296
297         this->net_present_cost +=
298             real_discount_scalar * this->operation_maintenance_cost_vec[i];
299     }
300
301     // assuming 8,760 hours per year
302     double n_years = time_vec_hrs_ptr->at(this->n_points - 1) / 8760;
303
304     double capital_recovery_factor =
305         (this->real_discount_annual * pow(1 + this->real_discount_annual, n_years)) /
306         (pow(1 + this->real_discount_annual, n_years) - 1);
307
308     double total_annualized_cost = capital_recovery_factor *
309         this->net_present_cost;
310
311     this->levellized_cost_of_energy_kWh =
312         (n_years * total_annualized_cost) /
313         this->total_discharge_kWh;
314
315     return;
316 } /* computeEconomics() */
```

4.22.3.8 getAcceptablekW()

```
virtual double Storage::getAcceptablekW (
    double ) [inline], [virtual]
```

Reimplemented in [Lilon](#).

```
132 {return 0;}
```

4.22.3.9 getAvailablekW()

```
virtual double Storage::getAvailablekW (
    double ) [inline], [virtual]
```

Reimplemented in [Lilon](#).

```
131 {return 0;}
```

4.22.3.10 handleReplacement()

```
void Storage::handleReplacement (
    int timestep ) [virtual]
```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented in [Lilon](#).

```
247 {
248     // 1. reset attributes
249     this->charge_kWh = 0;
250     this->power_kW = 0;
251
252     // 2. log replacement
253     this->n_replacements++;
254
255     // 3. incur capital cost in timestep
256     this->capital_cost_vec[timestep] = this->capital_cost;
257
258     return;
259 } /* __handleReplacement() */
```

4.22.3.11 writeResults()

```
void Storage::writeResults (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    int storage_index,
    int max_lines = -1 )
```

Method which writes [Storage](#) results to an output directory.

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <i>time_vec_hrs</i> attribute of the ElectricalLoad .
<i>storage_index</i>	An integer which corresponds to the index of the Storage asset in the Model .
<i>max_lines</i>	The maximum number of lines of output to write. If <0, then all available lines are written. If =0, then only summary results are written.

```

354 {
355     // 1. handle sentinel
356     if (max_lines < 0) {
357         max_lines = this->n_points;
358     }
359
360     // 2. create subdirectories
361     write_path += "Storage/";
362     if (not std::filesystem::is_directory(write_path)) {
363         std::filesystem::create_directory(write_path);
364     }
365
366     write_path += this->type_str;
367     write_path += "_";
368     write_path += std::to_string(int(ceil(this->power_capacity_kW)));
369     write_path += "kW";
370     write_path += std::to_string(int(ceil(this->energy_capacity_kWh)));
371     write_path += "kWh_idx";
372     write_path += std::to_string(storage_index);
373     write_path += "/";
374     std::filesystem::create_directory(write_path);
375
376     // 3. write summary
377     this->__writeSummary(write_path);
378
379     // 4. write time series
380     if (max_lines > this->n_points) {
381         max_lines = this->n_points;
382     }
383
384     if (max_lines > 0) {
385         this->__writeTimeSeries(
386             write_path,
387             time_vec_hrs_ptr,
388             max_lines
389         );
390     }
391
392     return;
393 } /* writeResults() */

```

4.22.4 Member Data Documentation

4.22.4.1 capital_cost

double Storage::capital_cost

The capital cost of the asset (undefined currency).

4.22.4.2 capital_cost_vec

std::vector<double> Storage::capital_cost_vec

A vector of capital costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).

4.22.4.3 charge_kWh

```
double Storage::charge_kWh
```

The energy [kWh] stored in the asset.

4.22.4.4 charge_vec_kWh

```
std::vector<double> Storage::charge_vec_kWh
```

A vector of the charge state [kWh] at each point in the modelling time series.

4.22.4.5 charging_power_vec_kW

```
std::vector<double> Storage::charging_power_vec_kW
```

A vector of the charging power [kW] at each point in the modelling time series.

4.22.4.6 discharging_power_vec_kW

```
std::vector<double> Storage::discharging_power_vec_kW
```

A vector of the discharging power [kW] at each point in the modelling time series.

4.22.4.7 energy_capacity_kWh

```
double Storage::energy_capacity_kWh
```

The rated energy capacity [kWh] of the asset.

4.22.4.8 interpolator

```
Interpolator Storage::interpolator
```

[Interpolator](#) component of [Storage](#).

4.22.4.9 is_depleted

```
bool Storage::is_depleted
```

A boolean which indicates whether or not the asset is currently considered depleted.

4.22.4.10 is_sunk

```
bool Storage::is_sunk
```

A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).

4.22.4.11 levellized_cost_of_energy_kWh

```
double Storage::levellized_cost_of_energy_kWh
```

The levellized cost of energy [1/kWh] (undefined currency) of this asset. This metric considers only discharge.

4.22.4.12 n_points

```
int Storage::n_points
```

The number of points in the modelling time series.

4.22.4.13 n_replacements

```
int Storage::n_replacements
```

The number of times the asset has been replaced.

4.22.4.14 n_years

```
double Storage::n_years
```

The number of years being modelled.

4.22.4.15 net_present_cost

```
double Storage::net_present_cost
```

The net present cost of this asset.

4.22.4.16 nominal_discount_annual

```
double Storage::nominal_discount_annual
```

The nominal, annual discount rate to use in computing model economics.

4.22.4.17 nominal_inflation_annual

```
double Storage::nominal_inflation_annual
```

The nominal, annual inflation rate to use in computing model economics.

4.22.4.18 operation_maintenance_cost_kWh

```
double Storage::operation_maintenance_cost_kWh
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy charged/discharged.

4.22.4.19 operation_maintenance_cost_vec

```
std::vector<double> Storage::operation_maintenance_cost_vec
```

A vector of operation and maintenance costs (undefined currency) incurred over each modelling time step. These costs are not discounted (i.e., these are actual costs).

4.22.4.20 power_capacity_kW

```
double Storage::power_capacity_kW
```

The rated power capacity [kW] of the asset.

4.22.4.21 power_kW

```
double Storage::power_kW
```

The power [kW] currently being charged/discharged by the asset.

4.22.4.22 print_flag

```
bool Storage::print_flag
```

A flag which indicates whether or not object construct/destruction should be verbose.

4.22.4.23 real_discount_annual

```
double Storage::real_discount_annual
```

The real, annual discount rate used in computing model economics. Is computed from the given nominal inflation and discount rates.

4.22.4.24 total_discharge_kWh

```
double Storage::total_discharge_kWh
```

The total energy discharged [kWh] over the [Model](#) run.

4.22.4.25 type

```
StorageType Storage::type
```

The type (StorageType) of the asset.

4.22.4.26 type_str

```
std::string Storage::type_str
```

A string describing the type of the asset.

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

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

4.23 StorageInputs Struct Reference

A structure which bundles the necessary inputs for the [Storage](#) constructor. Provides default values for every necessary input.

```
#include <Storage.h>
```

Public Attributes

- bool [print_flag](#) = false
A flag which indicates whether or not object construct/destruction should be verbose.
- bool [is_sunk](#) = false
A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).
- double [power_capacity_kW](#) = 100
The rated power capacity [kW] of the asset.
- double [energy_capacity_kWh](#) = 1000
The rated energy capacity [kWh] of the asset.
- double [nominal_inflation_annual](#) = 0.02
The nominal, annual inflation rate to use in computing model economics.
- double [nominal_discount_annual](#) = 0.04
The nominal, annual discount rate to use in computing model economics.

4.23.1 Detailed Description

A structure which bundles the necessary inputs for the [Storage](#) constructor. Provides default values for every necessary input.

4.23.2 Member Data Documentation

4.23.2.1 [energy_capacity_kWh](#)

```
double StorageInputs::energy_capacity_kWh = 1000
```

The rated energy capacity [kWh] of the asset.

4.23.2.2 [is_sunk](#)

```
bool StorageInputs::is_sunk = false
```

A boolean which indicates whether or not the asset should be considered a sunk cost (i.e., capital cost incurred at the start of the model, or no).

4.23.2.3 nominal_discount_annual

```
double StorageInputs::nominal_discount_annual = 0.04
```

The nominal, annual discount rate to use in computing model economics.

4.23.2.4 nominal_inflation_annual

```
double StorageInputs::nominal_inflation_annual = 0.02
```

The nominal, annual inflation rate to use in computing model economics.

4.23.2.5 power_capacity_kW

```
double StorageInputs::power_capacity_kW = 100
```

The rated power capacity [kW] of the asset.

4.23.2.6 print_flag

```
bool StorageInputs::print_flag = false
```

A flag which indicates whether or not object construct/destruction should be verbose.

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

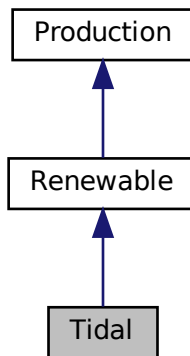
- header/Storage/[Storage.h](#)

4.24 Tidal Class Reference

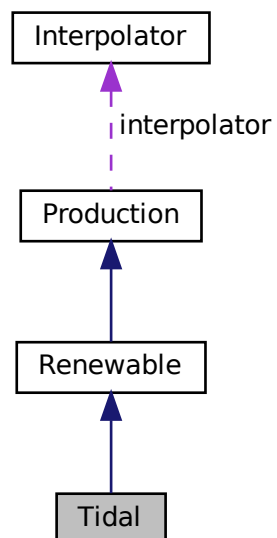
A derived class of the [Renewable](#) branch of [Production](#) which models tidal production.

```
#include <Tidal.h>
```

Inheritance diagram for Tidal:



Collaboration diagram for Tidal:



Public Member Functions

- [Tidal](#) (void)
Constructor (dummy) for the [Tidal](#) class.
- [Tidal](#) (int, double, [TidalInputs](#))
Constructor (intended) for the [Tidal](#) class.
- void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- double [computeProductionkW](#) (int, double, double)
Method which takes in the tidal resource at a particular point in time, and then returns the tidal turbine production at that point in time.
- double [commit](#) (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- [~Tidal](#) (void)
Destructor for the [Tidal](#) class.

Public Attributes

- double [design_speed_ms](#)
The tidal stream speed [m/s] at which the tidal turbine achieves its rated capacity.
- [TidalPowerProductionModel](#) [power_model](#)
The tidal power production model to be applied.
- std::string [power_model_string](#)
A string describing the active power production model.

Private Member Functions

- void [__checkInputs](#) ([TidalInputs](#))
Helper method to check inputs to the [Tidal](#) constructor.
- double [__getGenericCapitalCost](#) (void)
Helper method to generate a generic tidal turbine capital cost.
- double [__getGenericOpMaintCost](#) (void)
Helper method to generate a generic tidal turbine operation and maintenance cost. This is a cost incurred per unit energy produced.
- double [__computeCubicProductionkW](#) (int, double, double)
Helper method to compute tidal turbine production under a cubic production model.
- double [__computeExponentialProductionkW](#) (int, double, double)
Helper method to compute tidal turbine production under an exponential production model.
- double [__computeLookupProductionkW](#) (int, double, double)
Helper method to compute tidal turbine production by way of looking up using given power curve data.
- void [__writeSummary](#) (std::string)
Helper method to write summary results for [Tidal](#).
- void [__writeTimeSeries](#) (std::string, std::vector< double > *, std::map< int, std::vector< double >> *, std::vector< double > *, std::vector< double >> *, int=-1)
Helper method to write time series results for [Tidal](#).

4.24.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models tidal production.

4.24.2 Constructor & Destructor Documentation

4.24.2.1 Tidal() [1/2]

```
Tidal::Tidal (
    void )
```

Constructor (dummy) for the [Tidal](#) class.

```
427 {
428     return;
429 } /* Tidal() */
```

4.24.2.2 Tidal() [2/2]

```
Tidal::Tidal (
    int n_points,
    double n_years,
    TidalInputs tidal_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>tidal_inputs</i>	A structure of Tidal constructor inputs.

```
457 :
458 Renewable(
459     n_points,
460     n_years,
461     tidal_inputs.renewable_inputs
462 )
463 {
464     // 1. check inputs
465     this->__checkInputs(tidal_inputs);
466
467     // 2. set attributes
468     this->type = RenewableType :: TIDAL;
469     this->type_str = "TIDAL";
470
471     this->resource_key = tidal_inputs.resource_key;
472
473     this->design_speed_ms = tidal_inputs.design_speed_ms;
474
475     this->power_model = tidal_inputs.power_model;
476
477     switch (this->power_model) {
478         case (TidalPowerProductionModel :: TIDAL_POWER_CUBIC): {
479             this->power_model_string = "CUBIC";
480             break;
481         }
482
483         case (TidalPowerProductionModel :: TIDAL_POWER_EXPONENTIAL): {
484             this->power_model_string = "EXPONENTIAL";
485             break;
486         }
487
488         case (TidalPowerProductionModel :: TIDAL_POWER_LOOKUP): {
```

```

491         this->power_model_string = "LOOKUP";
492
493         break;
494     }
495
496     default: {
497         std::string error_str = "ERROR: Tidal(): ";
498         error_str += "power production model ";
499         error_str += std::to_string(this->power_model);
500         error_str += " not recognized";
501
502         #ifdef _WIN32
503             std::cout << error_str << std::endl;
504         #endif
505
506         throw std::runtime_error(error_str);
507
508         break;
509     }
510 }
511
512 if (tidal_inputs.capital_cost < 0) {
513     this->capital_cost = this->__getGenericCapitalCost();
514 }
515
516 if (tidal_inputs.operation_maintenance_cost_kWh < 0) {
517     this->operation_maintenance_cost_kWh = this->__getGenericOpMaintCost();
518 }
519
520 if (not this->is_sunk) {
521     this->capital_cost_vec[0] = this->capital_cost;
522 }
523
524 // 3. construction print
525 if (this->print_flag) {
526     std::cout << "Tidal object constructed at " << this << std::endl;
527 }
528
529 return;
530 } /* Renewable() */

```

4.24.2.3 ~Tidal()

```

Tidal::~Tidal (
    void )

```

Destructor for the `Tidal` class.

```

710 {
711     // 1. destruction print
712     if (this->print_flag) {
713         std::cout << "Tidal object at " << this << " destroyed" << std::endl;
714     }
715
716     return;
717 } /* ~Tidal() */

```

4.24.3 Member Function Documentation

4.24.3.1 __checkInputs()

```

void Tidal::__checkInputs (
    TidalInputs tidal_inputs ) [private]

```

Helper method to check inputs to the `Tidal` constructor.

```

37 {

```

```

38 // 1. check design_speed_ms
39 if (tidal_inputs.design_speed_ms <= 0) {
40     std::string error_str = "ERROR: Tidal(): ";
41     error_str += "TidalInputs::design_speed_ms must be > 0";
42
43     #ifdef _WIN32
44         std::cout << error_str << std::endl;
45     #endif
46
47     throw std::invalid_argument(error_str);
48 }
49
50 return;
51 } /* __checkInputs() */

```

4.24.3.2 __computeCubicProductionkW()

```

double Tidal::__computeCubicProductionkW (
    int timestep,
    double dt_hrs,
    double tidal_resource_ms ) [private]

```

Helper method to compute tidal turbine production under a cubic production model.

Ref: [Buckham et al. \[2023\]](#)

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>tidal_resource_ms</i>	The available tidal stream resource [m/s].

Returns

The production [kW] of the tidal turbine, under a cubic model.

```

138 {
139     double production = 0;
140
141     if (
142         tidal_resource_ms < 0.15 * this->design_speed_ms or
143         tidal_resource_ms > 1.25 * this->design_speed_ms
144     ){
145         production = 0;
146     }
147
148     else if (
149         0.15 * this->design_speed_ms <= tidal_resource_ms and
150         tidal_resource_ms <= this->design_speed_ms
151     ) {
152         production =
153             (1 / pow(this->design_speed_ms, 3)) * pow(tidal_resource_ms, 3);
154     }
155
156     else {
157         production = 1;
158     }
159
160     return production * this->capacity_kW;
161 } /* __computeCubicProductionkW() */

```

4.24.3.3 `__computeExponentialProductionkW()`

```
double Tidal::__computeExponentialProductionkW (
    int timestep,
    double dt_hrs,
    double tidal_resource_ms ) [private]
```

Helper method to compute tidal turbine production under an exponential production model.

Ref: [Truelove et al. \[2019\]](#)

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>tidal_resource_ms</i>	The available tidal stream resource [m/s].

Returns

The production [kW] of the tidal turbine, under an exponential model.

```
195 {
196     double production = 0;
197
198     double turbine_speed =
199         (tidal_resource_ms - this->design_speed_ms) / this->design_speed_ms;
200
201     if (turbine_speed < -0.71 or turbine_speed > 0.65) {
202         production = 0;
203     }
204
205     else if (turbine_speed >= -0.71 and turbine_speed <= 0) {
206         production = 1.69215 * exp(1.25909 * turbine_speed) - 0.69215;
207     }
208
209     else {
210         production = 1;
211     }
212
213     return production * this->capacity_kW;
214 } /* __computeExponentialProductionkW() */
```

4.24.3.4 `__computeLookupProductionkW()`

```
double Tidal::__computeLookupProductionkW (
    int timestep,
    double dt_hrs,
    double tidal_resource_ms ) [private]
```

Helper method to compute tidal turbine production by way of looking up using given power curve data.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>tidal_resource_ms</i>	The available tidal stream resource [m/s].

Returns

The interpolated production [kW] of the tidal tubrine.

```

246 {
247     // *** WORK IN PROGRESS *** //
248
249     return 0;
250 } /* __computeLookupProductionkW() */

```

4.24.3.5 __getGenericCapitalCost()

```

double Tidal::__getGenericCapitalCost (
    void ) [private]

```

Helper method to generate a generic tidal turbine capital cost.

Note that this model expresses cost in terms of Canadian dollars [CAD].

Ref: [MacDougall \[2019\]](#)

Returns

A generic capital cost for the tidal turbine [CAD].

```

73 {
74     double capital_cost_per_kW = 2000 * pow(this->capacity_kW, -0.15) + 4000;
75
76     return capital_cost_per_kW * this->capacity_kW;
77 } /* __getGenericCapitalCost() */

```

4.24.3.6 __getGenericOpMaintCost()

```

double Tidal::__getGenericOpMaintCost (
    void ) [private]

```

Helper method to generate a generic tidal turbine operation and maintenance cost. This is a cost incurred per unit energy produced.

Note that this model expresses cost in terms of Canadian dollars [CAD/kWh].

Ref: [MacDougall \[2019\]](#)

Returns

A generic operation and maintenance cost, per unit energy produced, for the tidal turbine [CAD/kWh].

```

100 {
101     double operation_maintenance_cost_kWh = 0.05 * pow(this->capacity_kW, -0.2) + 0.05;
102
103     return operation_maintenance_cost_kWh;
104 } /* __getGenericOpMaintCost() */

```

4.24.3.7 __writeSummary()

```

void Tidal::__writeSummary (
    std::string write_path ) [private], [virtual]

```

Helper method to write summary results for [Tidal](#).

Parameters

<code>write_path</code>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
-------------------------	--

Reimplemented from [Renewable](#).

```

268 {
269     // 1. create filestream
270     write_path += "summary_results.md";
271     std::ofstream ofs;
272     ofs.open(write_path, std::ofstream::out);
273
274     // 2. write summary results (markdown)
275     ofs << "# ";
276     ofs << std::to_string(int(ceil(this->capacity_kW)));
277     ofs << " kW TIDAL Summary Results\n";
278     ofs << "\n-----\n\n";
279
280     // 2.1. Production attributes
281     ofs << "## Production Attributes\n";
282     ofs << "\n";
283
284     ofs << "Capacity: " << this->capacity_kW << "kW \n";
285     ofs << "\n";
286
287     ofs << "Sunk Cost (N = 0 / Y = 1): " << this->is_sunk << " \n";
288     ofs << "Capital Cost: " << this->capital_cost << " \n";
289     ofs << "Operation and Maintenance Cost: " << this->operation_maintenance_cost_kWh
290         << " per kWh produced \n";
291     ofs << "Nominal Inflation Rate (annual): " << this->nominal_inflation_annual
292         << " \n";
293     ofs << "Nominal Discount Rate (annual): " << this->nominal_discount_annual
294         << " \n";
295     ofs << "Real Discount Rate (annual): " << this->real_discount_annual << " \n";
296     ofs << "\n";
297
298     ofs << "Replacement Running Hours: " << this->replace_running_hrs << " \n";
299     ofs << "\n-----\n\n";
300
301     // 2.2. Renewable attributes
302     ofs << "## Renewable Attributes\n";
303     ofs << "\n";
304
305     ofs << "Resource Key (ID): " << this->resource_key << " \n";
306
307     ofs << "\n-----\n\n";
308
309     // 2.3. Tidal attributes
310     ofs << "## Tidal Attributes\n";
311     ofs << "\n";
312
313     ofs << "Power Production Model: " << this->power_model_string << " \n";
314     ofs << "Design Speed: " << this->design_speed_ms << " m/s \n";
315
316     ofs << "\n-----\n\n";
317
318     // 2.4. Tidal Results
319     ofs << "## Results\n";
320     ofs << "\n";
321
322     ofs << "Net Present Cost: " << this->net_present_cost << " \n";
323     ofs << "\n";
324
325     ofs << "Total Dispatch: " << this->total_dispatch_kWh
326         << " kWh \n";
327
328     ofs << "Levellized Cost of Energy: " << this->levellized_cost_of_energy_kWh
329         << " per kWh dispatched \n";
330     ofs << "\n";
331
332     ofs << "Running Hours: " << this->running_hours << " \n";
333     ofs << "Replacements: " << this->n_replacements << " \n";
334
335     ofs << "\n-----\n\n";
336
337     ofs.close();
338
339     return;
340 } /* __writeSummary() */

```

4.24.3.8 `__writeTimeSeries()`

```
void Tidal::__writeTimeSeries (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    std::map< int, std::vector< double >> * resource_map_1D_ptr,
    std::map< int, std::vector< std::vector< double >>> * resource_map_2D_ptr,
    int max_lines = -1 ) [private], [virtual]
```

Helper method to write time series results for [Tidal](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <code>time_vec_hrs</code> attribute of the ElectricalLoad .
<i>resource_map_1D_ptr</i>	A pointer to the 1D map of Resources .
<i>resource_map_2D_ptr</i>	A pointer to the 2D map of Resources .
<i>max_lines</i>	The maximum number of lines of output to write.

Reimplemented from [Renewable](#).

```
378 {
379     // 1. create filestream
380     write_path += "time_series_results.csv";
381     std::ofstream ofs;
382     ofs.open(write_path, std::ofstream::out);
383
384     // 2. write time series results (comma separated value)
385     ofs << "Time (since start of data) [hrs],";
386     ofs << "Tidal Resource [m/s],";
387     ofs << "Production [kW],";
388     ofs << "Dispatch [kW],";
389     ofs << "Storage [kW],";
390     ofs << "Curtailment [kW],";
391     ofs << "Capital Cost (actual),";
392     ofs << "Operation and Maintenance Cost (actual),";
393     ofs << "\n";
394
395     for (int i = 0; i < max_lines; i++) {
396         ofs << time_vec_hrs_ptr->at(i) << ",";
397         ofs << resource_map_1D_ptr->at(this->resource_key)[i] << ",";
398         ofs << this->production_vec_kW[i] << ",";
399         ofs << this->dispatch_vec_kW[i] << ",";
400         ofs << this->storage_vec_kW[i] << ",";
401         ofs << this->curtailment_vec_kW[i] << ",";
402         ofs << this->capital_cost_vec[i] << ",";
403         ofs << this->operation_maintenance_cost_vec[i] << ",";
404         ofs << "\n";
405     }
406
407     return;
408 } /* __writeTimeSeries() */
```

4.24.3.9 `commit()`

```
double Tidal::commit (
    int timestep,
    double dt_hrs,
    double production_kW,
    double load_kW ) [virtual]
```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented from [Renewable](#).

```

682 {
683     // 1. invoke base class method
684     load_kW = Renewable::commit(
685         timestep,
686         dt_hrs,
687         production_kW,
688         load_kW
689     );
690
691
692     //...
693
694     return load_kW;
695 } /* commit() */

```

4.24.3.10 computeProductionkW()

```

double Tidal::computeProductionkW (
    int timestep,
    double dt_hrs,
    double tidal_resource_ms ) [virtual]

```

Method which takes in the tidal resource at a particular point in time, and then returns the tidal turbine production at that point in time.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>tidal_resource_ms</i>	Tidal resource (i.e. tidal stream speed) [m/s].

Returns

The production [kW] of the tidal turbine.

Reimplemented from [Renewable](#).

```

588 {
589     // check if no resource
590     if (tidal_resource_ms <= 0) {
591         return 0;
592     }
593
594     // compute production
595     double production_kW = 0;

```



```

596
597     switch (this->power_model) {
598         case (TidalPowerProductionModel :: TIDAL_POWER_CUBIC): {
599             production_kW = this->__computeCubicProductionkW(
600                 timestep,
601                 dt_hrs,
602                 tidal_resource_ms
603             );
604
605             break;
606         }
607
608         case (TidalPowerProductionModel :: TIDAL_POWER_EXPONENTIAL): {
609             production_kW = this->__computeExponentialProductionkW(
610                 timestep,
611                 dt_hrs,
612                 tidal_resource_ms
613             );
614
615             break;
616         }
617
618         case (TidalPowerProductionModel :: TIDAL_POWER_LOOKUP): {
619             production_kW = this->__computeLookupProductionkW(
620                 timestep,
621                 dt_hrs,
622                 tidal_resource_ms
623             );
624
625             break;
626         }
627
628         default: {
629             std::string error_str = "ERROR: Tidal::computeProductionkW(): ";
630             error_str += "power model ";
631             error_str += std::to_string(this->power_model);
632             error_str += " not recognized";
633
634             #ifdef _WIN32
635                 std::cout << error_str << std::endl;
636             #endif
637
638             throw std::runtime_error(error_str);
639
640             break;
641         }
642     }
643 }
644
645 return production_kW;
646 } /* computeProductionkW() */

```

4.24.3.11 handleReplacement()

```

void Tidal::handleReplacement (
    int timestep ) [virtual]

```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Renewable](#).

```

548 {
549     // 1. reset attributes
550     //...
551
552     // 2. invoke base class method
553     Renewable :: handleReplacement(timestep);
554
555     return;
556 } /* __handleReplacement() */

```

4.24.4 Member Data Documentation

4.24.4.1 design_speed_ms

```
double Tidal::design_speed_ms
```

The tidal stream speed [m/s] at which the tidal turbine achieves its rated capacity.

4.24.4.2 power_model

```
TidalPowerProductionModel Tidal::power_model
```

The tidal power production model to be applied.

4.24.4.3 power_model_string

```
std::string Tidal::power_model_string
```

A string describing the active power production model.

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

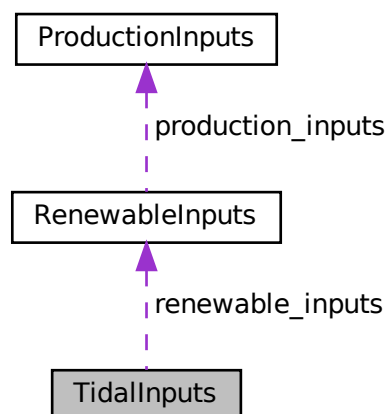
- [header/Production/Renewable/Tidal.h](#)
- [source/Production/Renewable/Tidal.cpp](#)

4.25 TidalInputs Struct Reference

A structure which bundles the necessary inputs for the [Tidal](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

```
#include <Tidal.h>
```

Collaboration diagram for TidalInputs:



Public Attributes

- [RenewableInputs renewable_inputs](#)
An encapsulated [RenewableInputs](#) instance.
- int [resource_key](#) = 0
A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.
- double [capital_cost](#) = -1
The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].
- double [operation_maintenance_cost_kWh](#) = -1
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].
- double [design_speed_ms](#) = 3
The tidal stream speed [m/s] at which the tidal turbine achieves its rated capacity.
- [TidalPowerProductionModel power_model](#) = [TidalPowerProductionModel](#) :: [TIDAL_POWER_CUBIC](#)
The tidal power production model to be applied.

4.25.1 Detailed Description

A structure which bundles the necessary inputs for the [Tidal](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

4.25.2 Member Data Documentation

4.25.2.1 capital_cost

```
double TidalInputs::capital_cost = -1
```

The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].

4.25.2.2 design_speed_ms

```
double TidalInputs::design_speed_ms = 3
```

The tidal stream speed [m/s] at which the tidal turbine achieves its rated capacity.

4.25.2.3 operation_maintenance_cost_kWh

```
double TidalInputs::operation_maintenance_cost_kWh = -1
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].

4.25.2.4 power_model

```
TidalPowerProductionModel TidalInputs::power_model = TidalPowerProductionModel :: TIDAL_POWER_CUBIC
```

The tidal power production model to be applied.

4.25.2.5 renewable_inputs

```
RenewableInputs TidalInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.25.2.6 resource_key

```
int TidalInputs::resource_key = 0
```

A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.

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

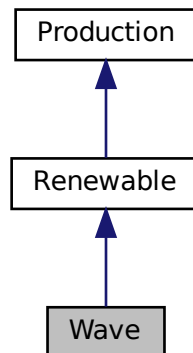
- [header/Production/Renewable/Tidal.h](#)

4.26 Wave Class Reference

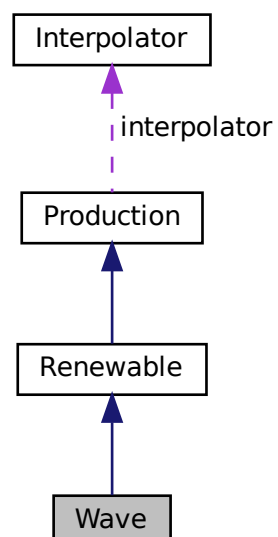
A derived class of the [Renewable](#) branch of [Production](#) which models wave production.

```
#include <Wave.h>
```

Inheritance diagram for Wave:



Collaboration diagram for Wave:



Public Member Functions

- [Wave](#) (void)
Constructor (dummy) for the [Wave](#) class.
- [Wave](#) (int, double, [WaveInputs](#))
Constructor (intended) for the [Wave](#) class.
- void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- double [computeProductionkW](#) (int, double, double, double)
Method which takes in the wave resource at a particular point in time, and then returns the wave turbine production at that point in time.
- double [commit](#) (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- [~Wave](#) (void)
Destructor for the [Wave](#) class.

Public Attributes

- double [design_significant_wave_height_m](#)
The significant wave height [m] at which the wave energy converter achieves its rated capacity.
- double [design_energy_period_s](#)
The energy period [s] at which the wave energy converter achieves its rated capacity.
- [WavePowerProductionModel](#) [power_model](#)
The wave power production model to be applied.
- std::string [power_model_string](#)
A string describing the active power production model.

Private Member Functions

- void [__checkInputs](#) ([WaveInputs](#))
Helper method to check inputs to the [Wave](#) constructor.
- double [__getGenericCapitalCost](#) (void)
Helper method to generate a generic wave energy converter capital cost.
- double [__getGenericOpMaintCost](#) (void)
Helper method to generate a generic wave energy converter operation and maintenance cost. This is a cost incurred per unit energy produced.
- double [__computeGaussianProductionkW](#) (int, double, double, double)
Helper method to compute wave energy converter production under a Gaussian production model.
- double [__computeParaboloidProductionkW](#) (int, double, double, double)
Helper method to compute wave energy converter production under a paraboloid production model.
- double [__computeLookupProductionkW](#) (int, double, double, double)
Helper method to compute wave energy converter production by way of looking up using given performance matrix.
- void [__writeSummary](#) (std::string)
Helper method to write summary results for [Wave](#).
- void [__writeTimeSeries](#) (std::string, std::vector< double > *, std::map< int, std::vector< double >> *, std::map< int, std::vector< std::vector< double >>> *, int=-1)
Helper method to write time series results for [Wave](#).

4.26.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models wave production.

4.26.2 Constructor & Destructor Documentation

4.26.2.1 Wave() [1/2]

```
Wave::Wave (
    void )
```

Constructor (dummy) for the [Wave](#) class.

```
480 {
481     return;
482 } /* Wave() */
```

4.26.2.2 Wave() [2/2]

```
Wave::Wave (
    int n_points,
    double n_years,
    WaveInputs wave_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>wave_inputs</i>	A structure of Wave constructor inputs.

```
510 :
511 Renewable(
512     n_points,
513     n_years,
514     wave_inputs.renewable_inputs
515 )
516 {
517     // 1. check inputs
518     this->__checkInputs(wave_inputs);
519
520     // 2. set attributes
521     this->type = RenewableType :: WAVE;
522     this->type_str = "WAVE";
523
524     this->resource_key = wave_inputs.resource_key;
525
526     this->design_significant_wave_height_m =
527         wave_inputs.design_significant_wave_height_m;
528     this->design_energy_period_s = wave_inputs.design_energy_period_s;
529
530     this->power_model = wave_inputs.power_model;
531
532     switch (this->power_model) {
533         case (WavePowerProductionModel :: WAVE_POWER_GAUSSIAN): {
534             this->power_model_string = "GAUSSIAN";
```

```

535
536         break;
537     }
538
539     case (WavePowerProductionModel :: WAVE_POWER_PARABOLOID): {
540         this->power_model_string = "PARABOLOID";
541
542         break;
543     }
544
545     case (WavePowerProductionModel :: WAVE_POWER_LOOKUP): {
546         this->power_model_string = "LOOKUP";
547
548         break;
549     }
550
551     default: {
552         std::string error_str = "ERROR: Wave(): ";
553         error_str += "power production model ";
554         error_str += std::to_string(this->power_model);
555         error_str += " not recognized";
556
557         #ifdef _WIN32
558             std::cout << error_str << std::endl;
559         #endif
560
561         throw std::runtime_error(error_str);
562
563         break;
564     }
565 }
566
567 if (wave_inputs.capital_cost < 0) {
568     this->capital_cost = this->__getGenericCapitalCost();
569 }
570
571 if (wave_inputs.operation_maintenance_cost_kWh < 0) {
572     this->operation_maintenance_cost_kWh = this->__getGenericOpMaintCost();
573 }
574
575 if (not this->is_sunk) {
576     this->capital_cost_vec[0] = this->capital_cost;
577 }
578
579 // 3. construction print
580 if (this->print_flag) {
581     std::cout << "Wave object constructed at " << this << std::endl;
582 }
583
584 return;
585 } /* Renewable() */

```

4.26.2.3 ~Wave()

```

Wave::~~Wave (
    void )

```

Destructor for the [Wave](#) class.

```

771 {
772     // 1. destruction print
773     if (this->print_flag) {
774         std::cout << "Wave object at " << this << " destroyed" << std::endl;
775     }
776
777     return;
778 } /* ~Wave() */

```

4.26.3 Member Function Documentation

4.26.3.1 `__checkInputs()`

```
void Wave::__checkInputs (
    WaveInputs wave_inputs ) [private]
```

Helper method to check inputs to the [Wave](#) constructor.

Parameters

<i>wave_inputs</i>	A structure of Wave constructor inputs.
--------------------	---

```
39 {
40     // 1. check design_significant_wave_height_m
41     if (wave_inputs.design_significant_wave_height_m <= 0) {
42         std::string error_str = "ERROR: Wave(): ";
43         error_str += "WaveInputs::design_significant_wave_height_m must be > 0";
44
45         #ifdef _WIN32
46             std::cout << error_str << std::endl;
47         #endif
48
49         throw std::invalid_argument(error_str);
50     }
51
52     // 2. check design_energy_period_s
53     if (wave_inputs.design_energy_period_s <= 0) {
54         std::string error_str = "ERROR: Wave(): ";
55         error_str += "WaveInputs::design_energy_period_s must be > 0";
56
57         #ifdef _WIN32
58             std::cout << error_str << std::endl;
59         #endif
60
61         throw std::invalid_argument(error_str);
62     }
63
64     return;
65 } /* __checkInputs() */
```

4.26.3.2 `__computeGaussianProductionkW()`

```
double Wave::__computeGaussianProductionkW (
    int timestep,
    double dt_hrs,
    double significant_wave_height_m,
    double energy_period_s ) [private]
```

Helper method to compute wave energy converter production under a Gaussian production model.

Ref: [Truelove et al. \[2019\]](#)

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>significant_wave_height_m</i>	The significant wave height [m] in the vicinity of the wave energy converter.
<i>energy_period_s</i>	The energy period [s] in the vicinity of the wave energy converter

Returns

The production [kW] of the wave energy converter, under an exponential model.

```

160 {
161     double H_s_nondim =
162         (significant_wave_height_m - this->design_significant_wave_height_m) /
163         this->design_significant_wave_height_m;
164
165     double T_e_nondim =
166         (energy_period_s - this->design_energy_period_s) /
167         this->design_energy_period_s;
168
169     double production = exp(
170         -2.25119 * pow(T_e_nondim, 2) +
171         3.44570 * T_e_nondim * H_s_nondim -
172         4.01508 * pow(H_s_nondim, 2)
173     );
174
175     return production * this->capacity_kW;
176 } /* __computeGaussianProductionkW() */

```

4.26.3.3 __computeLookupProductionkW()

```

double Wave::__computeLookupProductionkW (
    int timestep,
    double dt_hrs,
    double significant_wave_height_m,
    double energy_period_s ) [private]

```

Helper method to compute wave energy converter production by way of looking up using given performance matrix.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>significant_wave_height_m</i>	The significant wave height [m] in the vicinity of the wave energy converter.
<i>energy_period_s</i>	The energy period [s] in the vicinity of the wave energy converter

Returns

The interpolated production [kW] of the wave energy converter.

```

277 {
278     // *** WORK IN PROGRESS *** //
279
280     return 0;
281 } /* __computeLookupProductionkW() */

```

4.26.3.4 __computeParaboloidProductionkW()

```

double Wave::__computeParaboloidProductionkW (
    int timestep,
    double dt_hrs,
    double significant_wave_height_m,
    double energy_period_s ) [private]

```

Helper method to compute wave energy converter production under a paraboloid production model.

Ref: [Robertson et al. \[2021\]](#)

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>significant_wave_height_m</i>	The significant wave height [m] in the vicinity of the wave energy converter.
<i>energy_period_s</i>	The energy period [s] in the vicinity of the wave energy converter

Returns

The production [kW] of the wave energy converter, under a paraboloid model.

```

217 {
218     // first, check for idealized wave breaking (deep water)
219     if (significant_wave_height_m >= 0.2184 * pow(energy_period_s, 2)) {
220         return 0;
221     }
222
223     // otherwise, apply generic quadratic performance model
224     // (with outputs bounded to [0, 1])
225     double production =
226         0.289 * significant_wave_height_m -
227         0.00111 * pow(significant_wave_height_m, 2) * energy_period_s -
228         0.0169 * energy_period_s;
229
230     if (production < 0) {
231         production = 0;
232     }
233
234     else if (production > 1) {
235         production = 1;
236     }
237
238     return production * this->capacity_kW;
239 } /* __computeParaboloidProductionkW() */

```

4.26.3.5 __getGenericCapitalCost()

```

double Wave::__getGenericCapitalCost (
    void ) [private]

```

Helper method to generate a generic wave energy converter capital cost.

Note that this model expresses cost in terms of Canadian dollars [CAD].

Ref: [MacDougall \[2019\]](#)

Returns

A generic capital cost for the wave energy converter [CAD].

```

87 {
88     double capital_cost_per_kW = 7000 * pow(this->capacity_kW, -0.15) + 5000;
89
90     return capital_cost_per_kW * this->capacity_kW;
91 } /* __getGenericCapitalCost() */

```

4.26.3.6 `__getGenericOpMaintCost()`

```
double Wave::__getGenericOpMaintCost (
    void ) [private]
```

Helper method to generate a generic wave energy converter operation and maintenance cost. This is a cost incurred per unit energy produced.

Note that this model expresses cost in terms of Canadian dollars [CAD/kWh].

Ref: [MacDougall \[2019\]](#)

Returns

A generic operation and maintenance cost, per unit energy produced, for the wave energy converter [CAD/kWh].

```
115 {
116     double operation_maintenance_cost_kWh = 0.05 * pow(this->capacity_kW, -0.2) + 0.05;
117
118     return operation_maintenance_cost_kWh;
119 } /* __getGenericOpMaintCost() */
```

4.26.3.7 `__writeSummary()`

```
void Wave::__writeSummary (
    std::string write_path ) [private], [virtual]
```

Helper method to write summary results for [Wave](#).

Parameters

<code>write_path</code>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
-------------------------	--

Reimplemented from [Renewable](#).

```
299 {
300     // 1. create filestream
301     write_path += "summary_results.md";
302     std::ofstream ofs;
303     ofs.open(write_path, std::ofstream::out);
304
305     // 2. write summary results (markdown)
306     ofs << "# ";
307     ofs << std::to_string(int(ceil(this->capacity_kW)));
308     ofs << " kW WAVE Summary Results\n";
309     ofs << "\n-----\n\n";
310
311     // 2.1. Production attributes
312     ofs << "## Production Attributes\n";
313     ofs << "\n";
314
315     ofs << "Capacity: " << this->capacity_kW << "kW \n";
316     ofs << "\n";
317
318     ofs << "Sunk Cost (N = 0 / Y = 1): " << this->is_sunk << " \n";
319     ofs << "Capital Cost: " << this->capital_cost << " \n";
320     ofs << "Operation and Maintenance Cost: " << this->operation_maintenance_cost_kWh
321         << " per kWh produced \n";
322     ofs << "Nominal Inflation Rate (annual): " << this->nominal_inflation_annual
323         << " \n";
324     ofs << "Nominal Discount Rate (annual): " << this->nominal_discount_annual
```

```

325         « " \n";
326 ofs « "Real Discount Rate (annual): " « this->real_discount_annual « " \n";
327 ofs « "\n";
328
329 ofs « "Replacement Running Hours: " « this->replace_running_hrs « " \n";
330 ofs « "\n-----\n\n";
331
332 // 2.2. Renewable attributes
333 ofs « "## Renewable Attributes\n";
334 ofs « "\n";
335
336 ofs « "Resource Key (2D): " « this->resource_key « " \n";
337
338 ofs « "\n-----\n\n";
339
340 // 2.3. Wave attributes
341 ofs « "## Wave Attributes\n";
342 ofs « "\n";
343
344 ofs « "Power Production Model: " « this->power_model_string « " \n";
345 switch (this->power_model) {
346     case (WavePowerProductionModel :: WAVE_POWER_GAUSSIAN): {
347         ofs « "Design Significant Wave Height: "
348             « this->design_significant_wave_height_m « " m \n";
349
350         ofs « "Design Energy Period: " « this->design_energy_period_s « " s \n";
351
352         break;
353     }
354
355     case (WavePowerProductionModel :: WAVE_POWER_LOOKUP): {
356         //...
357
358         break;
359     }
360
361     default: {
362         // write nothing!
363
364         break;
365     }
366 }
367
368 ofs « "\n-----\n\n";
369
370 // 2.4. Wave Results
371 ofs « "## Results\n";
372 ofs « "\n";
373
374 ofs « "Net Present Cost: " « this->net_present_cost « " \n";
375 ofs « "\n";
376
377 ofs « "Total Dispatch: " « this->total_dispatch_kWh
378     « " kWh \n";
379
380 ofs « "Levellized Cost of Energy: " « this->levellized_cost_of_energy_kWh
381     « " per kWh dispatched \n";
382 ofs « "\n";
383
384 ofs « "Running Hours: " « this->running_hours « " \n";
385 ofs « "Replacements: " « this->n_replacements « " \n";
386
387 ofs « "\n-----\n\n";
388
389 ofs.close();
390
391 return;
392 } /* __writeSummary() */

```

4.26.3.8 __writeTimeSeries()

```

void Wave::__writeTimeSeries (
    std::string write_path,
    std::vector< double > * time_vec_hrs_ptr,
    std::map< int, std::vector< double >> * resource_map_1D_ptr,
    std::map< int, std::vector< std::vector< double >>> * resource_map_2D_ptr,
    int max_lines = -1 ) [private], [virtual]

```

Helper method to write time series results for [Wave](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <i>time_vec_hrs</i> attribute of the ElectricalLoad .
<i>resource_map_1D_ptr</i>	A pointer to the 1D map of Resources .
<i>resource_map_2D_ptr</i>	A pointer to the 2D map of Resources .
<i>max_lines</i>	The maximum number of lines of output to write.

Reimplemented from [Renewable](#).

```

430 {
431     // 1. create filestream
432     write_path += "time_series_results.csv";
433     std::ofstream ofs;
434     ofs.open(write_path, std::ofstream::out);
435
436     // 2. write time series results (comma separated value)
437     ofs << "Time (since start of data) [hrs],";
438     ofs << "Significant Wave Height [m],";
439     ofs << "Energy Period [s],";
440     ofs << "Production [kW],";
441     ofs << "Dispatch [kW],";
442     ofs << "Storage [kW],";
443     ofs << "Curtailment [kW],";
444     ofs << "Capital Cost (actual),";
445     ofs << "Operation and Maintenance Cost (actual),";
446     ofs << "\n";
447
448     for (int i = 0; i < max_lines; i++) {
449         ofs << time_vec_hrs_ptr->at(i) << ", ";
450         ofs << resource_map_2D_ptr->at(this->resource_key)[i][0] << ", ";
451         ofs << resource_map_2D_ptr->at(this->resource_key)[i][1] << ", ";
452         ofs << this->production_vec_kW[i] << ", ";
453         ofs << this->dispatch_vec_kW[i] << ", ";
454         ofs << this->storage_vec_kW[i] << ", ";
455         ofs << this->curtailment_vec_kW[i] << ", ";
456         ofs << this->capital_cost_vec[i] << ", ";
457         ofs << this->operation_maintenance_cost_vec[i] << ", ";
458         ofs << "\n";
459     }
460
461     return;
462 } /* __writeTimeSeries() */

```

4.26.3.9 commit()

```

double Wave::commit (
    int timestep,
    double dt_hrs,
    double production_kW,
    double load_kW ) [virtual]

```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented from [Renewable](#).

```

743 {
744     // 1. invoke base class method
745     load_kW = Renewable :: commit(
746         timestep,
747         dt_hrs,
748         production_kW,
749         load_kW
750     );
751
752
753     //...
754
755     return load_kW;
756 } /* commit() */

```

4.26.3.10 computeProductionkW()

```

double Wave::computeProductionkW (
    int timestep,
    double dt_hrs,
    double significant_wave_height_m,
    double energy_period_s ) [virtual]

```

Method which takes in the wave resource at a particular point in time, and then returns the wave turbine production at that point in time.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>signficiant_wave_height_m</i>	The significant wave height (wave statistic) [m].
<i>energy_period_s</i>	The energy period (wave statistic) [s].

Returns

The production [kW] of the wave turbine.

Reimplemented from [Renewable](#).

```

647 {
648     // check if no resource
649     if (significant_wave_height_m <= 0 or energy_period_s <= 0) {
650         return 0;
651     }
652
653     // compute production
654     double production_kW = 0;
655
656     switch (this->power_model) {
657         case (WavePowerProductionModel :: WAVE_POWER_PARABOLOID): {
658             production_kW = this->__computeParaboloidProductionkW(
659                 timestep,
660                 dt_hrs,
661                 significant_wave_height_m,
662                 energy_period_s
663             );
664         }

```



```

665         break;
666     }
667
668     case (WavePowerProductionModel :: WAVE_POWER_GAUSSIAN): {
669         production_kW = this->__computeGaussianProductionkW(
670             timestep,
671             dt_hrs,
672             significant_wave_height_m,
673             energy_period_s
674         );
675
676         break;
677     }
678
679     case (WavePowerProductionModel :: WAVE_POWER_LOOKUP): {
680         production_kW = this->__computeLookupProductionkW(
681             timestep,
682             dt_hrs,
683             significant_wave_height_m,
684             energy_period_s
685         );
686
687         break;
688     }
689
690     default: {
691         std::string error_str = "ERROR: Wave::computeProductionkW(): ";
692         error_str += "power model ";
693         error_str += std::to_string(this->power_model);
694         error_str += " not recognized";
695
696         #ifdef _WIN32
697             std::cout << error_str << std::endl;
698         #endif
699
700         throw std::runtime_error(error_str);
701
702         break;
703     }
704 }
705
706 return production_kW;
707 } /* computeProductionkW() */

```

4.26.3.11 handleReplacement()

```

void Wave::handleReplacement (
    int timestep ) [virtual]

```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Renewable](#).

```

603 {
604     // 1. reset attributes
605     //...
606
607     // 2. invoke base class method
608     Renewable :: handleReplacement(timestep);
609
610     return;
611 } /* __handleReplacement() */

```

4.26.4 Member Data Documentation

4.26.4.1 design_energy_period_s

```
double Wave::design_energy_period_s
```

The energy period [s] at which the wave energy converter achieves its rated capacity.

4.26.4.2 design_significant_wave_height_m

```
double Wave::design_significant_wave_height_m
```

The significant wave height [m] at which the wave energy converter achieves its rated capacity.

4.26.4.3 power_model

```
WavePowerProductionModel Wave::power_model
```

The wave power production model to be applied.

4.26.4.4 power_model_string

```
std::string Wave::power_model_string
```

A string describing the active power production model.

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

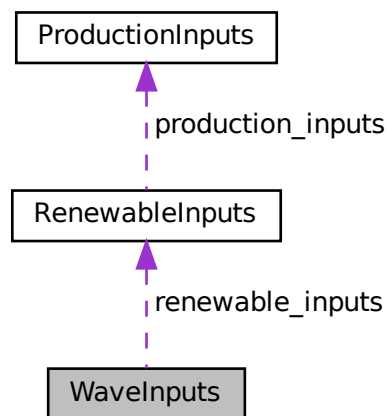
- [header/Production/Renewable/Wave.h](#)
- [source/Production/Renewable/Wave.cpp](#)

4.27 WaveInputs Struct Reference

A structure which bundles the necessary inputs for the [Wave](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

```
#include <Wave.h>
```

Collaboration diagram for WaveInputs:



Public Attributes

- [RenewableInputs](#) `renewable_inputs`
An encapsulated [RenewableInputs](#) instance.
- int `resource_key` = 0
A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.
- double `capital_cost` = -1
The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].
- double `operation_maintenance_cost_kWh` = -1
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].
- double `design_significant_wave_height_m` = 3
The significant wave height [m] at which the wave energy converter achieves its rated capacity.
- double `design_energy_period_s` = 10
The energy period [s] at which the wave energy converter achieves its rated capacity.
- [WavePowerProductionModel](#) `power_model` = [WavePowerProductionModel](#) :: [WAVE_POWER_PARABOLOID](#)
The wave power production model to be applied.

4.27.1 Detailed Description

A structure which bundles the necessary inputs for the [Wave](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

4.27.2 Member Data Documentation

4.27.2.1 capital_cost

```
double WaveInputs::capital_cost = -1
```

The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].

4.27.2.2 design_energy_period_s

```
double WaveInputs::design_energy_period_s = 10
```

The energy period [s] at which the wave energy converter achieves its rated capacity.

4.27.2.3 design_significant_wave_height_m

```
double WaveInputs::design_significant_wave_height_m = 3
```

The significant wave height [m] at which the wave energy converter achieves its rated capacity.

4.27.2.4 operation_maintenance_cost_kWh

```
double WaveInputs::operation_maintenance_cost_kWh = -1
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].

4.27.2.5 power_model

```
WavePowerProductionModel WaveInputs::power_model = WavePowerProductionModel :: WAVE_POWER_PARABOLOID
```

The wave power production model to be applied.

4.27.2.6 renewable_inputs

```
RenewableInputs WaveInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.27.2.7 resource_key

```
int WaveInputs::resource_key = 0
```

A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.

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

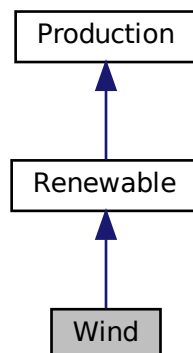
- [header/Production/Renewable/Wave.h](#)

4.28 Wind Class Reference

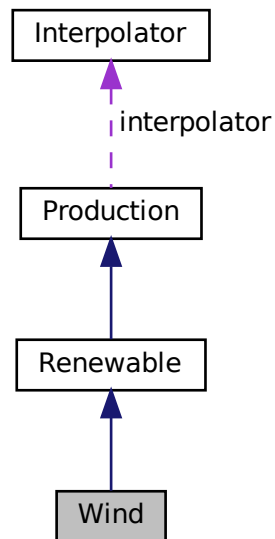
A derived class of the [Renewable](#) branch of [Production](#) which models wind production.

```
#include <Wind.h>
```

Inheritance diagram for Wind:



Collaboration diagram for Wind:



Public Member Functions

- [Wind](#) (void)
Constructor (dummy) for the [Wind](#) class.
- [Wind](#) (int, double, [WindInputs](#))
Constructor (intended) for the [Wind](#) class.
- void [handleReplacement](#) (int)
Method to handle asset replacement and capital cost incursion, if applicable.
- double [computeProductionkW](#) (int, double, double)
Method which takes in the wind resource at a particular point in time, and then returns the wind turbine production at that point in time.
- double [commit](#) (int, double, double, double)
Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.
- [~Wind](#) (void)
Destructor for the [Wind](#) class.

Public Attributes

- double [design_speed_ms](#)
The wind speed [m/s] at which the wind turbine achieves its rated capacity.
- [WindPowerProductionModel](#) [power_model](#)
The wind power production model to be applied.
- std::string [power_model_string](#)
A string describing the active power production model.

Private Member Functions

- void `__checkInputs` ([WindInputs](#))
Helper method to check inputs to the [Wind](#) constructor.
- double `__getGenericCapitalCost` (void)
Helper method to generate a generic wind turbine capital cost.
- double `__getGenericOpMaintCost` (void)
Helper method to generate a generic wind turbine operation and maintenance cost. This is a cost incurred per unit energy produced.
- double `__computeExponentialProductionkW` (int, double, double)
Helper method to compute wind turbine production under an exponential production model.
- double `__computeLookupProductionkW` (int, double, double)
Helper method to compute wind turbine production by way of looking up using given power curve data.
- void `__writeSummary` (std::string)
Helper method to write summary results for [Wind](#).
- void `__writeTimeSeries` (std::string, std::vector< double > *, std::map< int, std::vector< double >> *, std::map< int, std::vector< std::vector< double >>> *, int=-1)
Helper method to write time series results for [Wind](#).

4.28.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models wind production.

4.28.2 Constructor & Destructor Documentation

4.28.2.1 `Wind()` [1/2]

```
Wind::Wind (
    void )
```

Constructor (dummy) for the [Wind](#) class.

```
390 {
391     return;
392 } /* Wind() */
```

4.28.2.2 `Wind()` [2/2]

```
Wind::Wind (
    int n_points,
    double n_years,
    WindInputs wind_inputs )
```

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

Parameters

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>wind_inputs</i>	A structure of Wind constructor inputs.

```

420 :
421 Renewable(
422     n_points,
423     n_years,
424     wind_inputs.renewable_inputs
425 )
426 {
427     // 1. check inputs
428     this->__checkInputs(wind_inputs);
429
430     // 2. set attributes
431     this->type = RenewableType :: WIND;
432     this->type_str = "WIND";
433
434     this->resource_key = wind_inputs.resource_key;
435
436     this->design_speed_ms = wind_inputs.design_speed_ms;
437
438     this->power_model = wind_inputs.power_model;
439
440     switch (this->power_model) {
441         case (WindPowerProductionModel :: WIND_POWER_EXPONENTIAL): {
442             this->power_model_string = "EXPONENTIAL";
443
444             break;
445         }
446
447         case (WindPowerProductionModel :: WIND_POWER_LOOKUP): {
448             this->power_model_string = "LOOKUP";
449
450             break;
451         }
452
453         default: {
454             std::string error_str = "ERROR: Wind(): ";
455             error_str += "power production model ";
456             error_str += std::to_string(this->power_model);
457             error_str += " not recognized";
458
459             #ifdef _WIN32
460                 std::cout << error_str << std::endl;
461             #endif
462
463             throw std::runtime_error(error_str);
464
465             break;
466         }
467     }
468
469     if (wind_inputs.capital_cost < 0) {
470         this->capital_cost = this->__getGenericCapitalCost();
471     }
472
473     if (wind_inputs.operation_maintenance_cost_kWh < 0) {
474         this->operation_maintenance_cost_kWh = this->__getGenericOpMaintCost();
475     }
476
477     if (not this->is_sunk) {
478         this->capital_cost_vec[0] = this->capital_cost;
479     }
480
481     // 3. construction print
482     if (this->print_flag) {
483         std::cout << "Wind object constructed at " << this << std::endl;
484     }
485
486     return;
487 } /* Renewable() */

```

4.28.2.3 ~Wind()

```

Wind::~~Wind (
    void )

```


Destructor for the [Wind](#) class.

```

656 {
657     // 1. destruction print
658     if (this->print_flag) {
659         std::cout << "Wind object at " << this << " destroyed" << std::endl;
660     }
661     return;
662 }
663 } /* ~Wind() */

```

4.28.3 Member Function Documentation

4.28.3.1 __checkInputs()

```

void Wind::__checkInputs (
    WindInputs wind_inputs ) [private]

```

Helper method to check inputs to the [Wind](#) constructor.

Parameters

<i>wind_inputs</i>	A structure of Wind constructor inputs.
--------------------	---

```

39 {
40     // 1. check design_speed_ms
41     if (wind_inputs.design_speed_ms <= 0) {
42         std::string error_str = "ERROR: Wind(): ";
43         error_str += "WindInputs::design_speed_ms must be > 0";
44
45         #ifdef WIN32
46             std::cout << error_str << std::endl;
47         #endif
48
49         throw std::invalid_argument(error_str);
50     }
51     return;
52 }
53 } /* __checkInputs() */

```

4.28.3.2 __computeExponentialProductionkW()

```

double Wind::__computeExponentialProductionkW (
    int timestep,
    double dt_hrs,
    double wind_resource_ms ) [private]

```

Helper method to compute wind turbine production under an exponential production model.

Ref: [Truelove et al. \[2019\]](#)

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>wind_resource_ms</i>	The available wind resource [m/s].

Returns

The production [kW] of the wind turbine, under an exponential model.

```

140 {
141     double production = 0;
142
143     double turbine_speed = (wind_resource_ms - this->design_speed_ms) /
144         this->design_speed_ms;
145
146     if (turbine_speed < -0.76 or turbine_speed > 0.68) {
147         production = 0;
148     }
149
150     else if (turbine_speed >= -0.76 and turbine_speed <= 0) {
151         production = 1.03273 * exp(-5.97588 * pow(turbine_speed, 2)) - 0.03273;
152     }
153
154     else {
155         production = 0.16154 * exp(-9.30254 * pow(turbine_speed, 2)) + 0.83846;
156     }
157
158     return production * this->capacity_kW;
159 } /* __computeExponentialProductionkW() */

```

4.28.3.3 __computeLookupProductionkW()

```

double Wind::__computeLookupProductionkW (
    int timestep,
    double dt_hrs,
    double wind_resource_ms ) [private]

```

Helper method to compute wind turbine production by way of looking up using given power curve data.

Parameters

<i>timestep</i>	The current time step of the Model run.
<i>dt_hrs</i>	The interval of time [hrs] associated with the action.
<i>wind_resource_ms</i>	The available wind resource [m/s].

Returns

The interpolated production [kW] of the wind turbine.

```

191 {
192     // *** WORK IN PROGRESS *** //
193
194     return 0;
195 } /* __computeLookupProductionkW() */

```

4.28.3.4 __getGenericCapitalCost()

```

double Wind::__getGenericCapitalCost (
    void ) [private]

```

Helper method to generate a generic wind turbine capital cost.

This model was obtained by way of surveying an assortment of published wind turbine costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars [CAD].

Returns

A generic capital cost for the wind turbine [CAD].

```

75 {
76     double capital_cost_per_kW = 3000 * pow(this->capacity_kW, -0.15) + 3000;
77
78     return capital_cost_per_kW * this->capacity_kW;
79 } /* __getGenericCapitalCost() */

```

4.28.3.5 __getGenericOpMaintCost()

```

double Wind::__getGenericOpMaintCost (
    void ) [private]

```

Helper method to generate a generic wind turbine operation and maintenance cost. This is a cost incurred per unit energy produced.

This model was obtained by way of surveying an assortment of published wind turbine costs, and then constructing a best fit model. Note that this model expresses cost in terms of Canadian dollars [CAD/kWh].

Returns

A generic operation and maintenance cost, per unit energy produced, for the wind turbine [CAD/kWh].

```

102 {
103     double operation_maintenance_cost_kWh = 0.025 * pow(this->capacity_kW, -0.2) + 0.025;
104
105     return operation_maintenance_cost_kWh;
106 } /* __getGenericOpMaintCost() */

```

4.28.3.6 __writeSummary()

```

void Wind::__writeSummary (
    std::string write_path ) [private], [virtual]

```

Helper method to write summary results for [Wind](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
-------------------	--

Reimplemented from [Renewable](#).

```

213 {
214     // 1. create filestream
215     write_path += "summary_results.md";
216     std::ofstream ofs;
217     ofs.open(write_path, std::ofstream::out);
218
219     // 2. write summary results (markdown)
220     ofs << "# ";
221     ofs << std::to_string(int(ceil(this->capacity_kW)));
222     ofs << " kW WIND Summary Results\n";
223     ofs << "\n-----\n\n";
224
225
226     // 2.1. Production attributes

```

```

227 ofs << "## Production Attributes\n";
228 ofs << "\n";
229
230 ofs << "Capacity: " << this->capacity_kW << "kW  \n";
231 ofs << "\n";
232
233 ofs << "Sunk Cost (N = 0 / Y = 1): " << this->is_sunk << "  \n";
234 ofs << "Capital Cost: " << this->capital_cost << "  \n";
235 ofs << "Operation and Maintenance Cost: " << this->operation_maintenance_cost_kWh
236 << " per kWh produced  \n";
237 ofs << "Nominal Inflation Rate (annual): " << this->nominal_inflation_annual
238 << "  \n";
239 ofs << "Nominal Discount Rate (annual): " << this->nominal_discount_annual
240 << "  \n";
241 ofs << "Real Discount Rate (annual): " << this->real_discount_annual << "  \n";
242 ofs << "\n";
243
244 ofs << "Replacement Running Hours: " << this->replace_running_hrs << "  \n";
245 ofs << "\n-----\n\n";
246
247 // 2.2. Renewable attributes
248 ofs << "## Renewable Attributes\n";
249 ofs << "\n";
250
251 ofs << "Resource Key (1D): " << this->resource_key << "  \n";
252
253 ofs << "\n-----\n\n";
254
255 // 2.3. Wind attributes
256 ofs << "## Wind Attributes\n";
257 ofs << "\n";
258
259 ofs << "Power Production Model: " << this->power_model_string << "  \n";
260 switch (this->power_model) {
261     case (WindPowerProductionModel :: WIND_POWER_EXPONENTIAL): {
262         ofs << "Design Speed: " << this->design_speed_ms << " m/s  \n";
263
264         break;
265     }
266
267     case (WindPowerProductionModel :: WIND_POWER_LOOKUP): {
268         //...
269
270         break;
271     }
272
273     default: {
274         // write nothing!
275
276         break;
277     }
278 }
279
280 ofs << "\n-----\n\n";
281
282 // 2.4. Wind Results
283 ofs << "## Results\n";
284 ofs << "\n";
285
286 ofs << "Net Present Cost: " << this->net_present_cost << "  \n";
287 ofs << "\n";
288
289 ofs << "Total Dispatch: " << this->total_dispatch_kWh
290 << " kWh  \n";
291
292 ofs << "Levellized Cost of Energy: " << this->levellized_cost_of_energy_kWh
293 << " per kWh dispatched  \n";
294 ofs << "\n";
295
296 ofs << "Running Hours: " << this->running_hours << "  \n";
297 ofs << "Replacements: " << this->n_replacements << "  \n";
298
299 ofs << "\n-----\n\n";
300
301 ofs.close();
302
303 return;
304 } /* __writeSummary() */

```

4.28.3.7 __writeTimeSeries()

```
void Wind::__writeTimeSeries (
```

```
std::string write_path,
std::vector< double > * time_vec_hrs_ptr,
std::map< int, std::vector< double >> * resource_map_1D_ptr,
std::map< int, std::vector< std::vector< double >>> * resource_map_2D_ptr,
int max_lines = -1 ) [private], [virtual]
```

Helper method to write time series results for [Wind](#).

Parameters

<i>write_path</i>	A path (either relative or absolute) to the directory location where results are to be written. If already exists, will overwrite.
<i>time_vec_hrs_ptr</i>	A pointer to the <code>time_vec_hrs</code> attribute of the ElectricalLoad .
<i>resource_map_1D_ptr</i>	A pointer to the 1D map of Resources .
<i>resource_map_2D_ptr</i>	A pointer to the 2D map of Resources .
<i>max_lines</i>	The maximum number of lines of output to write.

Reimplemented from [Renewable](#).

```
342 {
343     // 1. create filestream
344     write_path += "time_series_results.csv";
345     std::ofstream ofs;
346     ofs.open(write_path, std::ofstream::out);
347
348     // 2. write time series results (comma separated value)
349     ofs << "Time (since start of data) [hrs],";
350     ofs << "Wind Resource [m/s],";
351     ofs << "Production [kW],";
352     ofs << "Dispatch [kW],";
353     ofs << "Storage [kW],";
354     ofs << "Curtailment [kW],";
355     ofs << "Capital Cost (actual),";
356     ofs << "Operation and Maintenance Cost (actual),";
357     ofs << "\n";
358
359     for (int i = 0; i < max_lines; i++) {
360         ofs << time_vec_hrs_ptr->at(i) << ", ";
361         ofs << resource_map_1D_ptr->at(this->resource_key)[i] << ", ";
362         ofs << this->production_vec_kW[i] << ", ";
363         ofs << this->dispatch_vec_kW[i] << ", ";
364         ofs << this->storage_vec_kW[i] << ", ";
365         ofs << this->curtailment_vec_kW[i] << ", ";
366         ofs << this->capital_cost_vec[i] << ", ";
367         ofs << this->operation_maintenance_cost_vec[i] << ", ";
368         ofs << "\n";
369     }
370
371     return;
372 } /* __writeTimeSeries() */
```

4.28.3.8 commit()

```
double Wind::commit (
    int timestep,
    double dt_hrs,
    double production_kW,
    double load_kW ) [virtual]
```

Method which takes in production and load for the current timestep, computes and records dispatch and curtailment, and then returns remaining load.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>production_kW</i>	The production [kW] of the asset in this timestep.
<i>load_kW</i>	The load [kW] passed to the asset in this timestep.

Returns

The load [kW] remaining after the dispatch is deducted from it.

Reimplemented from [Renewable](#).

```

628 {
629     // 1. invoke base class method
630     load_kW = Renewable::commit(
631         timestep,
632         dt_hrs,
633         production_kW,
634         load_kW
635     );
636
637
638     //...
639
640     return load_kW;
641 } /* commit() */

```

4.28.3.9 computeProductionkW()

```

double Wind::computeProductionkW (
    int timestep,
    double dt_hrs,
    double wind_resource_ms ) [virtual]

```

Method which takes in the wind resource at a particular point in time, and then returns the wind turbine production at that point in time.

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
<i>dt_hrs</i>	The interval of time [hrs] associated with the timestep.
<i>wind_resource_ms</i>	Wind resource (i.e. wind speed) [m/s].

Returns

The production [kW] of the wind turbine.

Reimplemented from [Renewable](#).

```

545 {
546     // check if no resource
547     if (wind_resource_ms <= 0) {
548         return 0;
549     }
550
551     // compute production
552     double production_kW = 0;

```

```

553
554     switch (this->power_model) {
555         case (WindPowerProductionModel :: WIND_POWER_EXPONENTIAL): {
556             production_kW = this->__computeExponentialProductionkW(
557                 timestep,
558                 dt_hrs,
559                 wind_resource_ms
560             );
561
562             break;
563         }
564
565         case (WindPowerProductionModel :: WIND_POWER_LOOKUP): {
566             production_kW = this->__computeLookupProductionkW(
567                 timestep,
568                 dt_hrs,
569                 wind_resource_ms
570             );
571
572             break;
573         }
574
575         default: {
576             std::string error_str = "ERROR: Wind::computeProductionkW(): ";
577             error_str += "power model ";
578             error_str += std::to_string(this->power_model);
579             error_str += " not recognized";
580
581             #ifdef _WIN32
582                 std::cout << error_str << std::endl;
583             #endif
584
585             throw std::runtime_error(error_str);
586
587             break;
588         }
589     }
590
591     return production_kW;
592 } /* computeProductionkW() */

```

4.28.3.10 handleReplacement()

```

void Wind::handleReplacement (
    int timestep ) [virtual]

```

Method to handle asset replacement and capital cost incursion, if applicable.

Parameters

<i>timestep</i>	The current time step of the Model run.
-----------------	---

Reimplemented from [Renewable](#).

```

505 {
506     // 1. reset attributes
507     //...
508
509     // 2. invoke base class method
510     Renewable :: handleReplacement(timestep);
511
512     return;
513 } /* __handleReplacement() */

```

4.28.4 Member Data Documentation

4.28.4.1 design_speed_ms

```
double Wind::design_speed_ms
```

The wind speed [m/s] at which the wind turbine achieves its rated capacity.

4.28.4.2 power_model

```
WindPowerProductionModel Wind::power_model
```

The wind power production model to be applied.

4.28.4.3 power_model_string

```
std::string Wind::power_model_string
```

A string describing the active power production model.

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

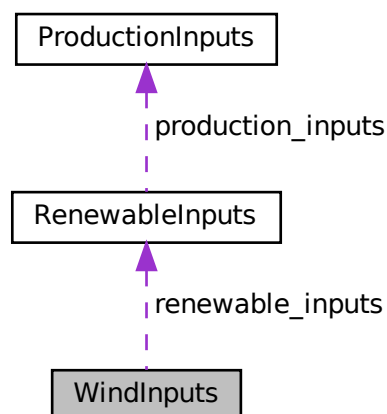
- [header/Production/Renewable/Wind.h](#)
- [source/Production/Renewable/Wind.cpp](#)

4.29 WindInputs Struct Reference

A structure which bundles the necessary inputs for the [Wind](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

```
#include <Wind.h>
```

Collaboration diagram for WindInputs:



Public Attributes

- [RenewableInputs renewable_inputs](#)
An encapsulated [RenewableInputs](#) instance.
- int [resource_key](#) = 0
A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.
- double [capital_cost](#) = -1
The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].
- double [operation_maintenance_cost_kWh](#) = -1
The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].
- double [design_speed_ms](#) = 8
The wind speed [m/s] at which the wind turbine achieves its rated capacity.
- [WindPowerProductionModel power_model](#) = [WindPowerProductionModel](#) :: [WIND_POWER_EXPONENTIAL](#)
The wind power production model to be applied.

4.29.1 Detailed Description

A structure which bundles the necessary inputs for the [Wind](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

4.29.2 Member Data Documentation

4.29.2.1 capital_cost

```
double WindInputs::capital_cost = -1
```

The capital cost of the asset (undefined currency). -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD].

4.29.2.2 design_speed_ms

```
double WindInputs::design_speed_ms = 8
```

The wind speed [m/s] at which the wind turbine achieves its rated capacity.

4.29.2.3 operation_maintenance_cost_kWh

```
double WindInputs::operation_maintenance_cost_kWh = -1
```

The operation and maintenance cost of the asset [1/kWh] (undefined currency). This is a cost incurred per unit of energy produced. -1 is a sentinel value, which triggers a generic cost model on construction (in fact, any negative value here will trigger). Note that the generic cost model is in terms of Canadian dollars [CAD/kWh].

4.29.2.4 power_model

```
WindPowerProductionModel WindInputs::power_model = WindPowerProductionModel :: WIND_POWER_EXPONENTIAL
```

The wind power production model to be applied.

4.29.2.5 renewable_inputs

```
RenewableInputs WindInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.29.2.6 resource_key

```
int WindInputs::resource_key = 0
```

A key used to index into the [Resources](#) object, to associate this asset with the appropriate resource time series.

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

- [header/Production/Renewable/Wind.h](#)

Chapter 5

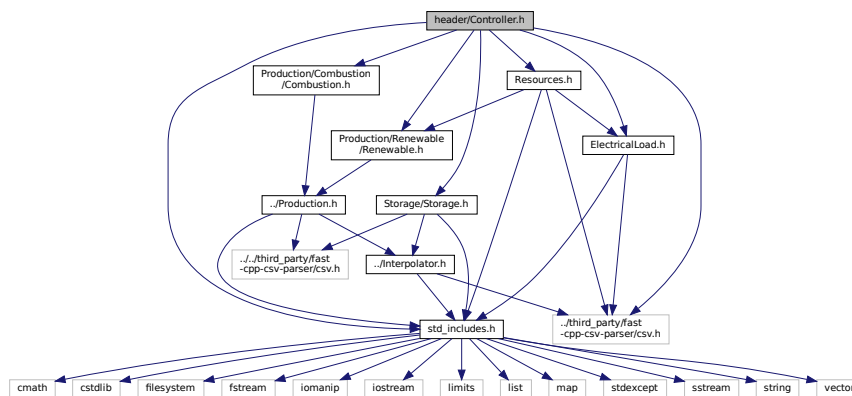
File Documentation

5.1 header/Controller.h File Reference

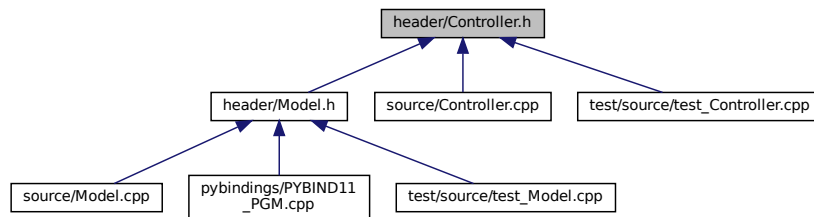
Header file for the [Controller](#) class.

```
#include "std_includes.h"
#include "../third_party/fast-cpp-csv-parser/csv.h"
#include "ElectricalLoad.h"
#include "Resources.h"
#include "Production/Combustion/Combustion.h"
#include "Production/Renewable/Renewable.h"
#include "Storage/Storage.h"
```

Include dependency graph for Controller.h:



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



Classes

- class [Controller](#)

A class which contains a various dispatch control logic. Intended to serve as a component class of [Model](#).

Enumerations

- enum [ControlMode](#) { [LOAD_FOLLOWING](#) , [CYCLE_CHARGING](#) , [N_CONTROL_MODES](#) }

An enumeration of the types of control modes supported by PGMcpp.

5.1.1 Detailed Description

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

5.1.2 Enumeration Type Documentation

5.1.2.1 ControlMode

enum [ControlMode](#)

An enumeration of the types of control modes supported by PGMcpp.

Enumerator

LOAD_FOLLOWING	Load following control, with in-order dispatch of non-Combustion assets and optimal dispatch of Combustion assets.
CYCLE_CHARGING	Cycle charging control, with in-order dispatch of non-Combustion assets and optimal dispatch of Combustion assets.
N_CONTROL_MODES	A simple hack to get the number of elements in ControlMode.

```

43     {
44         LOAD\_FOLLOWING,

```

```

45     CYCLE_CHARGING,
46     N_CONTROL_MODES
47 };

```

5.2 header/ElectricalLoad.h File Reference

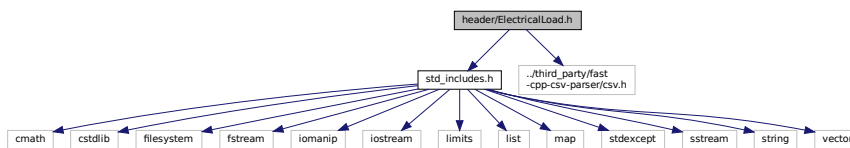
Header file for the [ElectricalLoad](#) class.

```

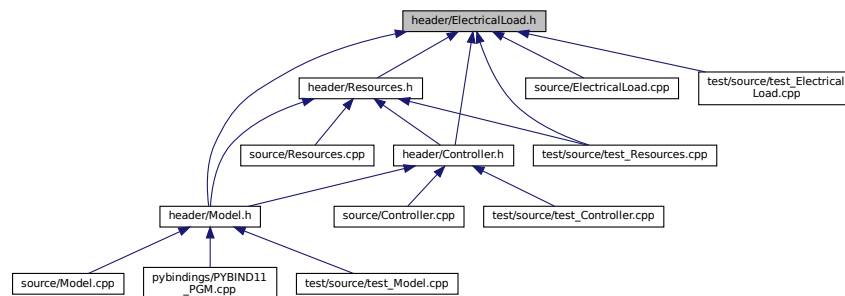
#include "std_includes.h"
#include "../third_party/fast-cpp-csv-parser/csv.h"

```

Include dependency graph for ElectricalLoad.h:



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



Classes

- class [ElectricalLoad](#)

A class which contains time and electrical load data. Intended to serve as a component class of [Model](#).

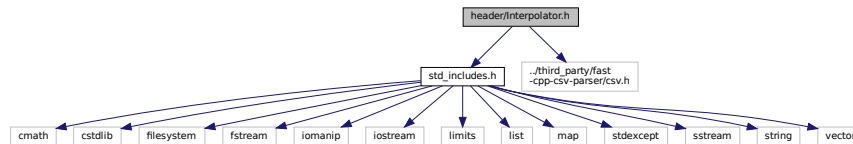
5.2.1 Detailed Description

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

5.3 header/Interpolator.h File Reference

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

```
#include "std_includes.h"
#include "../third_party/fast-cpp-csv-parser/csv.h"
Include dependency graph for Interpolator.h:
```



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



Classes

- struct [InterpolatorStruct1D](#)
A struct which holds two parallel vectors for use in 1D interpolation.
- struct [InterpolatorStruct2D](#)
A struct which holds two parallel vectors and a matrix for use in 2D interpolation.
- class [Interpolator](#)
A class which contains interpolation data and functionality. Intended to serve as a component of the [Production](#) and [Storage](#) hierarchies.

5.3.1 Detailed Description

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

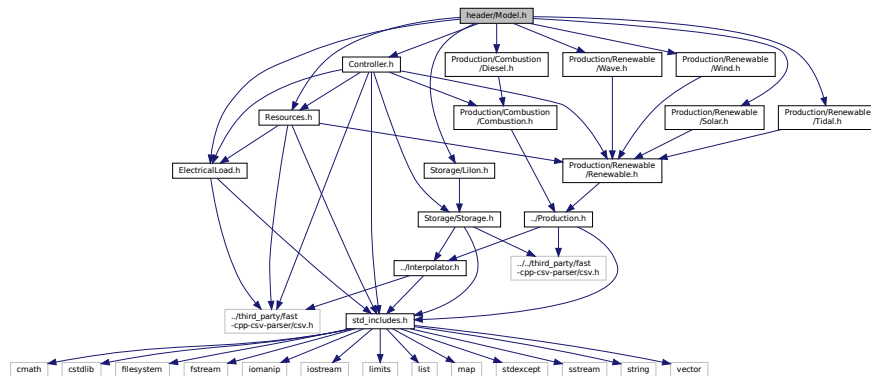
5.4 header/Model.h File Reference

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

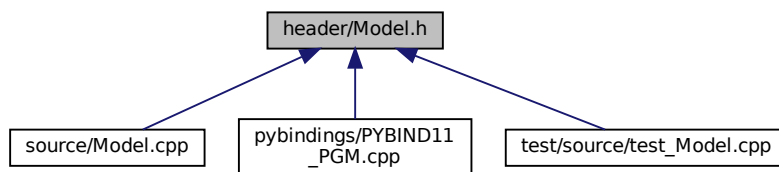
```
#include "Controller.h"
#include "ElectricalLoad.h"
#include "Resources.h"
#include "Production/Combustion/Diesel.h"
#include "Production/Renewable/Solar.h"
#include "Production/Renewable/Tidal.h"
```

```
#include "Production/Renewable/Wave.h"
#include "Production/Renewable/Wind.h"
#include "Storage/LiIon.h"
```

Include dependency graph for Model.h:



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



Classes

- struct [ModellInputs](#)

A structure which bundles the necessary inputs for the [Model](#) constructor. Provides default values for every necessary input (except `path_2_electrical_load_time_series`, for which a valid input must be provided).

- class [Model](#)

A container class which forms the centre of `PGMcpp`. The [Model](#) class is intended to serve as the primary user interface with the functionality of `PGMcpp`, and as such it contains all other classes.

5.4.1 Detailed Description

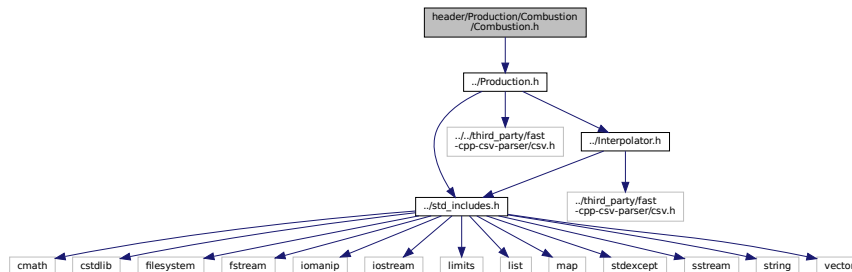
Header file for the [Model](#) class.

5.5 header/Production/Combustion/Combustion.h File Reference

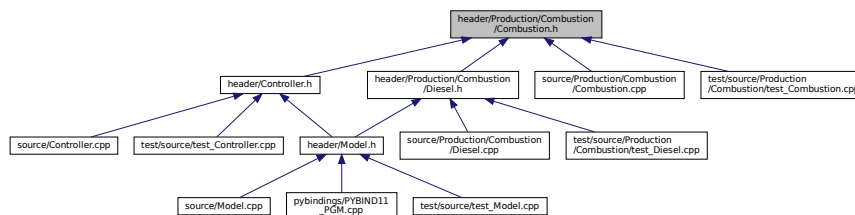
Header file for the [Combustion](#) class.

```
#include "../Production.h"
```

Include dependency graph for Combustion.h:



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



Classes

- struct [CombustionInputs](#)
A structure which bundles the necessary inputs for the [Combustion](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [ProductionInputs](#).
- struct [Emissions](#)
A structure which bundles the emitted masses of various emissions chemistries.
- class [Combustion](#)
The root of the [Combustion](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the production of energy by way of combustibles.

Enumerations

- enum [CombustionType](#) { [DIESEL](#) , [N_COMBUSTION_TYPES](#) }
An enumeration of the types of [Combustion](#) asset supported by PGMcpp.

5.5.1 Detailed Description

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

5.5.2 Enumeration Type Documentation

5.5.2.1 CombustionType

enum `CombustionType`

An enumeration of the types of `Combustion` asset supported by PGMcpp.

Enumerator

DIESEL	A diesel generator.
N_COMBUSTION_TYPES	A simple hack to get the number of elements in CombustionType.

```

33         {
34     DIESEL,
35     N_COMBUSTION_TYPES
36 };

```

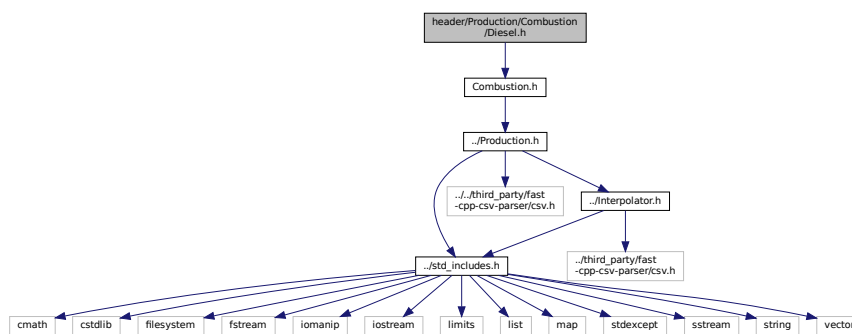
5.6 header/Production/Combustion/Diesel.h File Reference

Header file for the `Diesel` class.

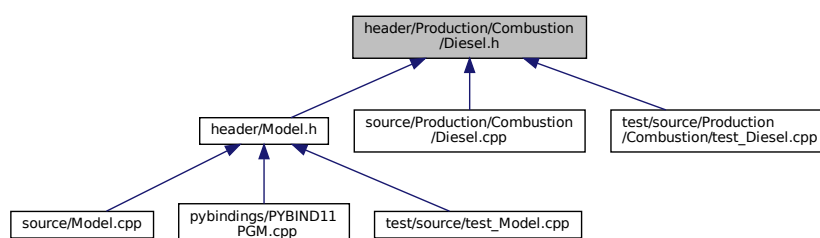
```
#include "Combustion.h"

```

Include dependency graph for Diesel.h:



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



Classes

- struct [DieselInputs](#)

A structure which bundles the necessary inputs for the [Diesel](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [CombustionInputs](#).

- class [Diesel](#)

A derived class of the [Combustion](#) branch of [Production](#) which models production using a diesel generator.

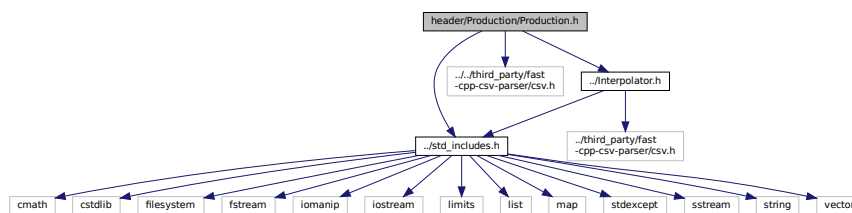
5.6.1 Detailed Description

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

5.7 header/Production/Production.h File Reference

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

```
#include "../std_includes.h"
#include "../../third_party/fast-cpp-csv-parser/csv.h"
#include "../Interpolator.h"
Include dependency graph for Production.h:
```



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



Classes

- struct [ProductionInputs](#)

A structure which bundles the necessary inputs for the [Production](#) constructor. Provides default values for every necessary input.

- class [Production](#)

The base class of the [Production](#) hierarchy. This hierarchy contains derived classes which model the production of energy, be it renewable or otherwise.

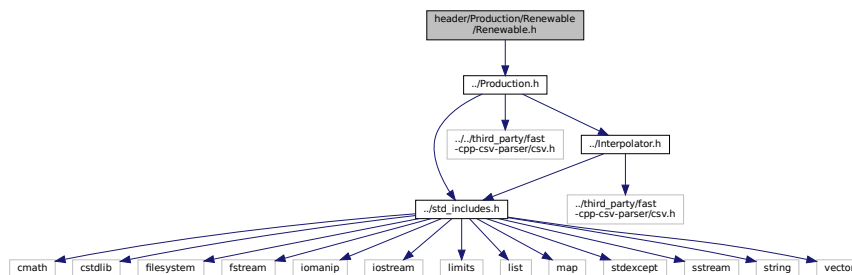
5.7.1 Detailed Description

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

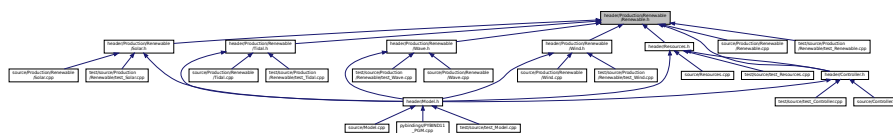
5.8 header/Production/Renewable/Renewable.h File Reference

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

```
#include "../Production.h"
Include dependency graph for Renewable.h:
```



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



Classes

- struct [RenewableInputs](#)

A structure which bundles the necessary inputs for the [Renewable](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [ProductionInputs](#).

- class [Renewable](#)

The root of the [Renewable](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the renewable production of energy.

Enumerations

- enum [RenewableType](#) {
[SOLAR](#) , [TIDAL](#) , [WAVE](#) , [WIND](#) ,
[N_RENEWABLE_TYPES](#) }

An enumeration of the types of [Renewable](#) asset supported by PGMcpp.

5.8.1 Detailed Description

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

5.8.2 Enumeration Type Documentation

5.8.2.1 RenewableType

enum [RenewableType](#)

An enumeration of the types of [Renewable](#) asset supported by PGMcpp.

Enumerator

SOLAR	A solar photovoltaic (PV) array.
TIDAL	A tidal stream turbine (or tidal energy converter, TEC)
WAVE	A wave energy converter (WEC)
WIND	A wind turbine.
N_RENEWABLE_TYPES	A simple hack to get the number of elements in RenewableType.

```

33         {
34     SOLAR,
35     TIDAL,
36     WAVE,
37     WIND,
38     N_RENEWABLE_TYPES
39 };

```

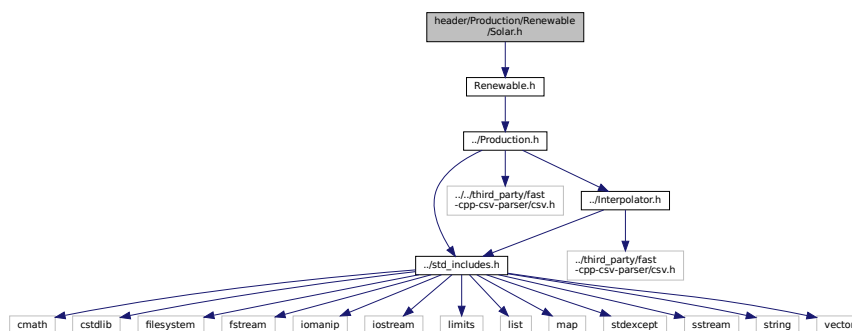
5.9 header/Production/Renewable/Solar.h File Reference

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

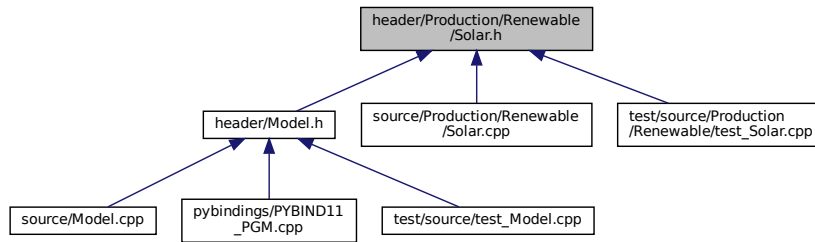
```
#include "Renewable.h"

```

Include dependency graph for Solar.h:



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



Classes

- struct [SolarInputs](#)

A structure which bundles the necessary inputs for the [Solar](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

- class [Solar](#)

A derived class of the [Renewable](#) branch of [Production](#) which models solar production.

5.9.1 Detailed Description

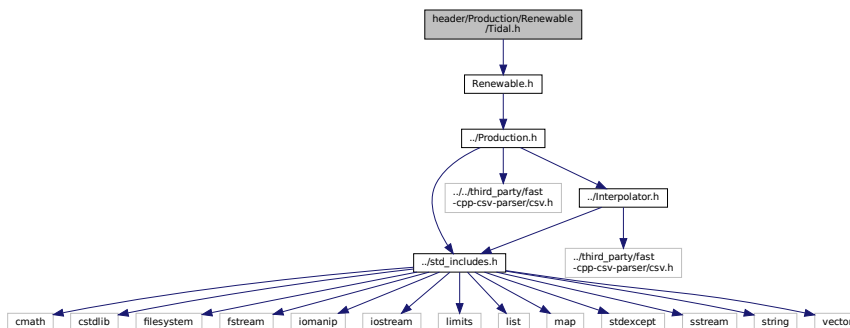
Header file for the [Solar](#) class.

5.10 header/Production/Renewable/Tidal.h File Reference

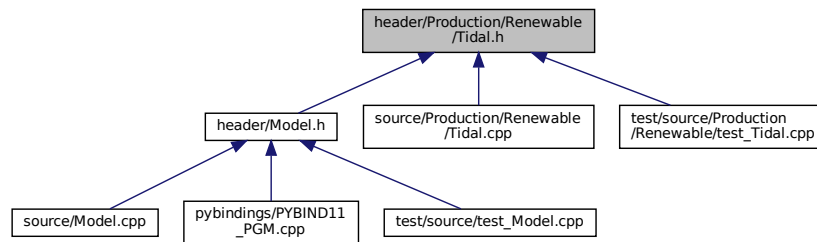
Header file for the [Tidal](#) class.

```
#include "Renewable.h"
```

Include dependency graph for Tidal.h:



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



Classes

- struct [TidalInputs](#)

A structure which bundles the necessary inputs for the [Tidal](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

- class [Tidal](#)

A derived class of the [Renewable](#) branch of [Production](#) which models tidal production.

Enumerations

- enum [TidalPowerProductionModel](#) { [TIDAL_POWER_CUBIC](#) , [TIDAL_POWER_EXPONENTIAL](#) , [TIDAL_POWER_LOOKUP](#) , [N_TIDAL_POWER_PRODUCTION_MODELS](#) }

5.10.1 Detailed Description

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

5.10.2 Enumeration Type Documentation

5.10.2.1 TidalPowerProductionModel

```
enum TidalPowerProductionModel
```

Enumerator

TIDAL_POWER_CUBIC	A cubic power production model.
TIDAL_POWER_EXPONENTIAL	An exponential power production model.
TIDAL_POWER_LOOKUP	Lookup from a given set of power curve data.
N_TIDAL_POWER_PRODUCTION_MODELS	A simple hack to get the number of elements in TidalPowerProductionModel .

```

34         {
35     TIDAL_POWER_CUBIC,
36     TIDAL_POWER_EXPONENTIAL,
37     TIDAL_POWER_LOOKUP,
38     N_TIDAL_POWER_PRODUCTION_MODELS
39 };

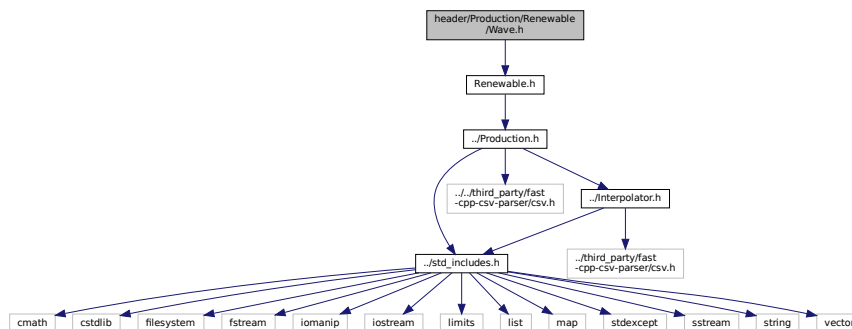
```

5.11 header/Production/Renewable/Wave.h File Reference

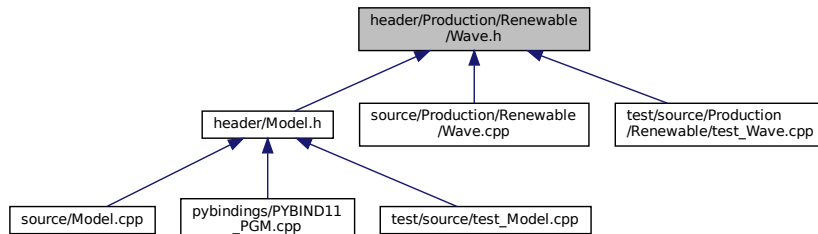
Header file for the [Wave](#) class.

```
#include "Renewable.h"
```

Include dependency graph for Wave.h:



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



Classes

- struct [WaveInputs](#)

A structure which bundles the necessary inputs for the [Wave](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).

- class [Wave](#)

A derived class of the [Renewable](#) branch of [Production](#) which models wave production.

Enumerations

- enum [WavePowerProductionModel](#) { [WAVE_POWER_GAUSSIAN](#) , [WAVE_POWER_PARABOLOID](#) , [WAVE_POWER_LOOKUP](#) , [N_WAVE_POWER_PRODUCTION_MODELS](#) }

5.11.1 Detailed Description

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

5.11.2 Enumeration Type Documentation

5.11.2.1 WavePowerProductionModel

```
enum WavePowerProductionModel
```

Enumerator

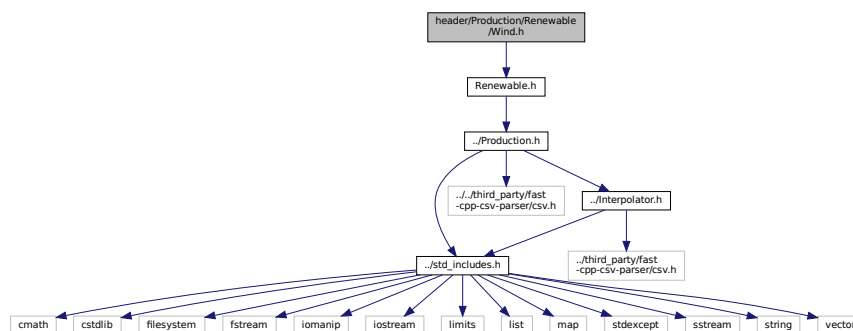
WAVE_POWER_GAUSSIAN	A Gaussian power production model.
WAVE_POWER_PARABOLOID	A paraboloid power production model.
WAVE_POWER_LOOKUP	Lookup from a given performance matrix.
N_WAVE_POWER_PRODUCTION_MODELS	A simple hack to get the number of elements in WavePowerProductionModel.

```
34
35     WAVE_POWER_GAUSSIAN,
36     WAVE_POWER_PARABOLOID,
37     WAVE_POWER_LOOKUP,
38     N_WAVE_POWER_PRODUCTION_MODELS
39 };
```

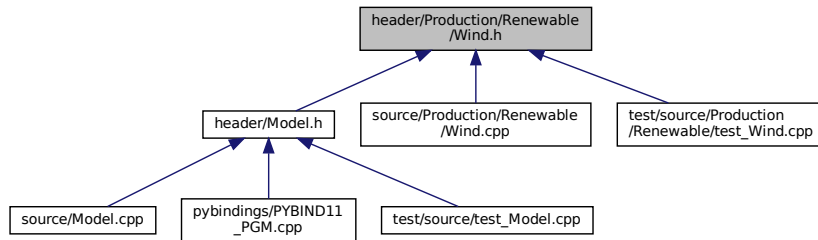
5.12 header/Production/Renewable/Wind.h File Reference

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

```
#include "Renewable.h"
Include dependency graph for Wind.h:
```



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



Classes

- struct [WindInputs](#)
A structure which bundles the necessary inputs for the [Wind](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [RenewableInputs](#).
- class [Wind](#)
A derived class of the [Renewable](#) branch of [Production](#) which models wind production.

Enumerations

- enum [WindPowerProductionModel](#) { [WIND_POWER_EXPONENTIAL](#) , [WIND_POWER_LOOKUP](#) , [N_WIND_POWER_PRODUCTION_MODELS](#) }

5.12.1 Detailed Description

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

5.12.2 Enumeration Type Documentation

5.12.2.1 WindPowerProductionModel

```
enum WindPowerProductionModel
```

Enumerator

WIND_POWER_EXPONENTIAL	An exponential power production model.
WIND_POWER_LOOKUP	Lookup from a given set of power curve data.
N_WIND_POWER_PRODUCTION_MODELS	A simple hack to get the number of elements in WindPowerProductionModel .

```

34     {
35         WIND\_POWER\_EXPONENTIAL,

```

```

36     WIND_POWER_LOOKUP,
37     N_WIND_POWER_PRODUCTION_MODELS
38 };

```

5.13 header/Resources.h File Reference

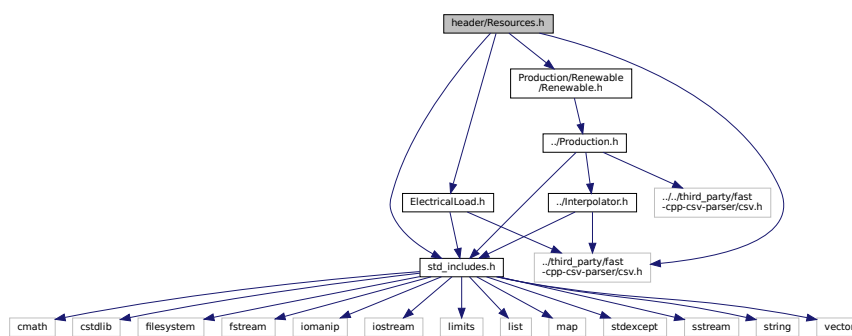
Header file for the [Resources](#) class.

```

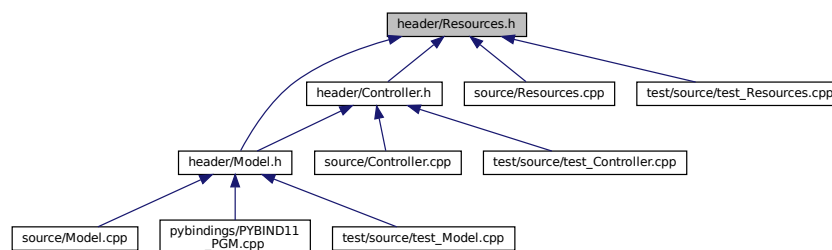
#include "std_includes.h"
#include "../third_party/fast-cpp-csv-parser/csv.h"
#include "ElectricalLoad.h"
#include "Production/Renewable/Renewable.h"

```

Include dependency graph for Resources.h:



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



Classes

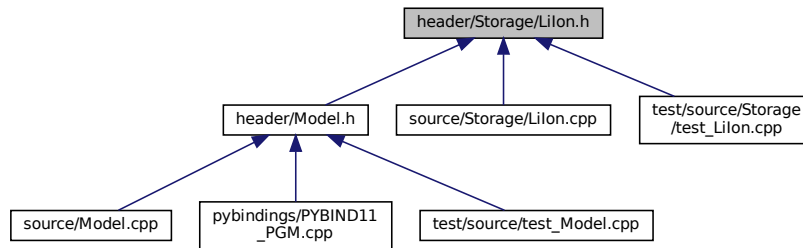
- class [Resources](#)

A class which contains renewable resource data. Intended to serve as a component class of [Model](#).

5.13.1 Detailed Description

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

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



Classes

- struct [LilonInputs](#)

A structure which bundles the necessary inputs for the [Lilon](#) constructor. Provides default values for every necessary input. Note that this structure encapsulates [StorageInputs](#).

- class [Lilon](#)

A derived class of [Storage](#) which models energy storage by way of lithium-ion batteries.

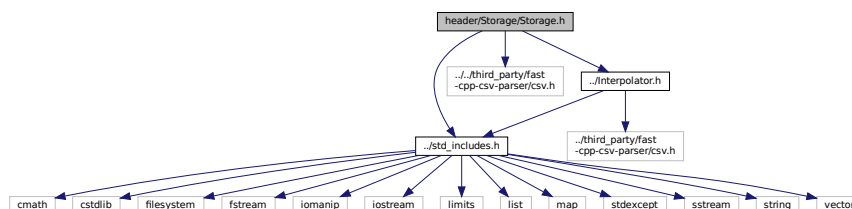
5.15.1 Detailed Description

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

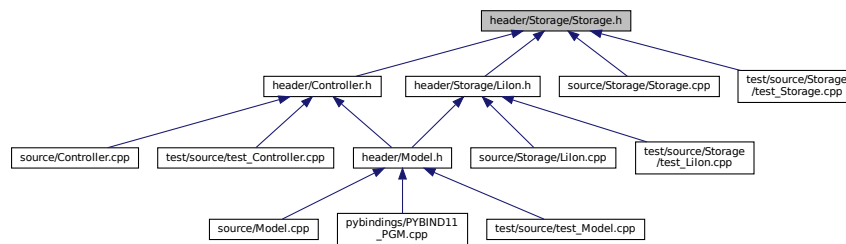
5.16 header/Storage/Storage.h File Reference

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

```
#include "../std_includes.h"
#include "../../third_party/fast-cpp-csv-parser/csv.h"
#include "../Interpolator.h"
Include dependency graph for Storage.h:
```



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



Classes

- struct [StorageInputs](#)
A structure which bundles the necessary inputs for the [Storage](#) constructor. Provides default values for every necessary input.
- class [Storage](#)
The base class of the [Storage](#) hierarchy. This hierarchy contains derived classes which model the storage of energy.

Enumerations

- enum [StorageType](#) { [LIION](#) , [N_STORAGE_TYPES](#) }
An enumeration of the types of [Storage](#) asset supported by PGMcpp.

5.16.1 Detailed Description

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

5.16.2 Enumeration Type Documentation

5.16.2.1 StorageType

enum [StorageType](#)

An enumeration of the types of [Storage](#) asset supported by PGMcpp.

Enumerator

LIION	A system of lithium ion batteries.
N_STORAGE_TYPES	A simple hack to get the number of elements in StorageType .

```

36     {
37         LIION,
```

```

38     N_STORAGE_TYPES
39 };

```

5.17 pybindings/PYBIND11_PGM.cpp File Reference

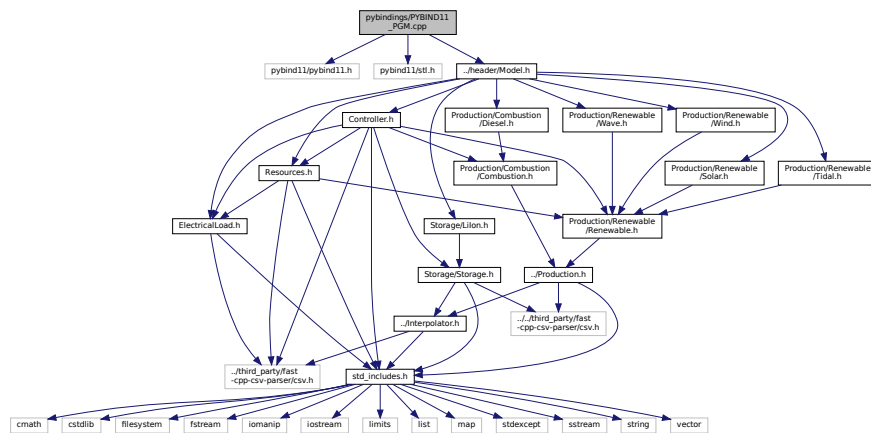
Python 3 bindings file for PGMcpp.

```

#include <pybind11/pybind11.h>
#include <pybind11/stl.h>
#include "../header/Model.h"

```

Include dependency graph for PYBIND11_PGM.cpp:



Functions

- [PYBIND11_MODULE](#) (PGMcpp, m)

5.17.1 Detailed Description

Python 3 bindings file for PGMcpp.

This is a file which defines the Python 3 bindings to be generated for PGMcpp. To generate bindings, use the provided setup.py.

ref: <https://pybind11.readthedocs.io/en/stable/>

5.17.2 Function Documentation

5.17.2.1 PYBIND11_MODULE()

```

PYBIND11_MODULE (
    PGMcpp ,
    m )
{
30
31
32 // ===== Controller ===== //
33 /*
34 pybind11::class_<Controller>(m, "Controller")
35     .def(pybind11::init());
36 */
37 // ===== END Controller ===== //
38
39
40
41 // ===== ElectricalLoad ===== //
42 /*
43 pybind11::class_<ElectricalLoad>(m, "ElectricalLoad")
44     .def_readwrite("n_points", &ElectricalLoad::n_points)
45     .def_readwrite("max_load_kW", &ElectricalLoad::max_load_kW)
46     .def_readwrite("mean_load_kW", &ElectricalLoad::mean_load_kW)
47     .def_readwrite("min_load_kW", &ElectricalLoad::min_load_kW)
48     .def_readwrite("dt_vec_hrs", &ElectricalLoad::dt_vec_hrs)
49     .def_readwrite("load_vec_kW", &ElectricalLoad::load_vec_kW)
50     .def_readwrite("time_vec_hrs", &ElectricalLoad::time_vec_hrs)
51
52     .def(pybind11::init<std::string>());
53 */
54 // ===== END ElectricalLoad ===== //
55
56
57
58 // ===== Model ===== //
59 /*
60 pybind11::class_<Model>(m, "Model")
61     .def(
62         pybind11::init<
63             ElectricalLoad*,
64             RenewableResources*
65         >()
66     );
67 */
68 // ===== END Model ===== //
69
70
71
72 // ===== RenewableResources ===== //
73 /*
74 pybind11::class_<RenewableResources>(m, "RenewableResources")
75     .def(pybind11::init());
76     /*
77     .def(pybind11::init<>());
78     */
79 */
80 // ===== END RenewableResources ===== //
81
82 } /* PYBIND11_MODULE() */

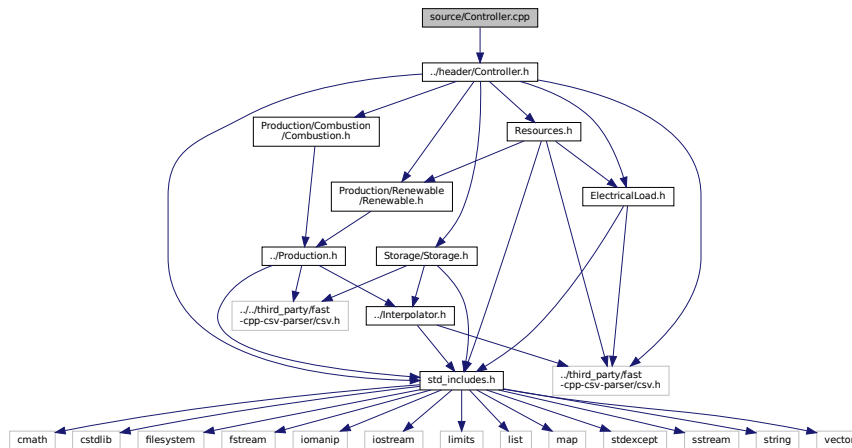
```

5.18 source/Controller.cpp File Reference

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

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

Include dependency graph for Controller.cpp:



5.18.1 Detailed Description

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

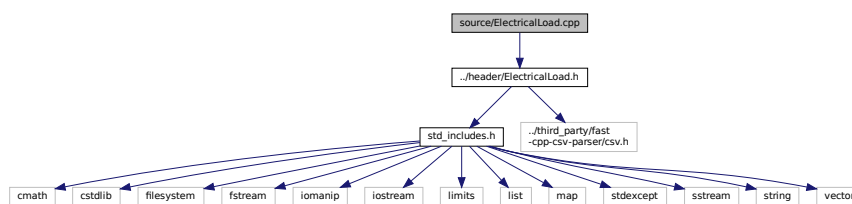
A class which contains a various dispatch control logic. Intended to serve as a component class of [Controller](#).

5.19 source/ElectricalLoad.cpp File Reference

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

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

Include dependency graph for ElectricalLoad.cpp:



5.19.1 Detailed Description

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

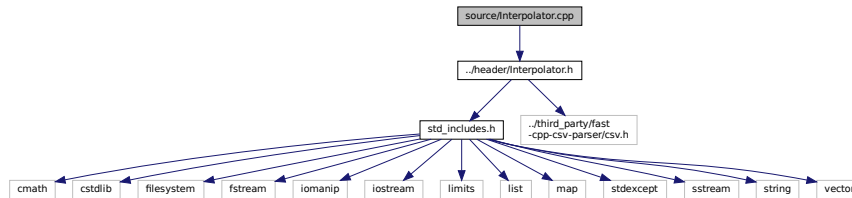
A class which contains time and electrical load data. Intended to serve as a component class of [Model](#).

5.20 source/Interpolator.cpp File Reference

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

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

Include dependency graph for Interpolator.cpp:



5.20.1 Detailed Description

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

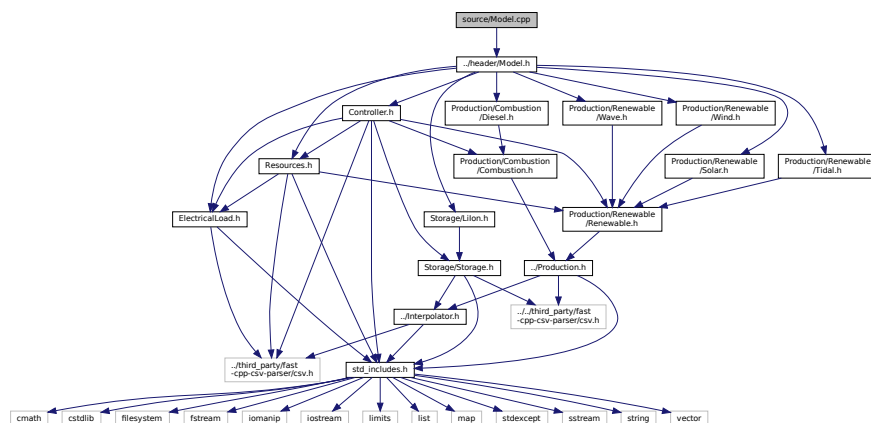
A class which contains interpolation data and functionality. Intended to serve as a

5.21 source/Model.cpp File Reference

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

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

Include dependency graph for Model.cpp:



5.21.1 Detailed Description

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

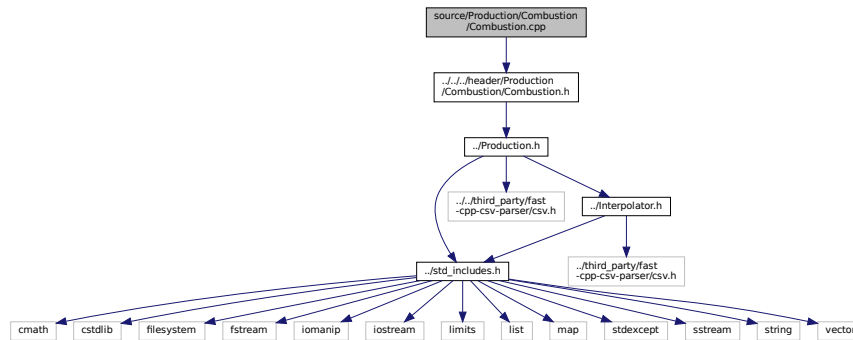
A container class which forms the centre of PGMcpp. The [Model](#) class is intended to serve as the primary user interface with the functionality of PGMcpp, and as such it contains all other classes.

5.22 source/Production/Combustion/Combustion.cpp File Reference

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

```
#include "../../../header/Production/Combustion/Combustion.h"
```

Include dependency graph for Combustion.cpp:



5.22.1 Detailed Description

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

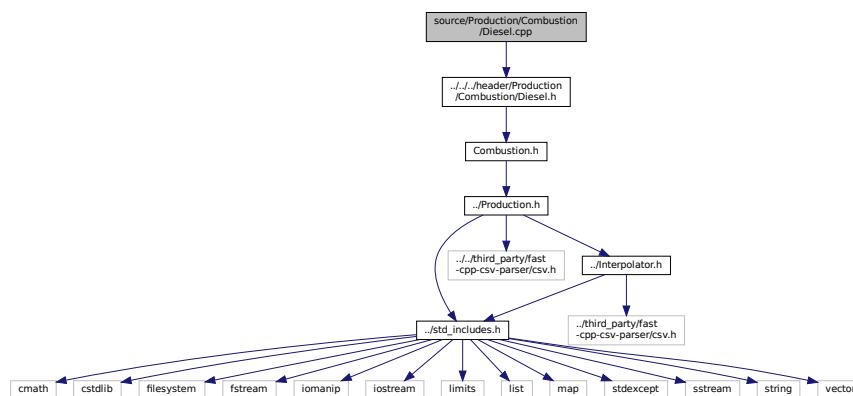
The root of the [Combustion](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the production of energy by way of combustibles.

5.23 source/Production/Combustion/Diesel.cpp File Reference

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

```
#include "../../../header/Production/Combustion/Diesel.h"
```

Include dependency graph for Diesel.cpp:



5.23.1 Detailed Description

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

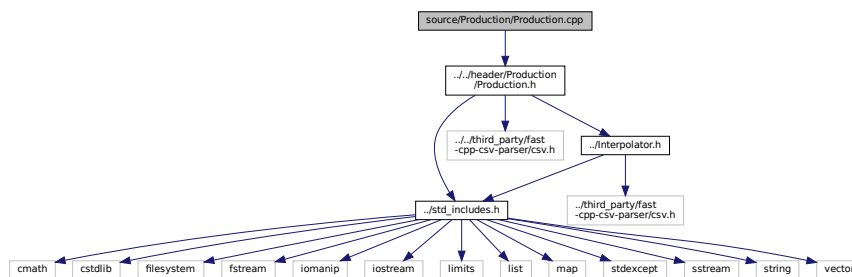
A derived class of the [Combustion](#) branch of [Production](#) which models production using a diesel generator.

5.24 source/Production/Production.cpp File Reference

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

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

Include dependency graph for Production.cpp:



5.24.1 Detailed Description

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

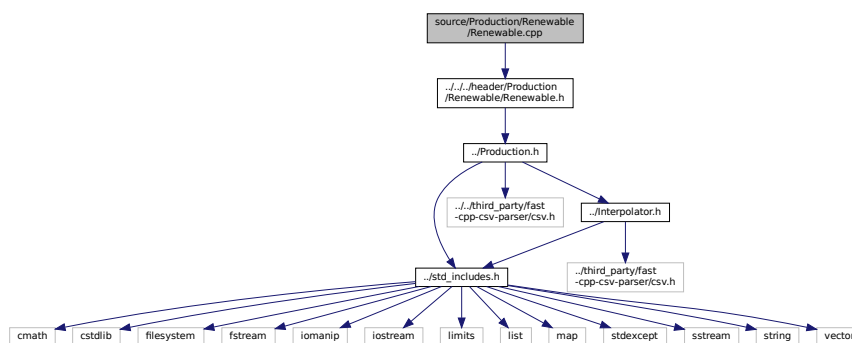
The base class of the [Production](#) hierarchy. This hierarchy contains derived classes which model the production of energy, be it renewable or otherwise.

5.25 source/Production/Renewable/Renewable.cpp File Reference

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

```
#include "../..//header/Production/Renewable/Renewable.h"
```

Include dependency graph for Renewable.cpp:



5.25.1 Detailed Description

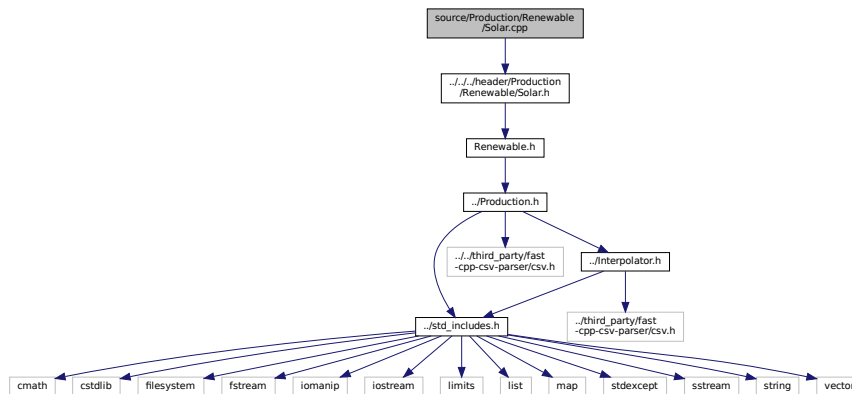
Implementation file for the [Renewable](#) class.

The root of the [Renewable](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the renewable production of energy.

5.26 source/Production/Renewable/Solar.cpp File Reference

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

```
#include "../../../../../header/Production/Renewable/Solar.h"
Include dependency graph for Solar.cpp:
```



5.26.1 Detailed Description

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

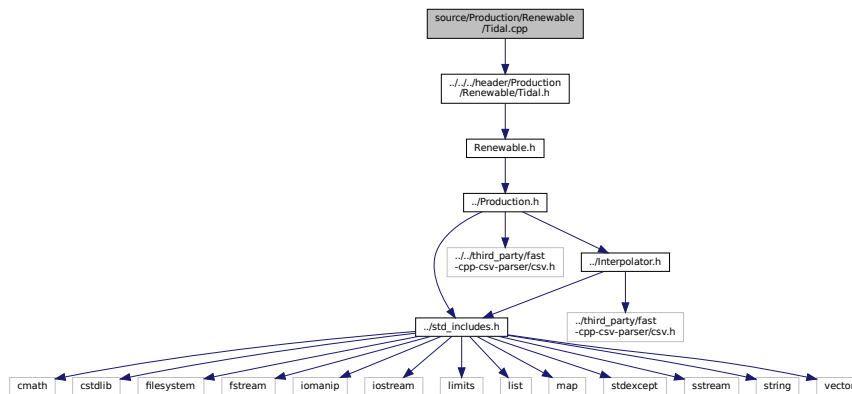
A derived class of the [Renewable](#) branch of [Production](#) which models solar production.

5.27 source/Production/Renewable/Tidal.cpp File Reference

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

```
#include "../../../header/Production/Renewable/Tidal.h"
```

Include dependency graph for Tidal.cpp:



5.27.1 Detailed Description

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

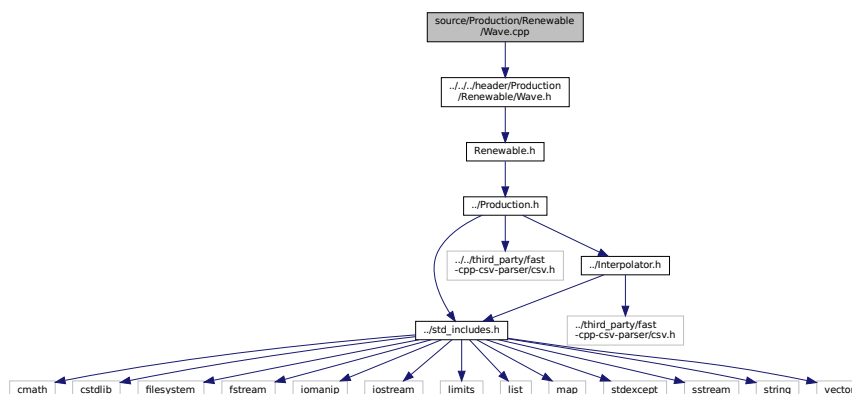
A derived class of the [Renewable](#) branch of [Production](#) which models tidal production.

5.28 source/Production/Renewable/Wave.cpp File Reference

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

```
#include "../../../header/Production/Renewable/Wave.h"
```

Include dependency graph for Wave.cpp:



5.28.1 Detailed Description

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

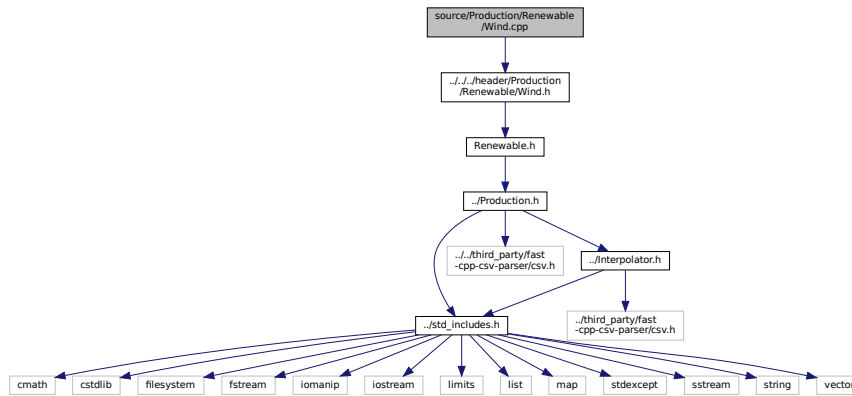
A derived class of the [Renewable](#) branch of [Production](#) which models wave production.

5.29 source/Production/Renewable/Wind.cpp File Reference

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

```
#include "../.../header/Production/Renewable/Wind.h"
```

Include dependency graph for Wind.cpp:



5.29.1 Detailed Description

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

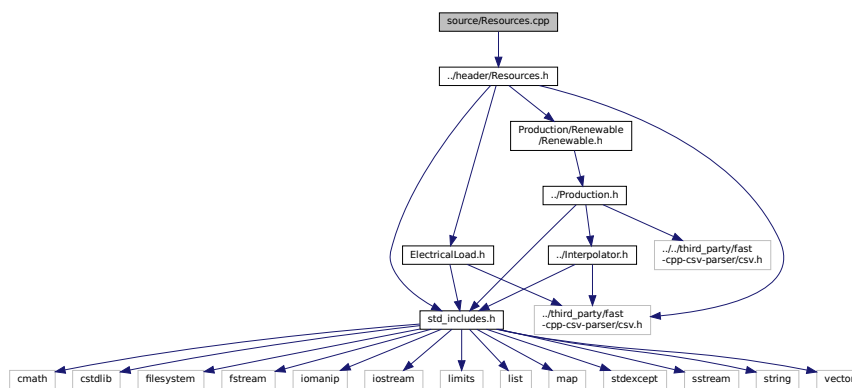
A derived class of the [Renewable](#) branch of [Production](#) which models wind production.

5.30 source/Resources.cpp File Reference

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

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

Include dependency graph for Resources.cpp:



5.30.1 Detailed Description

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

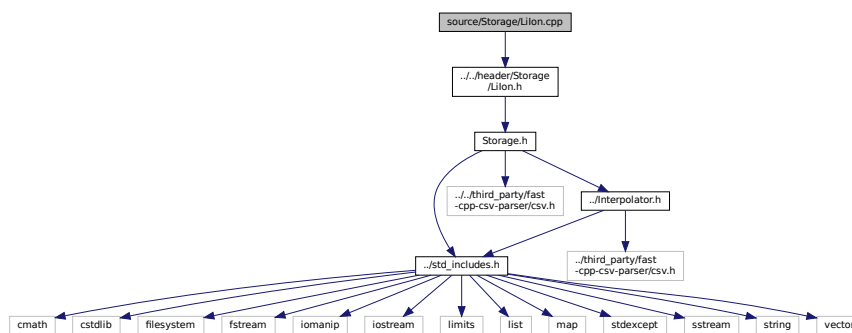
A class which contains renewable resource data. Intended to serve as a component class of [Model](#).

5.31 source/Storage/Lilon.cpp File Reference

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

```
#include "../..//header/Storage/LiIon.h"
```

Include dependency graph for Lilon.cpp:



5.31.1 Detailed Description

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

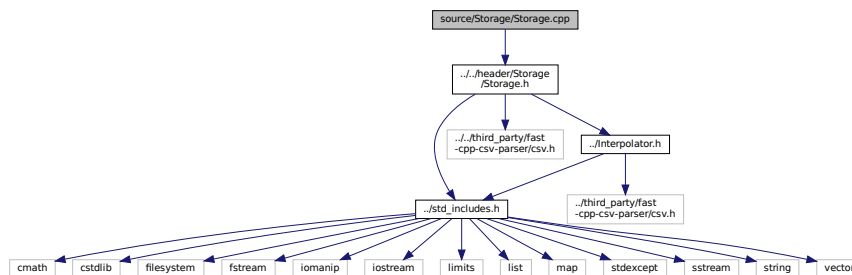
A derived class of [Storage](#) which models energy storage by way of lithium-ion batteries.

5.32 source/Storage/Storage.cpp File Reference

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

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

Include dependency graph for Storage.cpp:



5.32.1 Detailed Description

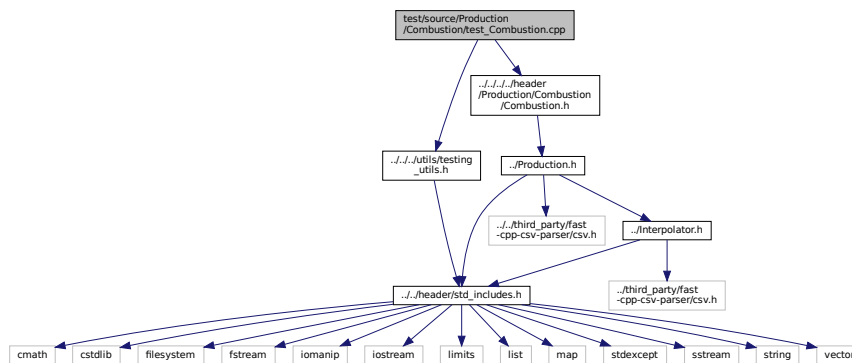
Implementation file for the [Storage](#) class.

The base class of the [Storage](#) hierarchy. This hierarchy contains derived classes which model the storage of energy.

5.33 test/source/Production/Combustion/test_Combustion.cpp File Reference

Testing suite for [Combustion](#) class.

```
#include "../../../utils/testing_utils.h"
#include "../../../header/Production/Combustion/Combustion.h"
Include dependency graph for test_Combustion.cpp:
```



Functions

- int [main](#) (int argc, char **argv)

5.33.1 Detailed Description

Testing suite for [Combustion](#) class.

A suite of tests for the [Combustion](#) class.

5.33.2 Function Documentation

5.33.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Production <-- Combustion");
33
34     srand(time(NULL));
35
36
37     try {
38
39         // ===== CONSTRUCTION ===== //
40
41         CombustionInputs combustion_inputs;
42
43         Combustion test_combustion(8760, 1, combustion_inputs);
44
45         // ===== END CONSTRUCTION ===== //
46
47
48
49         // ===== ATTRIBUTES ===== //
50
51         testTruth(
52             not combustion_inputs.production_inputs.print_flag,
53             __FILE__,
54             __LINE__
55         );
56
57         testFloatEquals(
58             test_combustion.fuel_consumption_vec_L.size(),
59             8760,
60             __FILE__,
61             __LINE__
62         );
63
64         testFloatEquals(
65             test_combustion.fuel_cost_vec.size(),
66             8760,
67             __FILE__,
68             __LINE__
69         );
70
71         testFloatEquals(
72             test_combustion.CO2_emissions_vec_kg.size(),
73             8760,
74             __FILE__,
75             __LINE__
76         );
77
78         testFloatEquals(
79             test_combustion.CO_emissions_vec_kg.size(),
80             8760,
81             __FILE__,
82             __LINE__
83         );
84
85         testFloatEquals(
86             test_combustion.NOx_emissions_vec_kg.size(),
87             8760,
88             __FILE__,
89             __LINE__
90         );
91
92         testFloatEquals(
93             test_combustion.SOx_emissions_vec_kg.size(),
94             8760,
95             __FILE__,
96             __LINE__
97         );
98
99         testFloatEquals(
100             test_combustion.CH4_emissions_vec_kg.size(),
101             8760,
102             __FILE__,
103             __LINE__
104         );
105
106         testFloatEquals(

```

```

107     test_combustion.PM_emissions_vec_kg.size(),
108     8760,
109     __FILE__,
110     __LINE__
111 );
112
113 // ===== END ATTRIBUTES ===== //
114
115 } /* try */
116
117
118 catch (...) {
119     //...
120
121     printGold(" ..... ");
122     printRed("FAIL");
123     std::cout << std::endl;
124     throw;
125 }
126
127
128 printGold(" ..... ");
129 printGreen("PASS");
130 std::cout << std::endl;
131 return 0;
132
133 } /* main() */

```

5.34 test/source/Production/Combustion/test_Diesel.cpp File Reference

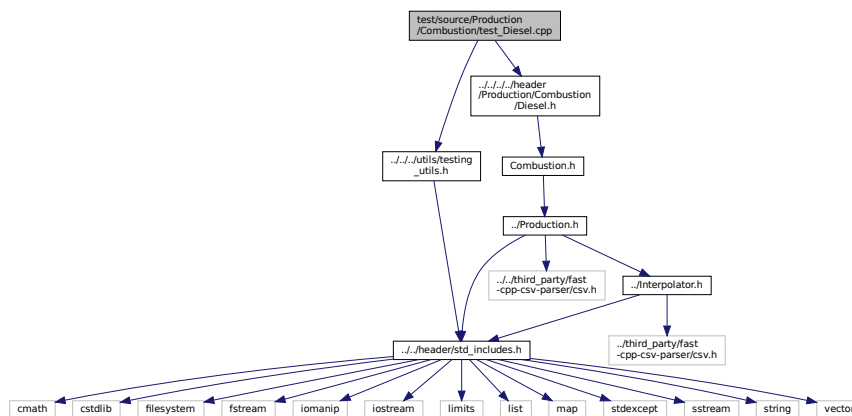
Testing suite for [Diesel](#) class.

```

#include "../../utils/testing_utils.h"
#include "../../header/Production/Combustion/Diesel.h"

```

Include dependency graph for test_Diesel.cpp:



Functions

- `int main (int argc, char **argv)`

5.34.1 Detailed Description

Testing suite for [Diesel](#) class.

A suite of tests for the [Diesel](#) class.

5.34.2 Function Documentation

5.34.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Production <-- Combustion <-- Diesel");
33
34     srand(time(NULL));
35
36     Combustion* test_diesel_ptr;
37
38
39     try {
40
41         // ===== CONSTRUCTION ===== //
42
43         bool error_flag = true;
44
45         try {
46             DieselInputs bad_diesel_inputs;
47             bad_diesel_inputs.fuel_cost_L = -1;
48
49             Diesel bad_diesel(8760, 1, bad_diesel_inputs);
50
51             error_flag = false;
52         } catch (...) {
53             // Task failed successfully! =P
54         }
55         if (not error_flag) {
56             expectedErrorNotDetected(__FILE__, __LINE__);
57         }
58         DieselInputs diesel_inputs;
59
60         test_diesel_ptr = new Diesel(8760, 1, diesel_inputs);
61
62
63         // ===== END CONSTRUCTION ===== //
64
65
66
67         // ===== ATTRIBUTES ===== //
68
69
70         testTruth(
71             not diesel_inputs.combustion_inputs.production_inputs.print_flag,
72             __FILE__,
73             __LINE__
74         );
75
76         testFloatEquals(
77             test_diesel_ptr->type,
78             CombustionType :: DIESEL,
79             __FILE__,
80             __LINE__
81         );
82
83         testTruth(
84             test_diesel_ptr->type_str == "DIESEL",
85             __FILE__,
86             __LINE__
87         );
88
89         testFloatEquals(
90             test_diesel_ptr->linear_fuel_slope_LkWh,
91             0.265675,
92             __FILE__,
93             __LINE__
94         );
95
96         testFloatEquals(
97             test_diesel_ptr->linear_fuel_intercept_LkWh,

```

```

98     0.026676,
99     __FILE__,
100    __LINE__
101 );
102
103 testFloatEquals(
104     test_diesel_ptr->capital_cost,
105     94125.375446,
106     __FILE__,
107     __LINE__
108 );
109
110 testFloatEquals(
111     test_diesel_ptr->operation_maintenance_cost_kWh,
112     0.069905,
113     __FILE__,
114     __LINE__
115 );
116
117 testFloatEquals(
118     ((Diesel*)test_diesel_ptr)->minimum_load_ratio,
119     0.2,
120     __FILE__,
121     __LINE__
122 );
123
124 testFloatEquals(
125     ((Diesel*)test_diesel_ptr)->minimum_runtime_hrs,
126     4,
127     __FILE__,
128     __LINE__
129 );
130
131 testFloatEquals(
132     test_diesel_ptr->replace_running_hrs,
133     30000,
134     __FILE__,
135     __LINE__
136 );
137
138 // ===== END ATTRIBUTES ===== //
139
140
141
142 // ===== METHODS ===== //
143
144 // test capacity constraint
145 testFloatEquals(
146     test_diesel_ptr->requestProductionkW(0, 1, 2 * test_diesel_ptr->capacity_kW),
147     test_diesel_ptr->capacity_kW,
148     __FILE__,
149     __LINE__
150 );
151
152 // test minimum load ratio constraint
153 testFloatEquals(
154     test_diesel_ptr->requestProductionkW(
155         0,
156         1,
157         0.5 * ((Diesel*)test_diesel_ptr)->minimum_load_ratio *
158             test_diesel_ptr->capacity_kW
159     ),
160     ((Diesel*)test_diesel_ptr)->minimum_load_ratio * test_diesel_ptr->capacity_kW,
161     __FILE__,
162     __LINE__
163 );
164
165 // test commit()
166 std::vector<double> dt_vec_hrs (48, 1);
167
168 std::vector<double> load_vec_kW = {
169     1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1,
170     1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0,
171     1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1,
172     1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0
173 };
174
175 std::vector<bool> expected_is_running_vec = {
176     1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1,
177     1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1,
178     1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1,
179     1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0
180 };
181
182 double load_kW = 0;
183 double production_kW = 0;
184 double roll = 0;

```

```

185
186 for (int i = 0; i < 48; i++) {
187     roll = (double)rand() / RAND_MAX;
188
189     if (roll >= 0.95) {
190         roll = 1.25;
191     }
192
193     load_vec_kW[i] *= roll * test_diesel_ptr->capacity_kW;
194     load_kW = load_vec_kW[i];
195
196     production_kW = test_diesel_ptr->requestProductionkW(
197         i,
198         dt_vec_hrs[i],
199         load_kW
200     );
201
202     load_kW = test_diesel_ptr->commit(
203         i,
204         dt_vec_hrs[i],
205         production_kW,
206         load_kW
207     );
208
209     // load_kW <= load_vec_kW (i.e., after vs before)
210     testLessThanOrEqualTo(
211         load_kW,
212         load_vec_kW[i],
213         __FILE__,
214         __LINE__
215     );
216
217     // production = dispatch + storage + curtailment
218     testFloatEquals(
219         test_diesel_ptr->production_vec_kW[i] -
220         test_diesel_ptr->dispatch_vec_kW[i] -
221         test_diesel_ptr->storage_vec_kW[i] -
222         test_diesel_ptr->curtailment_vec_kW[i],
223         0,
224         __FILE__,
225         __LINE__
226     );
227
228     // capacity constraint
229     if (load_vec_kW[i] > test_diesel_ptr->capacity_kW) {
230         testFloatEquals(
231             test_diesel_ptr->production_vec_kW[i],
232             test_diesel_ptr->capacity_kW,
233             __FILE__,
234             __LINE__
235         );
236     }
237
238     // minimum load ratio constraint
239     else if (
240         test_diesel_ptr->is_running and
241         test_diesel_ptr->production_vec_kW[i] > 0 and
242         load_vec_kW[i] <
243         ((Diesel*)test_diesel_ptr)->minimum_load_ratio * test_diesel_ptr->capacity_kW
244     ) {
245         testFloatEquals(
246             test_diesel_ptr->production_vec_kW[i],
247             ((Diesel*)test_diesel_ptr)->minimum_load_ratio *
248             test_diesel_ptr->capacity_kW,
249             __FILE__,
250             __LINE__
251         );
252     }
253
254     // minimum runtime constraint
255     testFloatEquals(
256         test_diesel_ptr->is_running_vec[i],
257         expected_is_running_vec[i],
258         __FILE__,
259         __LINE__
260     );
261
262     // O&M, fuel consumption, and emissions > 0 whenever diesel is running
263     if (test_diesel_ptr->is_running) {
264         testGreaterThan(
265             test_diesel_ptr->operation_maintenance_cost_vec[i],
266             0,
267             __FILE__,
268             __LINE__
269         );
270
271         testGreaterThan(

```

```

272         test_diesel_ptr->fuel_consumption_vec_L[i],
273         0,
274         __FILE__,
275         __LINE__
276     );
277
278     testGreaterThan(
279         test_diesel_ptr->fuel_cost_vec[i],
280         0,
281         __FILE__,
282         __LINE__
283     );
284
285     testGreaterThan(
286         test_diesel_ptr->CO2_emissions_vec_kg[i],
287         0,
288         __FILE__,
289         __LINE__
290     );
291
292     testGreaterThan(
293         test_diesel_ptr->CO_emissions_vec_kg[i],
294         0,
295         __FILE__,
296         __LINE__
297     );
298
299     testGreaterThan(
300         test_diesel_ptr->NOx_emissions_vec_kg[i],
301         0,
302         __FILE__,
303         __LINE__
304     );
305
306     testGreaterThan(
307         test_diesel_ptr->SOx_emissions_vec_kg[i],
308         0,
309         __FILE__,
310         __LINE__
311     );
312
313     testGreaterThan(
314         test_diesel_ptr->CH4_emissions_vec_kg[i],
315         0,
316         __FILE__,
317         __LINE__
318     );
319
320     testGreaterThan(
321         test_diesel_ptr->PM_emissions_vec_kg[i],
322         0,
323         __FILE__,
324         __LINE__
325     );
326 }
327
328 // O&M, fuel consumption, and emissions = 0 whenever diesel is not running
329 else {
330     testFloatEquals(
331         test_diesel_ptr->operation_maintenance_cost_vec[i],
332         0,
333         __FILE__,
334         __LINE__
335     );
336
337     testFloatEquals(
338         test_diesel_ptr->fuel_consumption_vec_L[i],
339         0,
340         __FILE__,
341         __LINE__
342     );
343
344     testFloatEquals(
345         test_diesel_ptr->fuel_cost_vec[i],
346         0,
347         __FILE__,
348         __LINE__
349     );
350
351     testFloatEquals(
352         test_diesel_ptr->CO2_emissions_vec_kg[i],
353         0,
354         __FILE__,
355         __LINE__
356     );
357
358     testFloatEquals(

```

```

359         test_diesel_ptr->CO_emissions_vec_kg[i],
360         0,
361         __FILE__,
362         __LINE__
363     );
364
365     testFloatEquals(
366         test_diesel_ptr->NOx_emissions_vec_kg[i],
367         0,
368         __FILE__,
369         __LINE__
370     );
371
372     testFloatEquals(
373         test_diesel_ptr->SOx_emissions_vec_kg[i],
374         0,
375         __FILE__,
376         __LINE__
377     );
378
379     testFloatEquals(
380         test_diesel_ptr->CH4_emissions_vec_kg[i],
381         0,
382         __FILE__,
383         __LINE__
384     );
385
386     testFloatEquals(
387         test_diesel_ptr->PM_emissions_vec_kg[i],
388         0,
389         __FILE__,
390         __LINE__
391     );
392 }
393 }
394
395 // ===== END METHODS ===== //
396
397 } /* try */
398
399 catch (...) {
400     delete test_diesel_ptr;
401
402     printGold(" ... ");
403     printRed("FAIL");
404     std::cout << std::endl;
405     throw;
406 }
407
408
409 delete test_diesel_ptr;
410
411 printGold(" ... ");
412 printGreen("PASS");
413 std::cout << std::endl;
414 return 0;
415
416
417 } /* main() */

```

5.35 test/source/Production/Renewable/test_Renewable.cpp File Reference

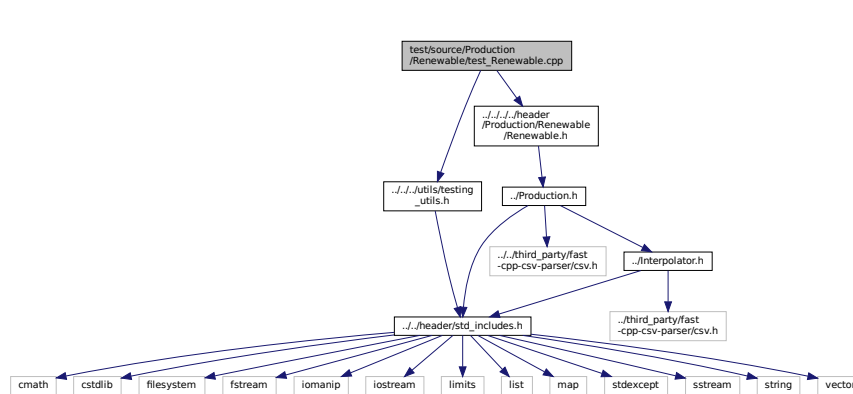
Testing suite for [Renewable](#) class.

```

#include "../.../utils/testing_utils.h"
#include "../.../header/Production/Renewable/Renewable.h"

```

Include dependency graph for test_Renewable.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.35.1 Detailed Description

Testing suite for [Renewable](#) class.

A suite of tests for the [Renewable](#) class.

5.35.2 Function Documentation

5.35.2.1 main()

```

int main (
    int argc,
    char ** argv )
{
    27 {
    28     #ifdef _WIN32
    29         activateVirtualTerminal();
    30     #endif /* _WIN32 */
    31
    32     printGold("\tTesting Production <-- Renewable");
    33
    34     srand(time(NULL));
    35
    36
    37     try {
    38
    39         // ===== CONSTRUCTION ===== //
    40
    41         RenewableInputs renewable_inputs;
    42
    43         Renewable test_renewable(8760, 1, renewable_inputs);
    44
    45         // ===== END CONSTRUCTION ===== //
    46
    47
    48
    49
    50
    51
    52
    53
    54
    55
    56
    57
    58
    59
    60
    61
    62
    63
    64
    65
    66
    67
    68
    69
    70
    71
    72
    73
    74
    75
    76
    77
    78
    79
    80
    81
    82
    83
    84
    85
    86
    87
    88
    89
    90
    91
    92
    93
    94
    95
    96
    97
    98
    99
    100
    101
    102
    103
    104
    105
    106
    107
    108
    109
    110
    111
    112
    113
    114
    115
    116
    117
    118
    119
    120
    121
    122
    123
    124
    125
    126
    127
    128
    129
    130
    131
    132
    133
    134
    135
    136
    137
    138
    139
    140
    141
    142
    143
    144
    145
    146
    147
    148
    149
    150
    151
    152
    153
    154
    155
    156
    157
    158
    159
    160
    161
    162
    163
    164
    165
    166
    167
    168
    169
    170
    171
    172
    173
    174
    175
    176
    177
    178
    179
    180
    181
    182
    183
    184
    185
    186
    187
    188
    189
    190
    191
    192
    193
    194
    195
    196
    197
    198
    199
    200
    201
    202
    203
    204
    205
    206
    207
    208
    209
    210
    211
    212
    213
    214
    215
    216
    217
    218
    219
    220
    221
    222
    223
    224
    225
    226
    227
    228
    229
    230
    231
    232
    233
    234
    235
    236
    237
    238
    239
    240
    241
    242
    243
    244
    245
    246
    247
    248
    249
    250
    251
    252
    253
    254
    255
    256
    257
    258
    259
    260
    261
    262
    263
    264
    265
    266
    267
    268
    269
    270
    271
    272
    273
    274
    275
    276
    277
    278
    279
    280
    281
    282
    283
    284
    285
    286
    287
    288
    289
    290
    291
    292
    293
    294
    295
    296
    297
    298
    299
    300
    301
    302
    303
    304
    305
    306
    307
    308
    309
    310
    311
    312
    313
    314
    315
    316
    317
    318
    319
    320
    321
    322
    323
    324
    325
    326
    327
    328
    329
    330
    331
    332
    333
    334
    335
    336
    337
    338
    339
    340
    341
    342
    343
    344
    345
    346
    347
    348
    349
    350
    351
    352
    353
    354
    355
    356
    357
    358
    359
    360
    361
    362
    363
    364
    365
    366
    367
    368
    369
    370
    371
    372
    373
    374
    375
    376
    377
    378
    379
    380
    381
    382
    383
    384
    385
    386
    387
    388
    389
    390
    391
    392
    393
    394
    395
    396
    397
    398
    399
    400
    401
    402
    403
    404
    405
    406
    407
    408
    409
    410
    411
    412
    413
    414
    415
    416
    417
    418
    419
    420
    421
    422
    423
    424
    425
    426
    427
    428
    429
    430
    431
    432
    433
    434
    435
    436
    437
    438
    439
    440
    441
    442
    443
    444
    445
    446
    447
    448
    449
    450
    451
    452
    453
    454
    455
    456
    457
    458
    459
    460
    461
    462
    463
    464
    465
    466
    467
    468
    469
    470
    471
    472
    473
    474
    475
    476
    477
    478
    479
    480
    481
    482
    483
    484
    485
    486
    487
    488
    489
    490
    491
    492
    493
    494
    495
    496
    497
    498
    499
    500
    501
    502
    503
    504
    505
    506
    507
    508
    509
    510
    511
    512
    513
    514
    515
    516
    517
    518
    519
    520
    521
    522
    523
    524
    525
    526
    527
    528
    529
    530
    531
    532
    533
    534
    535
    536
    537
    538
    539
    540
    541
    542
    543
    544
    545
    546
    547
    548
    549
    550
    551
    552
    553
    554
    555
    556
    557
    558
    559
    560
    561
    562
    563
    564
    565
    566
    567
    568
    569
    570
    571
    572
    573
    574
    575
    576
    577
    578
    579
    580
    581
    582
    583
    584
    585
    586
    587
    588
    589
    590
    591
    592
    593
    594
    595
    596
    597
    598
    599
    600
    601
    602
    603
    604
    605
    606
    607
    608
    609
    610
    611
    612
    613
    614
    615
    616
    617
    618
    619
    620
    621
    622
    623
    624
    625
    626
    627
    628
    629
    630
    631
    632
    633
    634
    635
    636
    637
    638
    639
    640
    641
    642
    643
    644
    645
    646
    647
    648
    649
    650
    651
    652
    653
    654
    655
    656
    657
    658
    659
    660
    661
    662
    663
    664
    665
    666
    667
    668
    669
    670
    671
    672
    673
    674
    675
    676
    677
    678
    679
    680
    681
    682
    683
    684
    685
    686
    687
    688
    689
    690
    691
    692
    693
    694
    695
    696
    697
    698
    699
    700
    701
    702
    703
    704
    705
    706
    707
    708
    709
    710
    711
    712
    713
    714
    715
    716
    717
    718
    719
    720
    721
    722
    723
    724
    725
    726
    727
    728
    729
    730
    731
    732
    733
    734
    735
    736
    737
    738
    739
    740
    741
    742
    743
    744
    745
    746
    747
    748
    749
    750
    751
    752
    753
    754
    755
    756
    757
    758
    759
    760
    761
    762
    763
    764
    765
    766
    767
    768
    769
    770
    771
    772
    773
    774
    775
    776
    777
    778
    779
    780
    781
    782
    783
    784
    785
    786
    787
    788
    789
    790
    791
    792
    793
    794
    795
    796
    797
    798
    799
    800
    801
    802
    803
    804
    805
    806
    807
    808
    809
    810
    811
    812
    813
    814
    815
    816
    817
    818
    819
    820
    821
    822
    823
    824
    825
    826
    827
    828
    829
    830
    831
    832
    833
    834
    835
    836
    837
    838
    839
    840
    841
    842
    843
    844
    845
    846
    847
    848
    849
    850
    851
    852
    853
    854
    855
    856
    857
    858
    859
    860
    861
    862
    863
    864
    865
    866
    867
    868
    869
    870
    871
    872
    873
    874
    875
    876
    877
    878
    879
    880
    881
    882
    883
    884
    885
    886
    887
    888
    889
    890
    891
    892
    893
    894
    895
    896
    897
    898
    899
    900
    901
    902
    903
    904
    905
    906
    907
    908
    909
    910
    911
    912
    913
    914
    915
    916
    917
    918
    919
    920
    921
    922
    923
    924
    925
    926
    927
    928
    929
    930
    931
    932
    933
    934
    935
    936
    937
    938
    939
    940
    941
    942
    943
    944
    945
    946
    947
    948
    949
    950
    951
    952
    953
    954
    955
    956
    957
    958
    959
    960
    961
    962
    963
    964
    965
    966
    967
    968
    969
    970
    971
    972
    973
    974
    975
    976
    977
    978
    979
    980
    981
    982
    983
    984
    985
    986
    987
    988
    989
    990
    991
    992
    993
    994
    995
    996
    997
    998
    999
    1000
    1001
    1002
    1003
    1004
    1005
    1006
    1007
    1008
    1009
    1010
    1011
    1012
    1013
    1014
    1015
    1016
    1017
    1018
    1019
    1020
    1021
    1022
    1023
    1024
    1025
    1026
    1027
    1028
    1029
    1030
    1031
    1032
    1033
    1034
    1035
    1036
    1037
    1038
    1039
    1040
    1041
    1042
    1043
    1044
    1045
    1046
    1047
    1048
    1049
    1050
    1051
    1052
    1053
    1054
    1055
    1056
    1057
    1058
    1059
    1060
    1061
    1062
    1063
    1064
    1065
    1066
    1067
    1068
    1069
    1070
    1071
    1072
    1073
    1074
    1075
    1076
    1077
    1078
    1079
    1080
    1081
    1082
    1083
    1084
    1085
    1086
    1087
    1088
    1089
    1090
    1091
    1092
    1093
    1094
    1095
    1096
    1097
    1098
    1099
    1100
    1101
    1102
    1103
    1104
    1105
    1106
    1107
    1108
    1109
    1110
    1111
    1112
    1113
    1114
    1115
    1116
    1117
    1118
    1119
    1120
    1121
    1122
    1123
    1124
    1125
    1126
    1127
    1128
    1129
    1130
    1131
    1132
    1133
    1134
    1135
    1136
    1137
    1138
    1139
    1140
    1141
    1142
    1143
    1144
    1145
    1146
    1147
    1148
    1149
    1150
    1151
    1152
    1153
    1154
    1155
    1156
    1157
    1158
    1159
    1160
    1161
    1162
    1163
    1164
    1165
    1166
    1167
    1168
    1169
    1170
    1171
    1172
    1173
    1174
    1175
    1176
    1177
    1178
    1179
    1180
    1181
    1182
    1183
    1184
    1185
    1186
    1187
    1188
    1189
    1190
    1191
    1192
    1193
    1194
    1195
    1196
    1197
    1198
    1199
    1200
    1201
    1202
    1203
    1204
    1205
    1206
    1207
    1208
    1209
    1210
    1211
    1212
    1213
    1214
    1215
    1216
    1217
    1218
    1219
    1220
    1221
    1222
    1223
    1224
    1225
    1226
    1227
    1228
    1229
    1230
    1231
    1232
    1233
    1234
    1235
    1236
    1237
    1238
    1239
    1240
    1241
    1242
    1243
    1244
    1245
    1246
    1247
    1248
    1249
    1250
    1251
    1252
    1253
    1254
    1255
    1256
    1257
    1258
    1259
    1260
    1261
    1262
    1263
    1264
    1265
    1266
    1267
    1268
    1269
    1270
    1271
    1272
    1273
    1274
    1275
    1276
    1277
    1278
    1279
    1280
    1281
    1282
    1283
    1284
    1285
    1286
    1287
    1288
    1289
    1290
    1291
    1292
    1293
    1294
    1295
    1296
    1297
    1298
    1299
    1300
    1301
    1302
    1303
    1304
    1305
    1306
    1307
    1308
    1309
    1310
    1311
    1312
    1313
    1314
    1315
    1316
    1317
    1318
    1319
    1320
    1321
    1322
    1323
    1324
    1325
    1326
    1327
    1328
    1329
    1330
    1331
    1332
    1333
    1334
    1335
    1336
    1337
    1338
    1339
    1340
    1341
    1342
    1343
    1344
    1345
    1346
    1347
    1348
    1349
    1350
    1351
    1352
    1353
    1354
    1355
    1356
    1357
    1358
    1359
    1360
    1361
    1362
    1363
    1364
    1365
    1366
    1367
    1368
    1369
    1370
    1371
    1372
    1373
    1374
    1375
    1376
    1377
    1378
    1379
    1380
    1381
    1382
    1383
    1384
    1385
    1386
    1387
    1388
    1389
    1390
    1391
    1392
    1393
    1394
    1395
    1396
    1397
    1398
    1399
    1400
    1401
    1402
    1403
    1404
    1405
    1406
    1407
    1408
    1409
    1410
    1411
    1412
    1413
    1414
    1415
    1416
    1417
    1418
    1419
    1420
    1421
    1422
    1423
    1424
    1425
    1426
    1427
    1428
    1429
    1430
    1431
    1432
    1433
    1434
    1435
    1436
    1437
    1438
    1439
    1440
    1441
    1442
    1443
    1444
    1445
    1446
    1447
    1448
    1449
    1450
    1451
    1452
    1453
    1454
    1455
    1456
    1457
    1458
    1459
    1460
    1461
    1462
    1463
    1464
    1465
    1466
    1467
    1468
    1469
    1470
    1471
    1472
    1473
    1474
    1475
    1476
    1477
    1478
    1479
    1480
    1481
    1482
    1483
    1484
    1485
    1486
    1487
    1488
    1489
    1490
    1491
    1492
    1493
    1494
    1495
    1496
    1497
    1498
    1499
    1500
    1501
    1502
    1503
    1504
    1505
    1506
    1507
    1508
    1509
    1510
    1511
    1512
    1513
    1514
    1515
    1516
    1517
    1518
    1519
    1520
    1521
    1522
    1523
    1524
    1525
    1526
    1527
    1528
    1529
    1530
    1531
    1532
    1533
    1534
    1535
    1536
    1537
    1538
    1539
    1540
    1541
    1542
    1543
    1544
    1545
    1546
    1547
    1548
    1549
    1550
    1551
    1552
    1553
    1554
    1555
    1556
    1557
    1558
    1559
    1560
    1561
    1562
    1563
    1564
    1565
    1566
    1567
    1568
    1569
    1570
    1571
    1572
    1573
    1574
    1575
    1576
    1577
    1578
    1579
    1580
    1581
    1582
    1583
    1584
    1585
    1586
    1587
    1588
    1589
    1590
    1591
    1592
    1593
    1594
    1595
    1596
    1597
    1598
    1599
    1600
    1601
    1602
    1603
    1604
    1605
    1606
    1607
    1608
    1609
    1610
    1611
    1612
    1613
    1614
    1615
    1616
    1617
    1618
    1619
    1620
    1621
    1622
    1623
    1624
    1625
    1626
    1627
    1628
    1629
    1630
    1631
    1632
    1633
    1634
    1635
    1636
    1637
    1638
    1639
    1640
    1641
    1642
    1643
    1644
    1645
    1646
    1647
    1648
    1649
    1650
    1651
    1652
    1653
    1654
    1655
    1656
    1657
    1658
    1659
    1660
    1661
    1662
    1663
    1664
    1665
    1666
    1667
    1668
    1669
    1670
    1671
    1672
    1673
    1674
    1675
    1676
    1677
    1678
    1679
    1680
    1681
    1682
    1683
    1684
    1685
    1686
    1687
    1688
    1689
    1690
    1691
    1692
    1693
    1694
    1695
    1696
    1697
    1698
    1699
    1700
    1701
    1702
    1703
    1704
    1705
    1706
    1707
    1708
    1709
    1710
    1711
    1712
    1713
    1714
    1715
    1716
    1717
    1718
    1719
    1720
    1721
    1722
    1723
    1724
    1725
    1726
    1727
    1728
    1729
    1730
    1731
    1732
    1733
    1734
    1735
    1736
    1737
    1738
    1739
    1740
    1741
    1742
    1743
    1744
    1745
    1746
    1747
    1748
    1749
    1750
    1751
    1752
    1753
    1754
    1755
    1756
    1757
    1758
    1759
    1760
    1761
    1762
    1763
    1764
    1765
    1766
    1767
    1768
    1769
    1770
    1771
    1772
    1773
    1774
    1775
    1776
    1777
    1778
    1779
    1780
    1781
    1782
    1783
    1784
    1785
    1786
    1787
    1788
    1789
    1790
    1791
    1792
    1793
    1794
    1795
   
```



```

49 // ===== ATTRIBUTES ===== //
50
51 testTruth(
52     not renewable_inputs.production_inputs.print_flag,
53     __FILE__,
54     __LINE__
55 );
56
57 // ===== END ATTRIBUTES ===== //
58
59 } /* try */
60
61
62 catch (...) {
63     //...
64
65     printGold(" ..... ");
66     printRed("FAIL");
67     std::cout << std::endl;
68     throw;
69 }
70
71
72 printGold(" ..... ");
73 printGreen("PASS");
74 std::cout << std::endl;
75 return 0;
76 } /* main() */

```

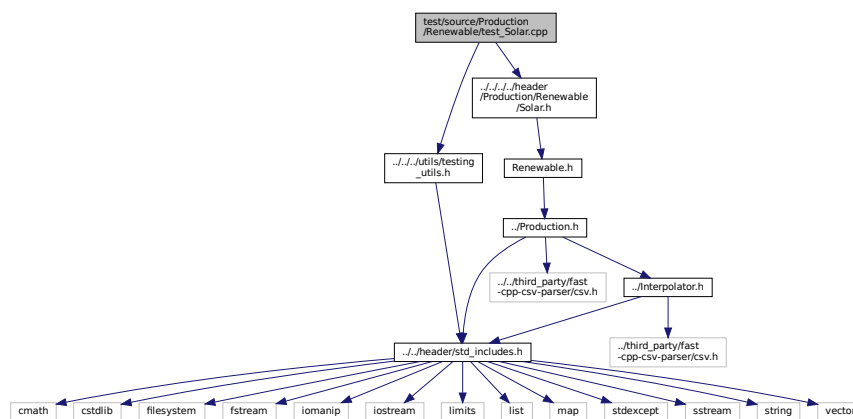
5.36 test/source/Production/Renewable/test_Solar.cpp File Reference

Testing suite for [Solar](#) class.

```
#include "../.../utils/testing_utils.h"
```

```
#include "../.../header/Production/Renewable/Solar.h"
```

Include dependency graph for test_Solar.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.36.1 Detailed Description

Testing suite for [Solar](#) class.

A suite of tests for the [Solar](#) class.

5.36.2 Function Documentation

5.36.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Production <-- Renewable <-- Solar");
33
34     srand(time(NULL));
35
36     Renewable* test_solar_ptr;
37
38     try {
39
40         // ===== CONSTRUCTION ===== //
41
42         bool error_flag = true;
43
44         try {
45             SolarInputs bad_solar_inputs;
46             bad_solar_inputs.derating = -1;
47
48             Solar bad_solar(8760, 1, bad_solar_inputs);
49
50             error_flag = false;
51         } catch (...) {
52             // Task failed successfully! =P
53         }
54         if (not error_flag) {
55             expectedErrorNotDetected(__FILE__, __LINE__);
56         }
57
58         SolarInputs solar_inputs;
59
60         test_solar_ptr = new Solar(8760, 1, solar_inputs);
61
62         // ===== END CONSTRUCTION ===== //
63
64
65
66         // ===== ATTRIBUTES ===== //
67
68         testTruth(
69             not solar_inputs.renewable_inputs.production_inputs.print_flag,
70             __FILE__,
71             __LINE__
72 );
73
74         testFloatEquals(
75             test_solar_ptr->type,
76             RenewableType :: SOLAR,
77             __FILE__,
78             __LINE__
79 );
80
81         testTruth(
82             test_solar_ptr->type_str == "SOLAR",
83             __FILE__,
84             __LINE__
85 );
86
87         testFloatEquals(
88             test_solar_ptr->capital_cost,
89             350118.723363,
90             __FILE__,
91             __LINE__
92 );
93
94         testFloatEquals(
95             test_solar_ptr->operation_maintenance_cost_kWh,
96             0.01,
97             __FILE__,

```

```

98     __LINE__
99 );
100
101 // ===== END ATTRIBUTES ===== //
102
103
104
105 // ===== METHODS ===== //
106
107 // test production constraints
108 testFloatEquals(
109     test_solar_ptr->computeProductionkW(0, 1, 2),
110     100,
111     __FILE__,
112     __LINE__
113 );
114
115 testFloatEquals(
116     test_solar_ptr->computeProductionkW(0, 1, -1),
117     0,
118     __FILE__,
119     __LINE__
120 );
121
122 // test commit()
123 std::vector<double> dt_vec_hrs (48, 1);
124
125 std::vector<double> load_vec_kW = {
126     1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1,
127     1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0,
128     1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1,
129     1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0
130 };
131
132 double load_kW = 0;
133 double production_kW = 0;
134 double roll = 0;
135 double solar_resource_kWm2 = 0;
136
137 for (int i = 0; i < 48; i++) {
138     roll = (double)rand() / RAND_MAX;
139
140     solar_resource_kWm2 = roll;
141
142     roll = (double)rand() / RAND_MAX;
143
144     if (roll <= 0.1) {
145         solar_resource_kWm2 = 0;
146     }
147
148     else if (roll >= 0.95) {
149         solar_resource_kWm2 = 1.25;
150     }
151
152     roll = (double)rand() / RAND_MAX;
153
154     if (roll >= 0.95) {
155         roll = 1.25;
156     }
157
158     load_vec_kW[i] *= roll * test_solar_ptr->capacity_kW;
159     load_kW = load_vec_kW[i];
160
161     production_kW = test_solar_ptr->computeProductionkW(
162         i,
163         dt_vec_hrs[i],
164         solar_resource_kWm2
165     );
166
167     load_kW = test_solar_ptr->commit(
168         i,
169         dt_vec_hrs[i],
170         production_kW,
171         load_kW
172     );
173
174     // is running (or not) as expected
175     if (solar_resource_kWm2 > 0) {
176         testTruth(
177             test_solar_ptr->is_running,
178             __FILE__,
179             __LINE__
180         );
181     }
182
183     else {
184         testTruth(

```

```

185         not test_solar_ptr->is_running,
186         __FILE__,
187         __LINE__
188     );
189 }
190
191 // load_kW <= load_vec_kW (i.e., after vs before)
192 testLessThanOrEqualTo(
193     load_kW,
194     load_vec_kW[i],
195     __FILE__,
196     __LINE__
197 );
198
199 // production = dispatch + storage + curtailment
200 testFloatEquals(
201     test_solar_ptr->production_vec_kW[i] -
202     test_solar_ptr->dispatch_vec_kW[i] -
203     test_solar_ptr->storage_vec_kW[i] -
204     test_solar_ptr->curtailment_vec_kW[i],
205     0,
206     __FILE__,
207     __LINE__
208 );
209
210 // capacity constraint
211 if (solar_resource_kWm2 > 1) {
212     testFloatEquals(
213         test_solar_ptr->production_vec_kW[i],
214         test_solar_ptr->capacity_kW,
215         __FILE__,
216         __LINE__
217     );
218 }
219
220 // resource, O&M > 0 whenever solar is running (i.e., producing)
221 if (test_solar_ptr->is_running) {
222     testGreaterThan(
223         solar_resource_kWm2,
224         0,
225         __FILE__,
226         __LINE__
227     );
228
229     testGreaterThan(
230         test_solar_ptr->operation_maintenance_cost_vec[i],
231         0,
232         __FILE__,
233         __LINE__
234     );
235 }
236
237 // resource, O&M = 0 whenever solar is not running (i.e., not producing)
238 else {
239     testFloatEquals(
240         solar_resource_kWm2,
241         0,
242         __FILE__,
243         __LINE__
244     );
245
246     testFloatEquals(
247         test_solar_ptr->operation_maintenance_cost_vec[i],
248         0,
249         __FILE__,
250         __LINE__
251     );
252 }
253 }
254
255
256 // ===== END METHODS ===== //
257
258 } /* try */
259
260
261 catch (...) {
262     delete test_solar_ptr;
263
264     printGold(" ..... ");
265     printRed("FAIL");
266     std::cout << std::endl;
267     throw;
268 }
269
270
271 delete test_solar_ptr;

```

```

272
273 printGold(" ..... ");
274 printGreen("PASS");
275 std::cout << std::endl;
276 return 0;
277 } /* main() */

```

5.37 test/source/Production/Renewable/test_Tidal.cpp File Reference

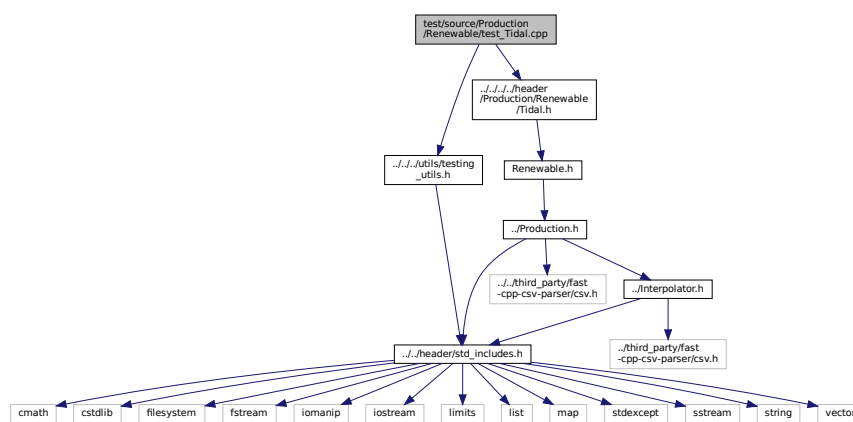
Testing suite for [Tidal](#) class.

```

#include "../.../utils/testing_utils.h"
#include "../.../header/Production/Renewable/Tidal.h"

```

Include dependency graph for test_Tidal.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.37.1 Detailed Description

Testing suite for [Tidal](#) class.

A suite of tests for the [Tidal](#) class.

5.37.2 Function Documentation

5.37.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Production <-- Renewable <-- Tidal");
33
34     srand(time(NULL));
35
36     Renewable* test_tidal_ptr;
37
38     try {
39
40     // ===== CONSTRUCTION ===== //
41
42     bool error_flag = true;
43
44     try {
45         TidalInputs bad_tidal_inputs;
46         bad_tidal_inputs.design_speed_ms = -1;
47
48         Tidal bad_tidal(8760, 1, bad_tidal_inputs);
49
50         error_flag = false;
51     } catch (...) {
52         // Task failed successfully! =P
53     }
54     if (not error_flag) {
55         expectedErrorNotDetected(__FILE__, __LINE__);
56     }
57
58     TidalInputs tidal_inputs;
59
60     test_tidal_ptr = new Tidal(8760, 1, tidal_inputs);
61
62     // ===== END CONSTRUCTION ===== //
63
64
65
66     // ===== ATTRIBUTES ===== //
67
68     testTruth(
69         not tidal_inputs.renewable_inputs.production_inputs.print_flag,
70         __FILE__,
71         __LINE__
72 );
73
74     testFloatEquals(
75         test_tidal_ptr->type,
76         RenewableType :: TIDAL,
77         __FILE__,
78         __LINE__
79 );
80
81     testTruth(
82         test_tidal_ptr->type_str == "TIDAL",
83         __FILE__,
84         __LINE__
85 );
86
87     testFloatEquals(
88         test_tidal_ptr->capital_cost,
89         500237.446725,
90         __FILE__,
91         __LINE__
92 );
93
94     testFloatEquals(
95         test_tidal_ptr->operation_maintenance_cost_kWh,
96         0.069905,
97         __FILE__,
98         __LINE__
99 );
100
101     // ===== END ATTRIBUTES ===== //
102
103
104
105     // ===== METHODS ===== //
106

```

```

107 // test production constraints
108 testFloatEquals(
109     test_tidal_ptr->computeProductionkW(0, 1, 1e6),
110     0,
111     __FILE__,
112     __LINE__
113 );
114
115 testFloatEquals(
116     test_tidal_ptr->computeProductionkW(
117         0,
118         1,
119         ((Tidal*)test_tidal_ptr)->design_speed_ms
120     ),
121     test_tidal_ptr->capacity_kW,
122     __FILE__,
123     __LINE__
124 );
125
126 testFloatEquals(
127     test_tidal_ptr->computeProductionkW(0, 1, -1),
128     0,
129     __FILE__,
130     __LINE__
131 );
132
133 // test commit()
134 std::vector<double> dt_vec_hrs (48, 1);
135
136 std::vector<double> load_vec_kW = {
137     1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1,
138     1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0,
139     1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1,
140     1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0
141 };
142
143 double load_kW = 0;
144 double production_kW = 0;
145 double roll = 0;
146 double tidal_resource_ms = 0;
147
148 for (int i = 0; i < 48; i++) {
149     roll = (double)rand() / RAND_MAX;
150
151     tidal_resource_ms = roll * ((Tidal*)test_tidal_ptr)->design_speed_ms;
152
153     roll = (double)rand() / RAND_MAX;
154
155     if (roll <= 0.1) {
156         tidal_resource_ms = 0;
157     }
158
159     else if (roll >= 0.95) {
160         tidal_resource_ms = 3 * ((Tidal*)test_tidal_ptr)->design_speed_ms;
161     }
162
163     roll = (double)rand() / RAND_MAX;
164
165     if (roll >= 0.95) {
166         roll = 1.25;
167     }
168
169     load_vec_kW[i] *= roll * test_tidal_ptr->capacity_kW;
170     load_kW = load_vec_kW[i];
171
172     production_kW = test_tidal_ptr->computeProductionkW(
173         i,
174         dt_vec_hrs[i],
175         tidal_resource_ms
176     );
177
178     load_kW = test_tidal_ptr->commit(
179         i,
180         dt_vec_hrs[i],
181         production_kW,
182         load_kW
183     );
184
185     // is running (or not) as expected
186     if (production_kW > 0) {
187         testTruth(
188             test_tidal_ptr->is_running,
189             __FILE__,
190             __LINE__
191         );
192     }
193 }

```

```

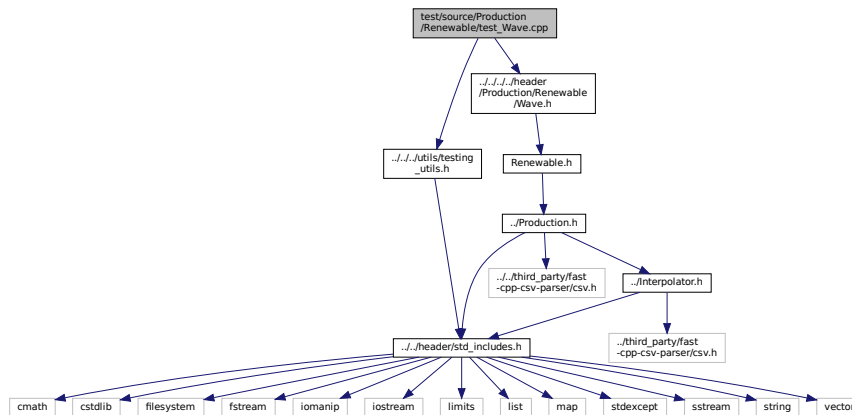
194     else {
195         testTruth(
196             not test_tidal_ptr->is_running,
197             __FILE__,
198             __LINE__
199         );
200     }
201
202     // load_kW <= load_vec_kW (i.e., after vs before)
203     testLessThanOrEqualTo(
204         load_kW,
205         load_vec_kW[i],
206         __FILE__,
207         __LINE__
208     );
209
210     // production = dispatch + storage + curtailment
211     testFloatEquals(
212         test_tidal_ptr->production_vec_kW[i] -
213         test_tidal_ptr->dispatch_vec_kW[i] -
214         test_tidal_ptr->storage_vec_kW[i] -
215         test_tidal_ptr->curtailment_vec_kW[i],
216         0,
217         __FILE__,
218         __LINE__
219     );
220
221     // resource, O&M > 0 whenever tidal is running (i.e., producing)
222     if (test_tidal_ptr->is_running) {
223         testGreaterThan(
224             tidal_resource_ms,
225             0,
226             __FILE__,
227             __LINE__
228         );
229
230         testGreaterThan(
231             test_tidal_ptr->operation_maintenance_cost_vec[i],
232             0,
233             __FILE__,
234             __LINE__
235         );
236     }
237
238     // O&M = 0 whenever tidal is not running (i.e., not producing)
239     else {
240         testFloatEquals(
241             test_tidal_ptr->operation_maintenance_cost_vec[i],
242             0,
243             __FILE__,
244             __LINE__
245         );
246     }
247 }
248
249
250 // ===== END METHODS ===== //
251
252 } /* try */
253
254
255 catch (...) {
256     delete test_tidal_ptr;
257
258     printGold(" ..... ");
259     printRed("FAIL");
260     std::cout << std::endl;
261     throw;
262 }
263
264
265 delete test_tidal_ptr;
266
267 printGold(" ..... ");
268 printGreen("PASS");
269 std::cout << std::endl;
270 return 0;
271 } /* main() */

```

5.38 test/source/Production/Renewable/test_Wave.cpp File Reference

Testing suite for [Wave](#) class.


```
#include "../../../utils/testing_utils.h"
#include "../../../header/Production/Renewable/Wave.h"
Include dependency graph for test_Wave.cpp:
```



Functions

- int [main](#) (int argc, char **argv)

5.38.1 Detailed Description

Testing suite for [Wave](#) class.

A suite of tests for the [Wave](#) class.

5.38.2 Function Documentation

5.38.2.1 main()

```
int main (
    int argc,
    char ** argv )
{
    27 {
    28     #ifdef _WIN32
    29         activateVirtualTerminal();
    30     #endif /* _WIN32 */
    31
    32     printGold("\tTesting Production <-- Renewable <-- Wave");
    33
    34     srand(time(NULL));
    35
    36     Renewable* test_wave_ptr;
    37
    38     try {
    39
    40     // ===== CONSTRUCTION ===== //
    41
    42     bool error_flag = true;
    43 }
```

```

44 try {
45     WaveInputs bad_wave_inputs;
46     bad_wave_inputs.design_significant_wave_height_m = -1;
47
48     Wave bad_wave(8760, 1, bad_wave_inputs);
49
50     error_flag = false;
51 } catch (...) {
52     // Task failed successfully! =P
53 }
54 if (not error_flag) {
55     expectedErrorNotDetected(__FILE__, __LINE__);
56 }
57
58 WaveInputs wave_inputs;
59
60 test_wave_ptr = new Wave(8760, 1, wave_inputs);
61
62 // ===== END CONSTRUCTION ===== //
63
64
65
66 // ===== ATTRIBUTES ===== //
67
68 testTruth(
69     not wave_inputs.renewable_inputs.production_inputs.print_flag,
70     __FILE__,
71     __LINE__
72 );
73
74 testFloatEquals(
75     test_wave_ptr->type,
76     RenewableType :: WAVE,
77     __FILE__,
78     __LINE__
79 );
80
81 testTruth(
82     test_wave_ptr->type_str == "WAVE",
83     __FILE__,
84     __LINE__
85 );
86
87 testFloatEquals(
88     test_wave_ptr->capital_cost,
89     850831.063539,
90     __FILE__,
91     __LINE__
92 );
93
94 testFloatEquals(
95     test_wave_ptr->operation_maintenance_cost_kWh,
96     0.069905,
97     __FILE__,
98     __LINE__
99 );
100
101 // ===== END ATTRIBUTES ===== //
102
103
104
105 // ===== METHODS ===== //
106
107 // test production constraints
108 testFloatEquals(
109     test_wave_ptr->computeProductionkW(0, 1, 0, rand()),
110     0,
111     __FILE__,
112     __LINE__
113 );
114
115 testFloatEquals(
116     test_wave_ptr->computeProductionkW(0, 1, rand(), 0),
117     0,
118     __FILE__,
119     __LINE__
120 );
121
122 // test commit()
123 std::vector<double> dt_vec_hrs (48, 1);
124
125 std::vector<double> load_vec_kW = {
126     1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1,
127     1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0,
128     1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1,
129     1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0
130 };

```

```

131
132 double load_kW = 0;
133 double production_kW = 0;
134 double roll = 0;
135 double significant_wave_height_m = 0;
136 double energy_period_s = 0;
137
138 for (int i = 0; i < 48; i++) {
139     roll = (double)rand() / RAND_MAX;
140
141     if (roll <= 0.05) {
142         roll = 0;
143     }
144
145     significant_wave_height_m = roll *
146         ((Wave*)test_wave_ptr)->design_significant_wave_height_m;
147
148     roll = (double)rand() / RAND_MAX;
149
150     if (roll <= 0.05) {
151         roll = 0;
152     }
153
154     energy_period_s = roll * ((Wave*)test_wave_ptr)->design_energy_period_s;
155
156     roll = (double)rand() / RAND_MAX;
157
158     if (roll >= 0.95) {
159         roll = 1.25;
160     }
161
162     load_vec_kW[i] *= roll * test_wave_ptr->capacity_kW;
163     load_kW = load_vec_kW[i];
164
165     production_kW = test_wave_ptr->computeProductionkW(
166         i,
167         dt_vec_hrs[i],
168         significant_wave_height_m,
169         energy_period_s
170     );
171
172     load_kW = test_wave_ptr->commit(
173         i,
174         dt_vec_hrs[i],
175         production_kW,
176         load_kW
177     );
178
179     // is running (or not) as expected
180     if (production_kW > 0) {
181         testTruth(
182             test_wave_ptr->is_running,
183             __FILE__,
184             __LINE__
185         );
186     }
187
188     else {
189         testTruth(
190             not test_wave_ptr->is_running,
191             __FILE__,
192             __LINE__
193         );
194     }
195
196     // load_kW <= load_vec_kW (i.e., after vs before)
197     testLessThanOrEqualTo(
198         load_kW,
199         load_vec_kW[i],
200         __FILE__,
201         __LINE__
202     );
203
204     // production = dispatch + storage + curtailment
205     testFloatEquals(
206         test_wave_ptr->production_vec_kW[i] -
207         test_wave_ptr->dispatch_vec_kW[i] -
208         test_wave_ptr->storage_vec_kW[i] -
209         test_wave_ptr->curtailment_vec_kW[i],
210         0,
211         __FILE__,
212         __LINE__
213     );
214
215     // resource, O&M > 0 whenever wave is running (i.e., producing)
216     if (test_wave_ptr->is_running) {
217         testGreaterThan(

```

```

218         significant_wave_height_m,
219         0,
220         __FILE__,
221         __LINE__
222     );
223
224     testGreaterThan(
225         energy_period_s,
226         0,
227         __FILE__,
228         __LINE__
229     );
230
231     testGreaterThan(
232         test_wave_ptr->operation_maintenance_cost_vec[i],
233         0,
234         __FILE__,
235         __LINE__
236     );
237 }
238
239 // O&M = 0 whenever wave is not running (i.e., not producing)
240 else {
241     testFloatEquals(
242         test_wave_ptr->operation_maintenance_cost_vec[i],
243         0,
244         __FILE__,
245         __LINE__
246     );
247 }
248 }
249 // ===== END METHODS ===== //
250
251 } /* try */
252
253
254 catch (...) {
255     delete test_wave_ptr;
256
257     printGold(" ..... ");
258     printRed("FAIL");
259     std::cout << std::endl;
260     throw;
261 }
262
263
264 delete test_wave_ptr;
265
266 printGold(" ..... ");
267 printGreen("PASS");
268 std::cout << std::endl;
269 return 0;
270 } /* main() */

```

5.39 test/source/Production/Renewable/test_Wind.cpp File Reference

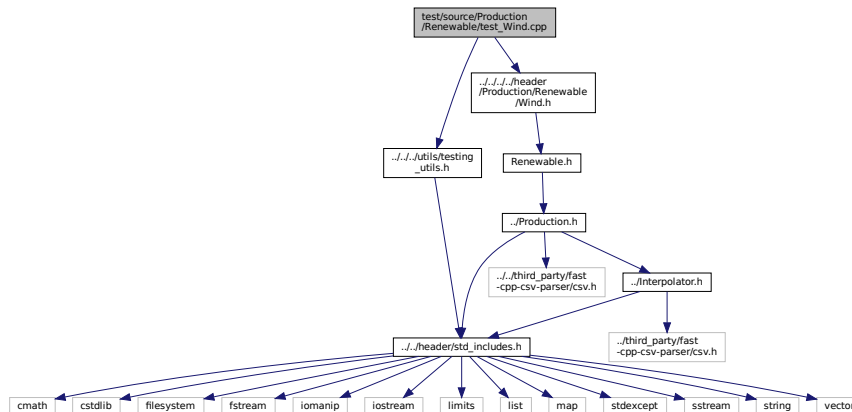
Testing suite for [Wind](#) class.

```

#include "../utils/testing_utils.h"
#include "../header/Production/Renewable/Wind.h"

```

Include dependency graph for test_Wind.cpp:



Functions

- `int main (int argc, char **argv)`

5.39.1 Detailed Description

Testing suite for [Wind](#) class.

A suite of tests for the [Wind](#) class.

5.39.2 Function Documentation

5.39.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Production <-- Renewable <-- Wind");
33
34     srand(time(NULL));
35
36     Renewable* test_wind_ptr;
37
38     try {
39
40     // ===== CONSTRUCTION ===== //
41
42     bool error_flag = true;
43
44     try {
45         WindInputs bad_wind_inputs;
46         bad_wind_inputs.design_speed_ms = -1;

```

```

47
48     Wind bad_wind(8760, 1, bad_wind_inputs);
49
50     error_flag = false;
51 } catch (...) {
52     // Task failed successfully! =P
53 }
54 if (not error_flag) {
55     expectedErrorNotDetected(__FILE__, __LINE__);
56 }
57
58 WindInputs wind_inputs;
59
60 test_wind_ptr = new Wind(8760, 1, wind_inputs);
61
62 // ===== END CONSTRUCTION ===== //
63
64
65
66 // ===== ATTRIBUTES ===== //
67
68 testTruth(
69     not wind_inputs.renewable_inputs.production_inputs.print_flag,
70     __FILE__,
71     __LINE__
72 );
73
74 testFloatEquals(
75     test_wind_ptr->type,
76     RenewableType :: WIND,
77     __FILE__,
78     __LINE__
79 );
80
81 testTruth(
82     test_wind_ptr->type_str == "WIND",
83     __FILE__,
84     __LINE__
85 );
86
87 testFloatEquals(
88     test_wind_ptr->capital_cost,
89     450356.170088,
90     __FILE__,
91     __LINE__
92 );
93
94 testFloatEquals(
95     test_wind_ptr->operation_maintenance_cost_kWh,
96     0.034953,
97     __FILE__,
98     __LINE__
99 );
100
101 // ===== END ATTRIBUTES ===== //
102
103
104
105 // ===== METHODS ===== //
106
107 // test production constraints
108 testFloatEquals(
109     test_wind_ptr->computeProductionkW(0, 1, 1e6),
110     0,
111     __FILE__,
112     __LINE__
113 );
114
115 testFloatEquals(
116     test_wind_ptr->computeProductionkW(
117         0,
118         1,
119         ((Wind*)test_wind_ptr)->design_speed_ms
120     ),
121     test_wind_ptr->capacity_kW,
122     __FILE__,
123     __LINE__
124 );
125
126 testFloatEquals(
127     test_wind_ptr->computeProductionkW(0, 1, -1),
128     0,
129     __FILE__,
130     __LINE__
131 );
132
133 // test commit()

```

```

134 std::vector<double> dt_vec_hrs (48, 1);
135
136 std::vector<double> load_vec_kW = {
137     1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1,
138     1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0,
139     1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1,
140     1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0
141 };
142
143 double load_kW = 0;
144 double production_kW = 0;
145 double roll = 0;
146 double wind_resource_ms = 0;
147
148 for (int i = 0; i < 48; i++) {
149     roll = (double)rand() / RAND_MAX;
150
151     wind_resource_ms = roll * ((Wind*)test_wind_ptr->design_speed_ms;
152
153     roll = (double)rand() / RAND_MAX;
154
155     if (roll <= 0.1) {
156         wind_resource_ms = 0;
157     }
158
159     else if (roll >= 0.95) {
160         wind_resource_ms = 3 * ((Wind*)test_wind_ptr->design_speed_ms;
161     }
162
163     roll = (double)rand() / RAND_MAX;
164
165     if (roll >= 0.95) {
166         roll = 1.25;
167     }
168
169     load_vec_kW[i] *= roll * test_wind_ptr->capacity_kW;
170     load_kW = load_vec_kW[i];
171
172     production_kW = test_wind_ptr->computeProductionkW(
173         i,
174         dt_vec_hrs[i],
175         wind_resource_ms
176     );
177
178     load_kW = test_wind_ptr->commit(
179         i,
180         dt_vec_hrs[i],
181         production_kW,
182         load_kW
183     );
184
185     // is running (or not) as expected
186     if (production_kW > 0) {
187         testTruth(
188             test_wind_ptr->is_running,
189             __FILE__,
190             __LINE__
191         );
192     }
193
194     else {
195         testTruth(
196             not test_wind_ptr->is_running,
197             __FILE__,
198             __LINE__
199         );
200     }
201
202     // load_kW <= load_vec_kW (i.e., after vs before)
203     testLessThanOrEqualTo(
204         load_kW,
205         load_vec_kW[i],
206         __FILE__,
207         __LINE__
208     );
209
210     // production = dispatch + storage + curtailment
211     testFloatEquals(
212         test_wind_ptr->production_vec_kW[i] -
213         test_wind_ptr->dispatch_vec_kW[i] -
214         test_wind_ptr->storage_vec_kW[i] -
215         test_wind_ptr->curtailment_vec_kW[i],
216         0,
217         __FILE__,
218         __LINE__
219     );
220

```

```

221 // resource, O&M > 0 whenever wind is running (i.e., producing)
222 if (test_wind_ptr->is_running) {
223     testGreaterThan(
224         wind_resource_ms,
225         0,
226         __FILE__,
227         __LINE__
228     );
229
230     testGreaterThan(
231         test_wind_ptr->operation_maintenance_cost_vec[i],
232         0,
233         __FILE__,
234         __LINE__
235     );
236 }
237
238 // O&M = 0 whenever wind is not running (i.e., not producing)
239 else {
240     testFloatEquals(
241         test_wind_ptr->operation_maintenance_cost_vec[i],
242         0,
243         __FILE__,
244         __LINE__
245     );
246 }
247 }
248
249
250 // ===== END METHODS ===== //
251
252 } /* try */
253
254
255 catch (...) {
256     delete test_wind_ptr;
257
258     printGold(" ..... ");
259     printRed("FAIL");
260     std::cout << std::endl;
261     throw;
262 }
263
264
265 delete test_wind_ptr;
266
267 printGold(" ..... ");
268 printGreen("PASS");
269 std::cout << std::endl;
270 return 0;
271 } /* main() */

```

5.40 test/source/Production/test_Production.cpp File Reference

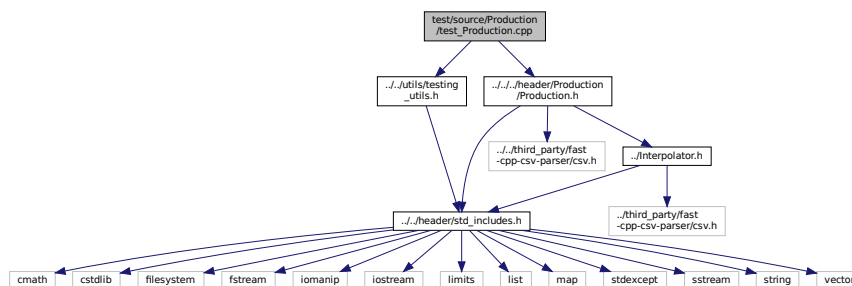
Testing suite for [Production](#) class.

```

#include "../utils/testing_utils.h"
#include "../header/Production/Production.h"

```

Include dependency graph for test_Production.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.40.1 Detailed Description

Testing suite for [Production](#) class.

A suite of tests for the [Production](#) class.

5.40.2 Function Documentation

5.40.2.1 main()

```
int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Production");
33
34     srand(time(NULL));
35
36
37     try {
38
39         // ===== CONSTRUCTION ===== //
40
41         bool error_flag = true;
42
43         try {
44             ProductionInputs production_inputs;
45
46             Production bad_production(0, 1, production_inputs);
47
48             error_flag = false;
49         } catch (...) {
50             // Task failed successfully! =P
51         }
52         if (not error_flag) {
53             expectedErrorNotDetected(__FILE__, __LINE__);
54         }
55
56         ProductionInputs production_inputs;
57
58         Production test_production(8760, 1, production_inputs);
59
60         // ===== END CONSTRUCTION ===== //
61
62
63
64         // ===== ATTRIBUTES ===== //
65
66         testTruth(
67             not production_inputs.print_flag,
68             __FILE__,
69             __LINE__
70 );
71
72         testFloatEquals(
73             production_inputs.nominal_inflation_annual,
74             0.02,
75             __FILE__,
76             __LINE__
77 );
```

```

78
79 testFloatEquals(
80     production_inputs.nominal_discount_annual,
81     0.04,
82     __FILE__,
83     __LINE__
84 );
85
86 testFloatEquals(
87     test_production.n_points,
88     8760,
89     __FILE__,
90     __LINE__
91 );
92
93 testFloatEquals(
94     test_production.capacity_kW,
95     100,
96     __FILE__,
97     __LINE__
98 );
99
100 testFloatEquals(
101     test_production.real_discount_annual,
102     0.0196078431372549,
103     __FILE__,
104     __LINE__
105 );
106
107 testFloatEquals(
108     test_production.production_vec_kW.size(),
109     8760,
110     __FILE__,
111     __LINE__
112 );
113
114 testFloatEquals(
115     test_production.dispatch_vec_kW.size(),
116     8760,
117     __FILE__,
118     __LINE__
119 );
120
121 testFloatEquals(
122     test_production.storage_vec_kW.size(),
123     8760,
124     __FILE__,
125     __LINE__
126 );
127
128 testFloatEquals(
129     test_production.curtailment_vec_kW.size(),
130     8760,
131     __FILE__,
132     __LINE__
133 );
134
135 testFloatEquals(
136     test_production.capital_cost_vec.size(),
137     8760,
138     __FILE__,
139     __LINE__
140 );
141
142 testFloatEquals(
143     test_production.operation_maintenance_cost_vec.size(),
144     8760,
145     __FILE__,
146     __LINE__
147 );
148
149 // ===== END ATTRIBUTES ===== //
150
151 } /* try */
152
153
154 catch (...) {
155     //...
156
157     printGold(" ..... ");
158     printRed("FAIL");
159     std::cout << std::endl;
160     throw;
161 }
162
163
164 printGold(" ..... ");

```

```

165 printGreen("PASS");
166 std::cout << std::endl;
167 return 0;
168
169 } /* main() */

```

5.41 test/source/Storage/test_Lilon.cpp File Reference

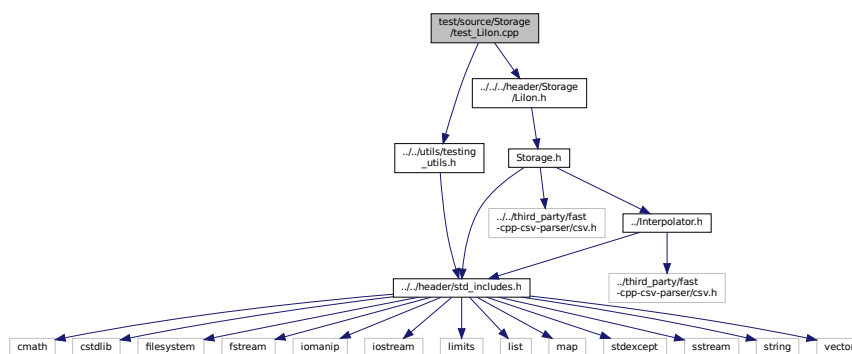
Testing suite for [Lilon](#) class.

```

#include "../..//utils/testing_utils.h"
#include "../..//header/Storage/LiIon.h"

```

Include dependency graph for test_Lilon.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.41.1 Detailed Description

Testing suite for [Lilon](#) class.

A suite of tests for the [Lilon](#) class.

5.41.2 Function Documentation

5.41.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Storage <-- LiIon");
33
34     srand(time(NULL));
35
36
37     try {
38
39         // ===== CONSTRUCTION ===== //
40
41     bool error_flag = true;
42
43     try {
44         LiIonInputs bad_liion_inputs;
45         bad_liion_inputs.min_SOC = -1;
46
47         LiIon bad_liion(8760, 1, bad_liion_inputs);
48
49         error_flag = false;
50     } catch (...) {
51         // Task failed successfully! =P
52     }
53     if (not error_flag) {
54         expectedErrorNotDetected(__FILE__, __LINE__);
55     }
56
57     LiIonInputs liion_inputs;
58
59     LiIon test_liion(8760, 1, liion_inputs);
60
61     // ===== END CONSTRUCTION ===== //
62
63
64
65     // ===== ATTRIBUTES ===== //
66
67     testTruth(
68         test_liion.type_str == "LIION",
69         __FILE__,
70         __LINE__
71 );
72
73     testFloatEquals(
74         test_liion.init_SOC,
75         0.5,
76         __FILE__,
77         __LINE__
78 );
79
80     testFloatEquals(
81         test_liion.min_SOC,
82         0.15,
83         __FILE__,
84         __LINE__
85 );
86
87     testFloatEquals(
88         test_liion.hysteresis_SOC,
89         0.5,
90         __FILE__,
91         __LINE__
92 );
93
94     testFloatEquals(
95         test_liion.max_SOC,
96         0.9,
97         __FILE__,
98         __LINE__
99 );
100
101     testFloatEquals(
102         test_liion.charging_efficiency,
103         0.9,
104         __FILE__,
105         __LINE__
106 );

```

```

107
108 testFloatEquals(
109     test_liion.discharging_efficiency,
110     0.9,
111     __FILE__,
112     __LINE__
113 );
114
115 testFloatEquals(
116     test_liion.replace_SOH,
117     0.8,
118     __FILE__,
119     __LINE__
120 );
121
122 testFloatEquals(
123     test_liion.power_kW,
124     0,
125     __FILE__,
126     __LINE__
127 );
128
129 testFloatEquals(
130     test_liion.SOH_vec.size(),
131     8760,
132     __FILE__,
133     __LINE__
134 );
135
136 // ===== END ATTRIBUTES ===== //
137
138
139
140 // ===== METHODS ===== //
141
142 testFloatEquals(
143     test_liion.getAvailablekW(1),
144     100, // hits power capacity constraint
145     __FILE__,
146     __LINE__
147 );
148
149 testFloatEquals(
150     test_liion.getAcceptablekW(1),
151     100, // hits power capacity constraint
152     __FILE__,
153     __LINE__
154 );
155
156 test_liion.power_kW = 100;
157
158 testFloatEquals(
159     test_liion.getAvailablekW(1),
160     100, // hits power capacity constraint
161     __FILE__,
162     __LINE__
163 );
164
165 testFloatEquals(
166     test_liion.getAcceptablekW(1),
167     100, // hits power capacity constraint
168     __FILE__,
169     __LINE__
170 );
171
172 test_liion.power_kW = 1e6;
173
174 testFloatEquals(
175     test_liion.getAvailablekW(1),
176     0, // is already hitting power capacity constraint
177     __FILE__,
178     __LINE__
179 );
180
181 testFloatEquals(
182     test_liion.getAcceptablekW(1),
183     0, // is already hitting power capacity constraint
184     __FILE__,
185     __LINE__
186 );
187
188 test_liion.commitCharge(0, 1, 100);
189
190 testFloatEquals(
191     test_liion.power_kW,
192     0,
193     __FILE__,

```

```

194     __LINE__
195 );
196
197 // ===== END METHODS ===== //
198
199 } /* try */
200
201
202 catch (...) {
203     //...
204
205     printGold(" ..... ");
206     printRed("FAIL");
207     std::cout << std::endl;
208     throw;
209 }
210
211
212 printGold(" ..... ");
213 printGreen("PASS");
214 std::cout << std::endl;
215 return 0;
216 } /* main() */

```

5.42 test/source/Storage/test_Storage.cpp File Reference

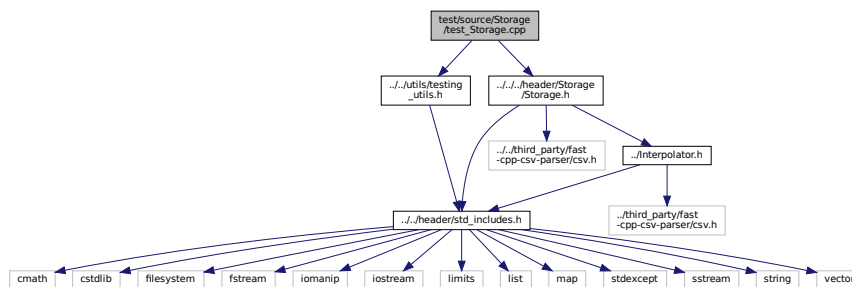
Testing suite for [Storage](#) class.

```

#include "../utils/testing_utils.h"
#include "../../header/Storage/Storage.h"

```

Include dependency graph for test_Storage.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.42.1 Detailed Description

Testing suite for [Storage](#) class.

A suite of tests for the [Storage](#) class.

5.42.2 Function Documentation

5.42.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Storage");
33
34     srand(time(NULL));
35
36
37     try {
38
39 // ===== CONSTRUCTION ===== //
40
41 bool error_flag = true;
42
43     try {
44         StorageInputs bad_storage_inputs;
45         bad_storage_inputs.energy_capacity_kWh = 0;
46
47         Storage bad_storage(8760, 1, bad_storage_inputs);
48
49         error_flag = false;
50     } catch (...) {
51         // Task failed successfully! =P
52     }
53     if (not error_flag) {
54         expectedErrorNotDetected(__FILE__, __LINE__);
55     }
56
57     StorageInputs storage_inputs;
58
59     Storage test_storage(8760, 1, storage_inputs);
60
61 // ===== END CONSTRUCTION ===== //
62
63
64
65 // ===== ATTRIBUTES ===== //
66
67     testFloatEquals(
68         test_storage.power_capacity_kW,
69         100,
70         __FILE__,
71         __LINE__
72 );
73
74     testFloatEquals(
75         test_storage.energy_capacity_kWh,
76         1000,
77         __FILE__,
78         __LINE__
79 );
80
81     testFloatEquals(
82         test_storage.charge_vec_kWh.size(),
83         8760,
84         __FILE__,
85         __LINE__
86 );
87
88     testFloatEquals(
89         test_storage.charging_power_vec_kW.size(),
90         8760,
91         __FILE__,
92         __LINE__
93 );
94
95     testFloatEquals(
96         test_storage.discharging_power_vec_kW.size(),
97         8760,
98         __FILE__,
99         __LINE__
100 );
101
102     testFloatEquals(
103         test_storage.capital_cost_vec.size(),
104         8760,
105         __FILE__,
106         __LINE__

```

```

107 );
108
109 testFloatEquals(
110     test_storage.operation_maintenance_cost_vec.size(),
111     8760,
112     __FILE__,
113     __LINE__
114 );
115
116 // ===== END ATTRIBUTES ===== //
117
118
119
120 // ===== METHODS ===== //
121
122 //...
123
124 // ===== END METHODS ===== //
125
126 } /* try */
127
128
129 catch (...) {
130     //...
131
132     printGold(" ..... ");
133     printRed("FAIL");
134     std::cout << std::endl;
135     throw;
136 }
137
138
139 printGold(" ..... ");
140 printGreen("PASS");
141 std::cout << std::endl;
142 return 0;
143 } /* main() */

```

5.43 test/source/test_Controller.cpp File Reference

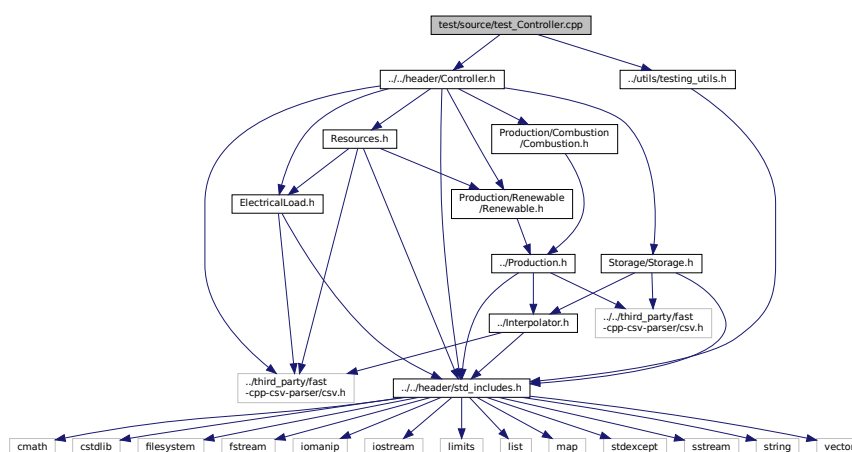
Testing suite for [Controller](#) class.

```

#include "../utils/testing_utils.h"
#include "../../header/Controller.h"

```

Include dependency graph for test_Controller.cpp:



Functions

- `int main(int argc, char **argv)`

5.43.1 Detailed Description

Testing suite for [Controller](#) class.

A suite of tests for the [Controller](#) class.

5.43.2 Function Documentation

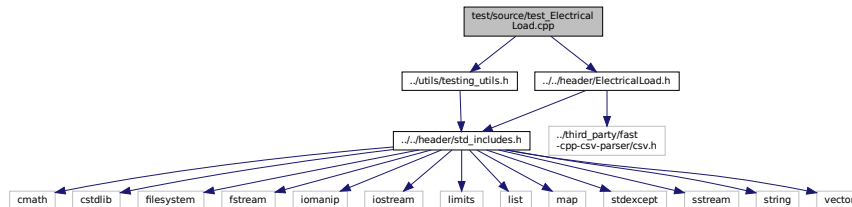
5.43.2.1 main()

```
int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Controller");
33
34     srand(time(NULL));
35
36
37 try {
38
39 // ===== CONSTRUCTION ===== //
40
41 Controller test_controller;
42
43 // ===== END CONSTRUCTION =====//
44
45
46
47 // ===== ATTRIBUTES ===== //
48
49 //...
50
51 // ===== END ATTRIBUTES ===== //
52
53
54
55 // ===== METHODS ===== //
56
57 //...
58
59 // ===== END METHODS ===== //
60
61 } /* try */
62
63
64 catch (...) {
65     //...
66
67     printGold(" ..... ");
68     printRed("FAIL");
69     std::cout << std::endl;
70     throw;
71 }
72
73
74 printGold(" ..... ");
75 printGreen("PASS");
76 std::cout << std::endl;
77 return 0;
78 } /* main() */
```

5.44 test/source/test_ElectricalLoad.cpp File Reference

Testing suite for [ElectricalLoad](#) class.

```
#include "../utils/testing_utils.h"
#include "../../header/ElectricalLoad.h"
Include dependency graph for test_ElectricalLoad.cpp:
```



Functions

- int [main](#) (int argc, char **argv)

5.44.1 Detailed Description

Testing suite for [ElectricalLoad](#) class.

A suite of tests for the [ElectricalLoad](#) class.

5.44.2 Function Documentation

5.44.2.1 main()

```
int main (
    int argc,
    char ** argv )
{
    27 {
    28     #ifdef _WIN32
    29         activateVirtualTerminal();
    30     #endif /* _WIN32 */
    31
    32     printGold("\tTesting ElectricalLoad");
    33
    34     srand(time(NULL));
    35
    36
    37     try {
    38
    39         // ===== CONSTRUCTION ===== //
    40
    41         std::string path_2_electrical_load_time_series =
    42             "data/test/electrical_load/electrical_load_generic_peak-500kW_1yr_dt-1hr.csv";
    43
    44         ElectricalLoad test_electrical_load(path_2_electrical_load_time_series);
    45
    46     }
```

```

46 // ===== END CONSTRUCTION ===== //
47
48
49
50 // ===== ATTRIBUTES ===== //
51
52 testTruth(
53     test_electrical_load.path_2_electrical_load_time_series ==
54     path_2_electrical_load_time_series,
55     __FILE__,
56     __LINE__
57 );
58
59 testFloatEquals(
60     test_electrical_load.n_points,
61     8760,
62     __FILE__,
63     __LINE__
64 );
65
66 testFloatEquals(
67     test_electrical_load.n_years,
68     0.999886,
69     __FILE__,
70     __LINE__
71 );
72
73 testFloatEquals(
74     test_electrical_load.min_load_kW,
75     82.1211213927802,
76     __FILE__,
77     __LINE__
78 );
79
80 testFloatEquals(
81     test_electrical_load.mean_load_kW,
82     258.373472633202,
83     __FILE__,
84     __LINE__
85 );
86
87
88 testFloatEquals(
89     test_electrical_load.max_load_kW,
90     500,
91     __FILE__,
92     __LINE__
93 );
94
95
96 std::vector<double> expected_dt_vec_hrs (48, 1);
97
98 std::vector<double> expected_time_vec_hrs = {
99     0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11,
100    12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
101    24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35,
102    36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47
103 };
104
105 std::vector<double> expected_load_vec_kW = {
106    360.253836463674,
107    355.171277826775,
108    353.776453532298,
109    353.75405737934,
110    346.592867404975,
111    340.132411175118,
112    337.354867340578,
113    340.644115618736,
114    363.639028500678,
115    378.787797779238,
116    372.215798201712,
117    395.093925731298,
118    402.325427142659,
119    386.907725462306,
120    380.709170928091,
121    372.062070914977,
122    372.328646856954,
123    391.841444284136,
124    394.029351759596,
125    383.369407765254,
126    381.093099675206,
127    382.604158946193,
128    390.744843709034,
129    383.13949492437,
130    368.150393976985,
131    364.629744480226,
132    363.572736804082,

```

```

133     359.854924202248,
134     355.207590170267,
135     349.094656012401,
136     354.365935871597,
137     343.380608328546,
138     404.673065729266,
139     486.296896820126,
140     480.225974100847,
141     457.318764401085,
142     418.177339948609,
143     414.399018364126,
144     409.678420185754,
145     404.768766016563,
146     401.699589920585,
147     402.44339040654,
148     398.138372541906,
149     396.010498627646,
150     390.165117432277,
151     375.850429417013,
152     365.567100746484,
153     365.429624610923
154 };
155
156 for (int i = 0; i < 48; i++) {
157     testFloatEquals(
158         test_electrical_load.dt_vec_hrs[i],
159         expected_dt_vec_hrs[i],
160         __FILE__,
161         __LINE__
162     );
163
164     testFloatEquals(
165         test_electrical_load.time_vec_hrs[i],
166         expected_time_vec_hrs[i],
167         __FILE__,
168         __LINE__
169     );
170
171     testFloatEquals(
172         test_electrical_load.load_vec_kW[i],
173         expected_load_vec_kW[i],
174         __FILE__,
175         __LINE__
176     );
177 }
178
179 // ===== END ATTRIBUTES ===== //
180
181 } /* try */
182
183
184 catch (...) {
185     //...
186
187     printGold(" ..... ");
188     printRed("FAIL");
189     std::cout << std::endl;
190     throw;
191 }
192
193
194 printGold(" ..... ");
195 printGreen("PASS");
196 std::cout << std::endl;
197 return 0;
198 } /* main() */

```

5.45 test/source/test_Interpolator.cpp File Reference

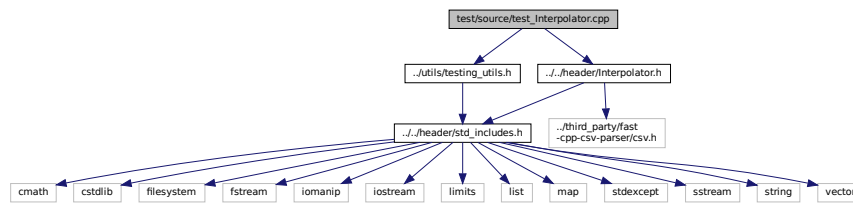
Testing suite for [Interpolator](#) class.

```

#include "../utils/testing_utils.h"
#include "../header/Interpolator.h"

```

Include dependency graph for test_Interpolator.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.45.1 Detailed Description

Testing suite for [Interpolator](#) class.

A suite of tests for the [Interpolator](#) class.

5.45.2 Function Documentation

5.45.2.1 main()

```

int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\n\tTesting Interpolator");
33
34     srand(time(NULL));
35
36
37     try {
38
39         // ===== CONSTRUCTION ===== //
40
41         Interpolator test_interpolator;
42
43         // ===== END CONSTRUCTION =====//
44
45
46
47         // ===== ATTRIBUTES ===== //
48
49         //...
50
51         // ===== END ATTRIBUTES ===== //
52
53
54
55         // ===== METHODS ===== //
56

```

```

57 // 1. 1D interpolation
58
59 int data_key = 1;
60 std::string path_2_data = "data/test/interpolation/diesel_fuel_curve.csv";
61
62 test_interpolator.addData1D(data_key, path_2_data);
63
64 testTruth(
65     test_interpolator.path_map_1D[data_key] == path_2_data,
66     __FILE__,
67     __LINE__
68 );
69
70 testFloatEquals(
71     test_interpolator.interp_map_1D[data_key].n_points,
72     16,
73     __FILE__,
74     __LINE__
75 );
76
77 testFloatEquals(
78     test_interpolator.interp_map_1D[data_key].x_vec.size(),
79     16,
80     __FILE__,
81     __LINE__
82 );
83
84 std::vector<double> expected_x_vec = {
85     0,
86     0.3,
87     0.35,
88     0.4,
89     0.45,
90     0.5,
91     0.55,
92     0.6,
93     0.65,
94     0.7,
95     0.75,
96     0.8,
97     0.85,
98     0.9,
99     0.95,
100    1
101 };
102
103 std::vector<double> expected_y_vec = {
104     4.68079520372916,
105     11.1278522361839,
106     12.4787834830748,
107     13.7808847600209,
108     15.0417468303382,
109     16.277263,
110     17.4612831516442,
111     18.6279054806525,
112     19.7698039220515,
113     20.8893499214868,
114     21.955378,
115     23.0690535155297,
116     24.1323614374927,
117     25.1797231192866,
118     26.2122451458747,
119     27.254952
120 };
121
122 for (int i = 0; i < test_interpolator.interp_map_1D[data_key].n_points; i++) {
123     testFloatEquals(
124         test_interpolator.interp_map_1D[data_key].x_vec[i],
125         expected_x_vec[i],
126         __FILE__,
127         __LINE__
128     );
129
130     testFloatEquals(
131         test_interpolator.interp_map_1D[data_key].y_vec[i],
132         expected_y_vec[i],
133         __FILE__,
134         __LINE__
135     );
136 }
137
138 //...
139
140
141 // 2. 2D interpolation
142
143 data_key = 2;

```

```

144 path_2_data =
145     "data/test/interpolation/wave_energy_converter_normalized_performance_matrix.csv";
146
147 test_interpolator.addData2D(data_key, path_2_data);
148
149 testTruth(
150     test_interpolator.path_map_2D[data_key] == path_2_data,
151     __FILE__,
152     __LINE__
153 );
154
155 testFloatEquals(
156     test_interpolator.interp_map_2D[data_key].n_rows,
157     16,
158     __FILE__,
159     __LINE__
160 );
161
162 testFloatEquals(
163     test_interpolator.interp_map_2D[data_key].n_cols,
164     16,
165     __FILE__,
166     __LINE__
167 );
168
169 testFloatEquals(
170     test_interpolator.interp_map_2D[data_key].x_vec.size(),
171     16,
172     __FILE__,
173     __LINE__
174 );
175
176 testFloatEquals(
177     test_interpolator.interp_map_2D[data_key].y_vec.size(),
178     16,
179     __FILE__,
180     __LINE__
181 );
182
183 testFloatEquals(
184     test_interpolator.interp_map_2D[data_key].z_matrix.size(),
185     16,
186     __FILE__,
187     __LINE__
188 );
189
190 testFloatEquals(
191     test_interpolator.interp_map_2D[data_key].z_matrix[0].size(),
192     16,
193     __FILE__,
194     __LINE__
195 );
196
197 expected_x_vec = {
198     0.25, 0.75, 1.25, 1.75, 2.25, 2.75, 3.25, 3.75, 4.25, 4.75, 5.25, 5.75, 6.25, 6.75, 7.25, 7.75
199 };
200
201 expected_y_vec = {
202     5,
203     6,
204     7,
205     8,
206     9,
207     10,
208     11,
209     12,
210     13,
211     14,
212     15,
213     16,
214     17,
215     18,
216     19,
217     20
218 };
219
220 for (int i = 0; i < test_interpolator.interp_map_2D[data_key].n_cols; i++) {
221     testFloatEquals(
222         test_interpolator.interp_map_2D[data_key].x_vec[i],
223         expected_x_vec[i],
224         __FILE__,
225         __LINE__
226     );
227 }
228
229 for (int i = 0; i < test_interpolator.interp_map_2D[data_key].n_rows; i++) {
230     testFloatEquals(

```

```

231         test_interpolator.interp_map_2D[data_key].y_vec[i],
232         expected_y_vec[i],
233         __FILE__,
234         __LINE__
235     );
236 }
237
238 std::vector<std::vector<double> expected_z_matrix = {
239     {0, 0.129128125, 0.268078125, 0.404253125, 0.537653125, 0.668278125, 0.796128125, 0.921203125, 1, 1,
240      1, 0, 0, 0, 0, 0},
241     {0, 0.11160375, 0.24944375, 0.38395375, 0.51513375, 0.64298375, 0.76750375, 0.88869375, 1, 1, 1, 1,
242      1, 1, 1, 1},
243     {0, 0.094079375, 0.230809375, 0.363654375, 0.492614375, 0.617689375, 0.738879375, 0.856184375,
244      0.969604375, 1, 1, 1, 1, 1, 1, 1},
245     {0, 0.076555, 0.212175, 0.343355, 0.470095, 0.592395, 0.710255, 0.823675, 0.932655, 1, 1, 1, 1, 1,
246      1, 1},
247     {0, 0.059030625, 0.193540625, 0.323055625, 0.447575625, 0.567100625, 0.681630625, 0.791165625,
248      0.895705625, 0.995250625, 1, 1, 1, 1, 1, 1},
249     {0, 0.04150625, 0.17490625, 0.30275625, 0.42505625, 0.54180625, 0.65300625, 0.75865625, 0.85875625,
250      0.95330625, 1, 1, 1, 1, 1, 1},
251     {0, 0.023981875, 0.156271875, 0.282456875, 0.402536875, 0.516511875, 0.624381875, 0.726146875,
252      0.821806875, 0.911361875, 0.994811875, 1, 1, 1, 1, 1},
253     {0, 0.0064575, 0.1376375, 0.2621575, 0.3800175, 0.4912175, 0.5957575, 0.6936375, 0.7848575,
254      0.8694175, 0.9473175, 1, 1, 1, 1, 1},
255     {0, 0, 0.119003125, 0.241858125, 0.357498125, 0.465923125, 0.567133125, 0.661128125, 0.747908125,
256      0.827473125, 0.899823125, 0.964958125, 1, 1, 1, 1},
257     {0, 0, 0.10036875, 0.22155875, 0.33497875, 0.44062875, 0.53850875, 0.62861875, 0.71095875,
258      0.78552875, 0.85232875, 0.91135875, 0.96261875, 1, 1, 1},
259     {0, 0, 0.081734375, 0.201259375, 0.312459375, 0.415334375, 0.509884375, 0.596109375, 0.674009375,
260      0.743584375, 0.804834375, 0.857759375, 0.902359375, 0.938634375, 0.966584375, 0.986209375},
261     {0, 0, 0.0631, 0.18096, 0.28994, 0.39004, 0.48126, 0.5636, 0.63706, 0.70164, 0.75734, 0.80416,
262      0.8421, 0.87116, 0.89134, 0.90264},
263     {0, 0, 0.044465625, 0.160660625, 0.267420625, 0.364745625, 0.452635625, 0.531090625, 0.600110625,
264      0.659695625, 0.709845625, 0.750560625, 0.781840625, 0.803685624999999, 0.816095625, 0.819070625},
265     {0, 0, 0.02583125, 0.14036125, 0.24490125, 0.33945125, 0.42401125, 0.49858125, 0.56316125,
266      0.61775125, 0.66235125, 0.69696125, 0.72158125, 0.73621125, 0.74085125, 0.73550125},
267     {0, 0, 0.007196875, 0.120061875, 0.222381875, 0.314156875, 0.395386875, 0.466071875, 0.526211875,
268      0.575806875, 0.614856875, 0.643361875, 0.661321875, 0.668736875, 0.665606875, 0.651931875},
269     {0, 0, 0, 0.0997625, 0.1998625, 0.2888625, 0.3667625, 0.4335625, 0.4892625, 0.5338625, 0.5673625,
270      0.5897625, 0.6010625, 0.6012625, 0.5903625, 0.5683625}
271 };
272
273 for (int i = 0; i < test_interpolator.interp_map_2D[data_key].n_rows; i++) {
274     for (int j = 0; j < test_interpolator.interp_map_2D[data_key].n_cols; j++) {
275         testFloatEquals(
276             test_interpolator.interp_map_2D[data_key].z_matrix[i][j],
277             expected_z_matrix[i][j],
278             __FILE__,
279             __LINE__
280         );
281     }
282 }
283
284 //...
285 // ===== END METHODS ===== //
286
287 } /* try */
288
289 catch (...) {
290     //...
291     printGold(" ..... ");
292     printRed("FAIL");
293     std::cout << std::endl;
294     throw;
295 }
296
297 printGold(" ..... ");
298 printGreen("PASS");
299 std::cout << std::endl;
300 return 0;
301 } /* main() */

```

5.46 test/source/test_Model.cpp File Reference

Testing suite for [Model](#) class.


```

43 try {
44     ModelInputs bad_model_inputs;    // path_2_electrical_load_time_series left empty
45
46     Model bad_model(bad_model_inputs);
47
48     error_flag = false;
49 } catch (...) {
50     // Task failed successfully! =P
51 }
52 if (not error_flag) {
53     expectedErrorNotDetected(__FILE__, __LINE__);
54 }
55
56
57 try {
58     ModelInputs bad_model_inputs;
59     bad_model_inputs.path_2_electrical_load_time_series =
60         "data/test/electrical_load/bad_path_240984069830.csv";
61
62     Model bad_model(bad_model_inputs);
63
64     error_flag = false;
65 } catch (...) {
66     // Task failed successfully! =P
67 }
68 if (not error_flag) {
69     expectedErrorNotDetected(__FILE__, __LINE__);
70 }
71
72
73 std::string path_2_electrical_load_time_series =
74     "data/test/electrical_load/electrical_load_generic_peak-500kW_1yr_dt-1hr.csv";
75
76 ModelInputs test_model_inputs;
77 test_model_inputs.path_2_electrical_load_time_series =
78     path_2_electrical_load_time_series;
79
80 Model test_model(test_model_inputs);
81
82 // ===== END CONSTRUCTION ===== //
83
84
85 // ===== ATTRIBUTES ===== //
86
87 testTruth(
88     test_model.electrical_load.path_2_electrical_load_time_series ==
89     path_2_electrical_load_time_series,
90     __FILE__,
91     __LINE__
92 );
93
94 testFloatEquals(
95     test_model.electrical_load.n_points,
96     8760,
97     __FILE__,
98     __LINE__
99 );
100
101 testFloatEquals(
102     test_model.electrical_load.n_years,
103     0.999886,
104     __FILE__,
105     __LINE__
106 );
107
108 testFloatEquals(
109     test_model.electrical_load.min_load_kW,
110     82.1211213927802,
111     __FILE__,
112     __LINE__
113 );
114
115 testFloatEquals(
116     test_model.electrical_load.mean_load_kW,
117     258.373472633202,
118     __FILE__,
119     __LINE__
120 );
121
122
123 testFloatEquals(
124     test_model.electrical_load.max_load_kW,
125     500,
126     __FILE__,
127     __LINE__
128 );
129

```

```

130
131 std::vector<double> expected_dt_vec_hrs (48, 1);
132
133 std::vector<double> expected_time_vec_hrs = {
134     0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11,
135     12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
136     24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35,
137     36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47
138 };
139
140 std::vector<double> expected_load_vec_kW = {
141     360.253836463674,
142     355.171277826775,
143     353.776453532298,
144     353.75405737934,
145     346.592867404975,
146     340.132411175118,
147     337.354867340578,
148     340.644115618736,
149     363.639028500678,
150     378.787797779238,
151     372.215798201712,
152     395.093925731298,
153     402.325427142659,
154     386.907725462306,
155     380.709170928091,
156     372.062070914977,
157     372.328646856954,
158     391.841444284136,
159     394.029351759596,
160     383.369407765254,
161     381.093099675206,
162     382.604158946193,
163     390.744843709034,
164     383.13949492437,
165     368.150393976985,
166     364.629744480226,
167     363.572736804082,
168     359.854924202248,
169     355.207590170267,
170     349.094656012401,
171     354.365935871597,
172     343.380608328546,
173     404.673065729266,
174     486.296896820126,
175     480.225974100847,
176     457.318764401085,
177     418.177339948609,
178     414.399018364126,
179     409.678420185754,
180     404.768766016563,
181     401.699589920585,
182     402.44339040654,
183     398.138372541906,
184     396.010498627646,
185     390.165117432277,
186     375.850429417013,
187     365.567100746484,
188     365.429624610923
189 };
190
191 for (int i = 0; i < 48; i++) {
192     testFloatEquals(
193         test_model.electrical_load.dt_vec_hrs[i],
194         expected_dt_vec_hrs[i],
195         __FILE__,
196         __LINE__
197     );
198
199     testFloatEquals(
200         test_model.electrical_load.time_vec_hrs[i],
201         expected_time_vec_hrs[i],
202         __FILE__,
203         __LINE__
204     );
205
206     testFloatEquals(
207         test_model.electrical_load.load_vec_kW[i],
208         expected_load_vec_kW[i],
209         __FILE__,
210         __LINE__
211     );
212 }
213
214 // ===== END ATTRIBUTES ===== //
215
216

```

```

217
218 // ===== METHODS ===== //
219
220 // add Solar resource
221 int solar_resource_key = 0;
222 std::string path_2_solar_resource_data =
223     "data/test/resources/solar_GHI_peak-1kWm2_1yr-dt-1hr.csv";
224
225 test_model.addResource(
226     RenewableType :: SOLAR,
227     path_2_solar_resource_data,
228     solar_resource_key
229 );
230
231 std::vector<double> expected_solar_resource_vec_kWm2 = {
232     0,
233     0,
234     0,
235     0,
236     0,
237     0,
238     8.51702662684015E-05,
239     0.000348341567045,
240     0.00213793728593,
241     0.004099863613322,
242     0.000997135230553,
243     0.009534527624657,
244     0.022927996790616,
245     0.0136071715294,
246     0.002535134127751,
247     0.005206897515821,
248     0.005627658648597,
249     0.000701186722215,
250     0.00017119827089,
251     0,
252     0,
253     0,
254     0,
255     0,
256     0,
257     0,
258     0,
259     0,
260     0,
261     0,
262     0,
263     0.000141055102242,
264     0.00084525014743,
265     0.024893647822702,
266     0.091245556190749,
267     0.158722176731637,
268     0.152859680515876,
269     0.149922903895116,
270     0.13049996570866,
271     0.03081254222795,
272     0.001218928911125,
273     0.000206092647423,
274     0,
275     0,
276     0,
277     0,
278     0,
279     0
280 };
281
282 for (size_t i = 0; i < expected_solar_resource_vec_kWm2.size(); i++) {
283     testFloatEquals(
284         test_model.resources.resource_map_1D[solar_resource_key][i],
285         expected_solar_resource_vec_kWm2[i],
286         __FILE__,
287         __LINE__
288     );
289 }
290
291
292 // add Tidal resource
293 int tidal_resource_key = 1;
294 std::string path_2_tidal_resource_data =
295     "data/test/resources/tidal_speed_peak-3ms_1yr-dt-1hr.csv";
296
297 test_model.addResource(
298     RenewableType :: TIDAL,
299     path_2_tidal_resource_data,
300     tidal_resource_key
301 );
302
303

```

```

304 // add Wave resource
305 int wave_resource_key = 2;
306 std::string path_2_wave_resource_data =
307     "data/test/resources/waves_H_s_peak-8m_T_e_peak-15s_1yr_dt-1hr.csv";
308
309 test_model.addResource(
310     RenewableType :: WAVE,
311     path_2_wave_resource_data,
312     wave_resource_key
313 );
314
315
316 // add Wind resource
317 int wind_resource_key = 3;
318 std::string path_2_wind_resource_data =
319     "data/test/resources/wind_speed_peak-25ms_1yr_dt-1hr.csv";
320
321 test_model.addResource(
322     RenewableType :: WIND,
323     path_2_wind_resource_data,
324     wind_resource_key
325 );
326
327
328 // add Diesel assets
329 DieselInputs diesel_inputs;
330 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 100;
331 diesel_inputs.combustion_inputs.production_inputs.is_sunk = true;
332
333 test_model.addDiesel(diesel_inputs);
334
335 testFloatEquals(
336     test_model.combustion_ptr_vec.size(),
337     1,
338     __FILE__,
339     __LINE__
340 );
341
342 testFloatEquals(
343     test_model.combustion_ptr_vec[0]->type,
344     CombustionType :: DIESEL,
345     __FILE__,
346     __LINE__
347 );
348
349 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 150;
350
351 test_model.addDiesel(diesel_inputs);
352
353 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 250;
354
355 test_model.addDiesel(diesel_inputs);
356
357 testFloatEquals(
358     test_model.combustion_ptr_vec.size(),
359     3,
360     __FILE__,
361     __LINE__
362 );
363
364 std::vector<int> expected_diesel_capacity_vec_kW = {100, 150, 250};
365
366 for (int i = 0; i < 3; i++) {
367     testFloatEquals(
368         test_model.combustion_ptr_vec[i]->capacity_kW,
369         expected_diesel_capacity_vec_kW[i],
370         __FILE__,
371         __LINE__
372     );
373 }
374
375 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 100;
376
377 for (int i = 0; i < 2 * ((double)rand() / RAND_MAX); i++) {
378     test_model.addDiesel(diesel_inputs);
379 }
380
381
382 // add Solar asset
383 SolarInputs solar_inputs;
384 solar_inputs.resource_key = solar_resource_key;
385
386 test_model.addSolar(solar_inputs);
387
388 testFloatEquals(
389     test_model.renewable_ptr_vec.size(),
390     1,

```

```

391     __FILE__,
392     __LINE__
393 );
394
395 testFloatEquals(
396     test_model.renewable_ptr_vec[0]->type,
397     RenewableType :: SOLAR,
398     __FILE__,
399     __LINE__
400 );
401
402
403 // add Tidal asset
404 TidalInputs tidal_inputs;
405 tidal_inputs.resource_key = tidal_resource_key;
406
407 test_model.addTidal(tidal_inputs);
408
409 testFloatEquals(
410     test_model.renewable_ptr_vec.size(),
411     2,
412     __FILE__,
413     __LINE__
414 );
415
416 testFloatEquals(
417     test_model.renewable_ptr_vec[1]->type,
418     RenewableType :: TIDAL,
419     __FILE__,
420     __LINE__
421 );
422
423
424 // add Wave asset
425 WaveInputs wave_inputs;
426 wave_inputs.resource_key = wave_resource_key;
427
428 test_model.addWave(wave_inputs);
429
430 testFloatEquals(
431     test_model.renewable_ptr_vec.size(),
432     3,
433     __FILE__,
434     __LINE__
435 );
436
437 testFloatEquals(
438     test_model.renewable_ptr_vec[2]->type,
439     RenewableType :: WAVE,
440     __FILE__,
441     __LINE__
442 );
443
444
445 // add Wind asset
446 WindInputs wind_inputs;
447 wind_inputs.resource_key = wind_resource_key;
448
449 test_model.addWind(wind_inputs);
450
451 testFloatEquals(
452     test_model.renewable_ptr_vec.size(),
453     4,
454     __FILE__,
455     __LINE__
456 );
457
458 testFloatEquals(
459     test_model.renewable_ptr_vec[3]->type,
460     RenewableType :: WIND,
461     __FILE__,
462     __LINE__
463 );
464
465
466 // add LiIon asset
467 LiIonInputs liion_inputs;
468
469 test_model.addLiIon(liion_inputs);
470
471 testFloatEquals(
472     test_model.storage_ptr_vec.size(),
473     1,
474     __FILE__,
475     __LINE__
476 );
477

```

```

478 testFloatEquals(
479     test_model.storage_ptr_vec[0]->type,
480     StorageType :: LIION,
481     __FILE__,
482     __LINE__
483 );
484
485
486 // run
487 test_model.run();
488
489
490 // write results
491 test_model.writeResults("test/test_results/");
492
493
494 // test post-run attributes
495 double net_load_kW;
496
497 Combustion* combustion_ptr;
498 Renewable* renewable_ptr;
499 Storage* storage_ptr;
500
501 for (int i = 0; i < test_model.electrical_load.n_points; i++) {
502     net_load_kW = test_model.controller.net_load_vec_kW[i];
503
504     testLessThanOrEqualTo(
505         test_model.controller.net_load_vec_kW[i],
506         test_model.electrical_load.max_load_kW,
507         __FILE__,
508         __LINE__
509     );
510
511     for (size_t j = 0; j < test_model.combustion_ptr_vec.size(); j++) {
512         combustion_ptr = test_model.combustion_ptr_vec[j];
513
514         testFloatEquals(
515             combustion_ptr->production_vec_kW[i] -
516             combustion_ptr->dispatch_vec_kW[i] -
517             combustion_ptr->curtailment_vec_kW[i] -
518             combustion_ptr->storage_vec_kW[i],
519             0,
520             __FILE__,
521             __LINE__
522         );
523
524         net_load_kW -= combustion_ptr->production_vec_kW[i];
525     }
526
527     for (size_t j = 0; j < test_model.renewable_ptr_vec.size(); j++) {
528         renewable_ptr = test_model.renewable_ptr_vec[j];
529
530         testFloatEquals(
531             renewable_ptr->production_vec_kW[i] -
532             renewable_ptr->dispatch_vec_kW[i] -
533             renewable_ptr->curtailment_vec_kW[i] -
534             renewable_ptr->storage_vec_kW[i],
535             0,
536             __FILE__,
537             __LINE__
538         );
539
540         net_load_kW -= renewable_ptr->production_vec_kW[i];
541     }
542
543     for (size_t j = 0; j < test_model.storage_ptr_vec.size(); j++) {
544         storage_ptr = test_model.storage_ptr_vec[j];
545
546         testTruth(
547             not (
548                 storage_ptr->charging_power_vec_kW[i] > 0 and
549                 storage_ptr->discharging_power_vec_kW[i] > 0
550             ),
551             __FILE__,
552             __LINE__
553         );
554
555         net_load_kW -= storage_ptr->discharging_power_vec_kW[i];
556     }
557
558     testLessThanOrEqualTo(
559         net_load_kW,
560         0,
561         __FILE__,
562         __LINE__
563     );
564 }

```

```

565
566 testGreaterThan(
567     test_model.net_present_cost,
568     0,
569     __FILE__,
570     __LINE__
571 );
572
573 testFloatEquals(
574     test_model.total_dispatch_discharge_kWh,
575     2263351.62026685,
576     __FILE__,
577     __LINE__
578 );
579
580 testGreaterThan(
581     test_model.levelized_cost_of_energy_kWh,
582     0,
583     __FILE__,
584     __LINE__
585 );
586
587 testGreaterThan(
588     test_model.total_fuel_consumed_L,
589     0,
590     __FILE__,
591     __LINE__
592 );
593
594 testGreaterThan(
595     test_model.total_emissions.CO2_kg,
596     0,
597     __FILE__,
598     __LINE__
599 );
600
601 testGreaterThan(
602     test_model.total_emissions.CO_kg,
603     0,
604     __FILE__,
605     __LINE__
606 );
607
608 testGreaterThan(
609     test_model.total_emissions.NOx_kg,
610     0,
611     __FILE__,
612     __LINE__
613 );
614
615 testGreaterThan(
616     test_model.total_emissions.SOx_kg,
617     0,
618     __FILE__,
619     __LINE__
620 );
621
622 testGreaterThan(
623     test_model.total_emissions.CH4_kg,
624     0,
625     __FILE__,
626     __LINE__
627 );
628
629 testGreaterThan(
630     test_model.total_emissions.PM_kg,
631     0,
632     __FILE__,
633     __LINE__
634 );
635
636 // ===== END METHODS ===== //
637
638 } /* try */
639
640
641 catch (...) {
642     //...
643
644     printGold(" ..... ");
645     printRed("FAIL");
646     std::cout << std::endl;
647     throw;
648 }
649
650
651 printGold(" ..... ");

```



```

652 printGreen("PASS");
653 std::cout << std::endl;
654 return 0;
655 } /* main() */

```

5.47 test/source/test_Resources.cpp File Reference

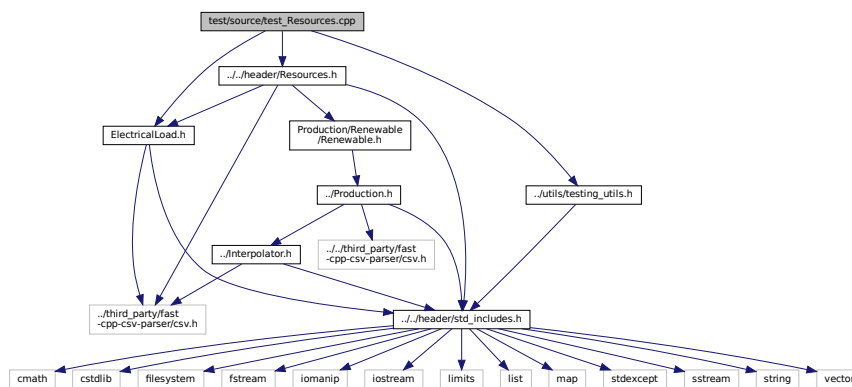
Testing suite for [Resources](#) class.

```

#include "../utils/testing_utils.h"
#include "../../header/Resources.h"
#include "../../header/ElectricalLoad.h"

```

Include dependency graph for test_Resources.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.47.1 Detailed Description

Testing suite for [Resources](#) class.

A suite of tests for the [Resources](#) class.

5.47.2 Function Documentation

5.47.2.1 main()

```

int main (
    int argc,
    char ** argv )
28 {
29     #ifdef _WIN32
30         activateVirtualTerminal();
31     #endif /* _WIN32 */
32
33     printGold("\tTesting Resources");
34
35     srand(time(NULL));
36
37
38     try {
39
40     // ===== CONSTRUCTION ===== //
41
42     std::string path_2_electrical_load_time_series =
43         "data/test/electrical_load/electrical_load_generic_peak-500kW_1yr_dt-1hr.csv";
44
45     ElectricalLoad test_electrical_load(path_2_electrical_load_time_series);
46
47     Resources test_resources;
48
49     // ===== END CONSTRUCTION ===== //
50
51
52
53     // ===== ATTRIBUTES ===== //
54
55     testFloatEquals(
56         test_resources.resource_map_1D.size(),
57         0,
58         __FILE__,
59         __LINE__
60     );
61
62     testFloatEquals(
63         test_resources.path_map_1D.size(),
64         0,
65         __FILE__,
66         __LINE__
67     );
68
69     testFloatEquals(
70         test_resources.resource_map_2D.size(),
71         0,
72         __FILE__,
73         __LINE__
74     );
75
76     testFloatEquals(
77         test_resources.path_map_2D.size(),
78         0,
79         __FILE__,
80         __LINE__
81     );
82
83     // ===== END ATTRIBUTES ===== //
84
85
86     // ===== METHODS ===== //
87
88     int solar_resource_key = 0;
89     std::string path_2_solar_resource_data =
90         "data/test/resources/solar_GHI_peak-1kWm2_1yr_dt-1hr.csv";
91
92     test_resources.addResource(
93         RenewableType::SOLAR,
94         path_2_solar_resource_data,
95         solar_resource_key,
96         &test_electrical_load
97     );
98
99     bool error_flag = true;
100     try {
101         test_resources.addResource(
102             RenewableType::SOLAR,
103             path_2_solar_resource_data,
104             solar_resource_key,
105             &test_electrical_load
106         );
107

```

```

108     error_flag = false;
109 } catch (...) {
110     // Task failed successfully! =P
111 }
112 if (not error_flag) {
113     expectedErrorNotDetected(__FILE__, __LINE__);
114 }
115
116
117 try {
118     std::string path_2_solar_resource_data_BAD_TIMES =
119         "data/test/resources/solar_GHI_peak-1kWm2_1yr_dt-1hr_BAD_TIMES.csv";
120
121     test_resources.addResource(
122         RenewableType::SOLAR,
123         path_2_solar_resource_data_BAD_TIMES,
124         -1,
125         &test_electrical_load
126     );
127
128     error_flag = false;
129 } catch (...) {
130     // Task failed successfully! =P
131 }
132 if (not error_flag) {
133     expectedErrorNotDetected(__FILE__, __LINE__);
134 }
135
136
137 try {
138     std::string path_2_solar_resource_data_BAD_LENGTH =
139         "data/test/resources/solar_GHI_peak-1kWm2_1yr_dt-1hr_BAD_LENGTH.csv";
140
141     test_resources.addResource(
142         RenewableType::SOLAR,
143         path_2_solar_resource_data_BAD_LENGTH,
144         -2,
145         &test_electrical_load
146     );
147
148     error_flag = false;
149 } catch (...) {
150     // Task failed successfully! =P
151 }
152 if (not error_flag) {
153     expectedErrorNotDetected(__FILE__, __LINE__);
154 }
155
156 std::vector<double> expected_solar_resource_vec_kWm2 = {
157     0,
158     0,
159     0,
160     0,
161     0,
162     0,
163     8.51702662684015E-05,
164     0.000348341567045,
165     0.00213793728593,
166     0.004099863613322,
167     0.000997135230553,
168     0.009534527624657,
169     0.022927996790616,
170     0.0136071715294,
171     0.002535134127751,
172     0.005206897515821,
173     0.005627658648597,
174     0.000701186722215,
175     0.00017119827089,
176     0,
177     0,
178     0,
179     0,
180     0,
181     0,
182     0,
183     0,
184     0,
185     0,
186     0,
187     0,
188     0.000141055102242,
189     0.00084525014743,
190     0.024893647822702,
191     0.091245556190749,
192     0.158722176731637,
193     0.152859680515876,
194     0.149922903895116,

```

```

195     0.13049996570866,
196     0.03081254222795,
197     0.001218928911125,
198     0.000206092647423,
199     0,
200     0,
201     0,
202     0,
203     0,
204     0
205 };
206
207 for (size_t i = 0; i < expected_solar_resource_vec_kWm2.size(); i++) {
208     testFloatEquals(
209         test_resources.resource_map_1D[solar_resource_key][i],
210         expected_solar_resource_vec_kWm2[i],
211         __FILE__,
212         __LINE__
213     );
214 }
215
216
217 int tidal_resource_key = 1;
218 std::string path_2_tidal_resource_data =
219     "data/test/resources/tidal_speed_peak-3ms_1yr_dt-1hr.csv";
220
221 test_resources.addResource(
222     RenewableType::TIDAL,
223     path_2_tidal_resource_data,
224     tidal_resource_key,
225     &test_electrical_load
226 );
227
228 std::vector<double> expected_tidal_resource_vec_ms = {
229     0.347439913040533,
230     0.770545522195602,
231     0.731352084836198,
232     0.293389814389542,
233     0.209959110813115,
234     0.610609623896497,
235     1.78067162013604,
236     2.53522775118089,
237     2.75966627832024,
238     2.52101111143895,
239     2.05389330201031,
240     1.3461515862445,
241     0.28909254878384,
242     0.897754086048563,
243     1.71406453837407,
244     1.85047408742869,
245     1.71507908595979,
246     1.33540349705416,
247     0.434586143463003,
248     0.500623815700637,
249     1.37172172646733,
250     1.68294125491228,
251     1.56101300975417,
252     1.04925834219412,
253     0.211395463930223,
254     1.03720048903385,
255     1.85059536356448,
256     1.85203242794517,
257     1.4091471616277,
258     0.767776539039899,
259     0.251464906990961,
260     1.47018469375652,
261     2.36260493698197,
262     2.46653750048625,
263     2.12851908739291,
264     1.62783753197988,
265     0.734594890957439,
266     0.441886297300355,
267     1.6574418350918,
268     2.0684558286637,
269     1.87717416992136,
270     1.58871262337931,
271     1.03451227609235,
272     0.193371305159817,
273     0.976400122458815,
274     1.6583227369707,
275     1.76690616570953,
276     1.54801328553115
277 };
278
279 for (size_t i = 0; i < expected_tidal_resource_vec_ms.size(); i++) {
280     testFloatEquals(
281         test_resources.resource_map_1D[tidal_resource_key][i],

```

```

282         expected_tidal_resource_vec_ms[i],
283         __FILE__,
284         __LINE__
285     );
286 }
287
288
289 int wave_resource_key = 2;
290 std::string path_2_wave_resource_data =
291     "data/test/resources/waves_H_s_peak-8m_T_e_peak-15s_1yr_dt-1hr.csv";
292
293 test_resources.addResource(
294     RenewableType::WAVE,
295     path_2_wave_resource_data,
296     wave_resource_key,
297     &test_electrical_load
298 );
299
300 std::vector<double> expected_significant_wave_height_vec_m = {
301     4.26175222125028,
302     4.25020976167872,
303     4.25656524330349,
304     4.27193854786718,
305     4.28744955711233,
306     4.29421815278154,
307     4.2839937266082,
308     4.25716982457976,
309     4.22419391611483,
310     4.19588925217606,
311     4.17338788587412,
312     4.14672746914214,
313     4.10560041173665,
314     4.05074966447193,
315     3.9953696962433,
316     3.95316976150866,
317     3.92771018142378,
318     3.91129562488595,
319     3.89558312094911,
320     3.87861093931749,
321     3.86538307240754,
322     3.86108961027929,
323     3.86459448853189,
324     3.86796474016882,
325     3.86357412779993,
326     3.85554872014731,
327     3.86044266668675,
328     3.89445961915999,
329     3.95554798115731,
330     4.02265508610476,
331     4.07419587011404,
332     4.10314247143958,
333     4.11738045085928,
334     4.12554995596708,
335     4.12923992001675,
336     4.1229292327442,
337     4.10123955307441,
338     4.06748827895363,
339     4.0336230651344,
340     4.01134236393876,
341     4.00136570034559,
342     3.99368787690411,
343     3.97820924247644,
344     3.95369335178055,
345     3.92742545608532,
346     3.90683362771686,
347     3.89331520944006,
348     3.88256045801583
349 };
350
351 std::vector<double> expected_energy_period_vec_s = {
352     10.4456008226821,
353     10.4614151137651,
354     10.4462827795433,
355     10.4127692097884,
356     10.3734397942723,
357     10.3408599227669,
358     10.32637292093,
359     10.3245412676322,
360     10.310409818185,
361     10.2589529840966,
362     10.1728100603103,
363     10.0862908658929,
364     10.03480243813,
365     10.023673635806,
366     10.0243418565116,
367     10.0063487117653,
368     9.96050302286607,

```

```
369     9.9011999635568,
370     9.84451822125472,
371     9.79726875879626,
372     9.75614594835158,
373     9.7173447961368,
374     9.68342904390577,
375     9.66380508567062,
376     9.6674009575699,
377     9.68927134575103,
378     9.70979984863046,
379     9.70967357906908,
380     9.68983025704562,
381     9.6722855524805,
382     9.67973599910003,
383     9.71977125328293,
384     9.78450442291421,
385     9.86532355233449,
386     9.96158937600019,
387     10.0807018356507,
388     10.2291022504937,
389     10.39458528356,
390     10.5464393581004,
391     10.6553277500484,
392     10.7245553190084,
393     10.7893127285064,
394     10.8846512240849,
395     11.0148158739075,
396     11.1544325654719,
397     11.2772785848343,
398     11.3744362756187,
399     11.4533643503183
400 };
401
402 for (size_t i = 0; i < expected_significant_wave_height_vec_m.size(); i++) {
403     testFloatEquals (
404         test_resources.resource_map_2D[wave_resource_key][i][0],
405         expected_significant_wave_height_vec_m[i],
406         __FILE__,
407         __LINE__
408     );
409
410     testFloatEquals (
411         test_resources.resource_map_2D[wave_resource_key][i][1],
412         expected_energy_period_vec_s[i],
413         __FILE__,
414         __LINE__
415     );
416 }
417
418
419 int wind_resource_key = 3;
420 std::string path_2_wind_resource_data =
421     "data/test/resources/wind_speed_peak-25ms_1yr_dt-1hr.csv";
422
423 test_resources.addResource (
424     RenewableType::WIND,
425     path_2_wind_resource_data,
426     wind_resource_key,
427     &test_electrical_load
428 );
429
430 std::vector<double> expected_wind_resource_vec_ms = {
431     6.88566688469997,
432     5.02177105466549,
433     3.74211715899568,
434     5.67169579985362,
435     4.90670669971858,
436     4.29586955031368,
437     7.41155377205065,
438     10.2243290476943,
439     13.1258696725555,
440     13.7016198628274,
441     16.2481482330233,
442     16.5096744355418,
443     13.4354482206162,
444     14.0129230731609,
445     14.5554549260515,
446     13.4454539065912,
447     13.3447169512094,
448     11.7372615098554,
449     12.7200070078013,
450     10.6421127908149,
451     6.09869498990661,
452     5.66355596602321,
453     4.97316966910831,
454     3.48937138360567,
455     2.15917470979169,
```

```

456     1.29061103587027,
457     3.43475751425219,
458     4.11706326260927,
459     4.28905275747408,
460     5.75850263196241,
461     8.98293663055264,
462     11.7069822941315,
463     12.4031987075858,
464     15.4096570910089,
465     16.6210843829552,
466     13.3421219142573,
467     15.2112831900548,
468     18.350864533037,
469     15.8751799822971,
470     15.3921198799796,
471     15.9729192868434,
472     12.4728950178772,
473     10.177050481096,
474     10.7342247355551,
475     8.98846695631389,
476     4.14671169124739,
477     3.17256452697149,
478     3.40036336968628
479 };
480
481 for (size_t i = 0; i < expected_wind_resource_vec_ms.size(); i++) {
482     testFloatEquals(
483         test_resources.resource_map_1D[wind_resource_key][i],
484         expected_wind_resource_vec_ms[i],
485         __FILE__,
486         __LINE__
487     );
488 }
489
490 // ===== END METHODS ===== //
491
492 } /* try */
493
494
495 catch (...) {
496     printGold(" ..... ");
497     printRed("FAIL");
498     std::cout << std::endl;
499     throw;
500 }
501
502
503 printGold(" ..... ");
504 printGreen("PASS");
505 std::cout << std::endl;
506 return 0;
507 } /* main() */

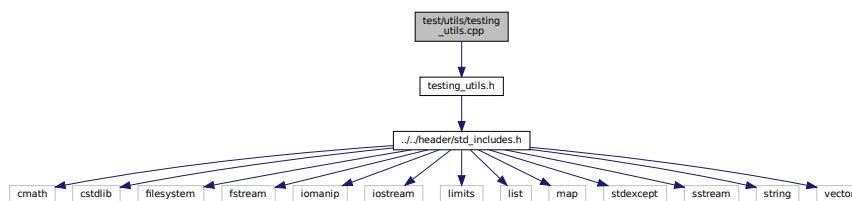
```

5.48 test/utls/testing_utils.cpp File Reference

Header file for various PGMcpp testing utilities.

```
#include "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.

5.48.1 Detailed Description

Header file for various PGMcpp testing utilities.

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

5.48.2 Function Documentation

5.48.2.1 `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__").

```
432 {
433     std::string error_str = "\n ERROR   failed to throw expected error prior to line ";
434     error_str += std::to_string(line);
```



```
435     error_str += " of ";
436     error_str += file;
437
438     #ifdef _WIN32
439         std::cout << error_str << std::endl;
440     #endif
441
442     throw std::runtime_error(error_str);
443     return;
444 } /* expectedErrorNotDetected() */
```

5.48.2.2 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.
------------------	---

```
84 {
85     std::cout << "\x1B[33m" << input_str << "\033[0m";
86     return;
87 } /* printGold() */
```

5.48.2.3 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.
------------------	---

```
64 {
65     std::cout << "\x1B[32m" << input_str << "\033[0m";
66     return;
67 } /* printGreen() */
```

5.48.2.4 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> .
------------------	---

```

104 {
105     std::cout << "\x1B[31m" << input_str << "\033[0m";
106     return;
107 } /* printRed() */

```

5.48.2.5 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> ").

```

138 {
139     if (fabs(x - y) <= FLOAT_TOLERANCE) {
140         return;
141     }
142
143     std::string error_str = "ERROR: testFloatEquals():\t in ";
144     error_str += file;
145     error_str += "\tline ";
146     error_str += std::to_string(line);
147     error_str += ":\t\n";
148     error_str += std::to_string(x);
149     error_str += " and ";
150     error_str += std::to_string(y);
151     error_str += " are not equal to within +/- ";
152     error_str += std::to_string(FLOAT_TOLERANCE);
153     error_str += "\n";
154
155     #ifdef WIN32
156         std::cout << error_str << std::endl;
157     #endif
158
159     throw std::runtime_error(error_str);
160     return;
161 } /* testFloatEquals() */

```

5.48.2.6 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__").

```

191 {
192     if (x > y) {
193         return;
194     }
195
196     std::string error_str = "ERROR: testGreaterThan():\t in ";
197     error_str += file;
198     error_str += "\tline ";
199     error_str += std::to_string(line);
200     error_str += ":\t\n";
201     error_str += std::to_string(x);
202     error_str += " is not greater than ";
203     error_str += std::to_string(y);
204     error_str += "\n";
205
206     #ifdef _WIN32
207         std::cout << error_str << std::endl;
208     #endif
209
210     throw std::runtime_error(error_str);
211     return;
212 } /* testGreaterThan() */

```

5.48.2.7 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__").

```

242 {
243     if (x >= y) {
244         return;
245     }
246
247     std::string error_str = "ERROR: testGreaterThanOrEqualTo():\t in ";
248     error_str += file;
249     error_str += "\tline ";
250     error_str += std::to_string(line);
251     error_str += ":\t\n";
252     error_str += std::to_string(x);
253     error_str += " is not greater than or equal to ";
254     error_str += std::to_string(y);
255     error_str += "\n";
256
257     #ifdef _WIN32
258         std::cout << error_str << std::endl;
259     #endif
260
261     throw std::runtime_error(error_str);

```

```

262     return;
263 } /* testGreaterThanOrEqualTo() */

```

5.48.2.8 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__").

```

293 {
294     if (x < y) {
295         return;
296     }
297
298     std::string error_str = "ERROR: testLessThan():\t in ";
299     error_str += file;
300     error_str += "\tline ";
301     error_str += std::to_string(line);
302     error_str += ":\t\n";
303     error_str += std::to_string(x);
304     error_str += " is not less than ";
305     error_str += std::to_string(y);
306     error_str += "\n";
307
308     #ifdef _WIN32
309         std::cout << error_str << std::endl;
310     #endif
311
312     throw std::runtime_error(error_str);
313     return;
314 } /* testLessThan() */

```

5.48.2.9 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__").

```

344 {
345     if (x <= y) {
346         return;
347     }
348
349     std::string error_str = "ERROR: testLessThanOrEqualTo():\t in ";
350     error_str += file;
351     error_str += "\tline ";
352     error_str += std::to_string(line);
353     error_str += ":\t\n";
354     error_str += std::to_string(x);
355     error_str += " is not less than or equal to ";
356     error_str += std::to_string(y);
357     error_str += "\n";
358
359     #ifdef _WIN32
360         std::cout << error_str << std::endl;
361     #endif
362
363     throw std::runtime_error(error_str);
364     return;
365 } /* testLessThanOrEqualTo() */

```

5.48.2.10 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__").

```

392 {
393     if (statement) {
394         return;
395     }
396
397     std::string error_str = "ERROR: testTruth():\t in ";
398     error_str += file;
399     error_str += "\tline ";
400     error_str += std::to_string(line);
401     error_str += ":\t\n";
402     error_str += "Given statement is not true";
403
404     #ifdef _WIN32
405         std::cout << error_str << std::endl;
406     #endif
407
408     throw std::runtime_error(error_str);
409     return;
410 } /* testTruth() */

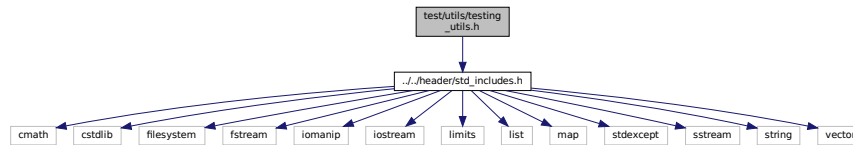
```

5.49 test/utills/testing_utils.h File Reference

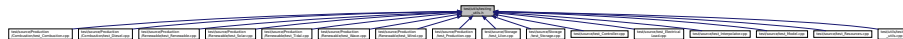
Header file for various PGMcpp testing utilities.

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

Include dependency graph for testing_utils.h:



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



Macros

- `#define FLOAT_TOLERANCE 1e-6`
A tolerance for application to floating point equality tests.

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.

5.49.1 Detailed Description

Header file for various PGMcpp testing utilities.

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

5.49.2 Macro Definition Documentation

5.49.2.1 FLOAT_TOLERANCE

```
#define FLOAT_TOLERANCE 1e-6
```

A tolerance for application to floating point equality tests.

5.49.3 Function Documentation

5.49.3.1 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__").

```
432 {
433     std::string error_str = "\n ERROR   failed to throw expected error prior to line ";
434     error_str += std::to_string(line);
435     error_str += " of ";
436     error_str += file;
437
438     #ifdef _WIN32
439         std::cout << error_str << std::endl;
440     #endif
441
442     throw std::runtime_error(error_str);
443     return;
444 } /* expectedErrorNotDetected() */
```

5.49.3.2 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.
------------------	---

```

84 {
85     std::cout << "\x1B[33m" << input_str << "\033[0m";
86     return;
87 } /* printGold() */

```

5.49.3.3 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.
------------------	---

```

64 {
65     std::cout << "\x1B[32m" << input_str << "\033[0m";
66     return;
67 } /* printGreen() */

```

5.49.3.4 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.
------------------	---

```

104 {
105     std::cout << "\x1B[31m" << input_str << "\033[0m";
106     return;
107 } /* printRed() */

```

5.49.3.5 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.
----------	-----------------------------------

Parameters

<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

138 {
139     if (fabs(x - y) <= FLOAT_TOLERANCE) {
140         return;
141     }
142
143     std::string error_str = "ERROR: testFloatEquals():\t in ";
144     error_str += file;
145     error_str += "\tline ";
146     error_str += std::to_string(line);
147     error_str += ":\t\n";
148     error_str += std::to_string(x);
149     error_str += " and ";
150     error_str += std::to_string(y);
151     error_str += " are not equal to within +/- ";
152     error_str += std::to_string(FLOAT_TOLERANCE);
153     error_str += "\n";
154
155     #ifdef _WIN32
156         std::cout << error_str << std::endl;
157     #endif
158
159     throw std::runtime_error(error_str);
160     return;
161 } /* testFloatEquals() */

```

5.49.3.6 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__").

```

191 {
192     if (x > y) {
193         return;
194     }
195
196     std::string error_str = "ERROR: testGreaterThan():\t in ";
197     error_str += file;
198     error_str += "\tline ";
199     error_str += std::to_string(line);
200     error_str += ":\t\n";
201     error_str += std::to_string(x);
202     error_str += " is not greater than ";
203     error_str += std::to_string(y);
204     error_str += "\n";
205
206     #ifdef _WIN32
207         std::cout << error_str << std::endl;
208     #endif
209

```

```

210     throw std::runtime_error(error_str);
211     return;
212 } /* testGreaterThan() */

```

5.49.3.7 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__").

```

242 {
243     if (x >= y) {
244         return;
245     }
246
247     std::string error_str = "ERROR: testGreaterThanOrEqualTo():\t in ";
248     error_str += file;
249     error_str += "\tline ";
250     error_str += std::to_string(line);
251     error_str += ":\t\n";
252     error_str += std::to_string(x);
253     error_str += " is not greater than or equal to ";
254     error_str += std::to_string(y);
255     error_str += "\n";
256
257     #ifdef _WIN32
258         std::cout << error_str << std::endl;
259     #endif
260
261     throw std::runtime_error(error_str);
262     return;
263 } /* testGreaterThanOrEqualTo() */

```

5.49.3.8 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__").

```

293 {
294     if (x < y) {
295         return;
296     }
297
298     std::string error_str = "ERROR: testLessThan():\t in ";
299     error_str += file;
300     error_str += "\tline ";
301     error_str += std::to_string(line);
302     error_str += ":\t\n";
303     error_str += std::to_string(x);
304     error_str += " is not less than ";
305     error_str += std::to_string(y);
306     error_str += "\n";
307
308     #ifdef _WIN32
309         std::cout << error_str << std::endl;
310     #endif
311
312     throw std::runtime_error(error_str);
313     return;
314 } /* testLessThan() */

```

5.49.3.9 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__").

```

344 {
345     if (x <= y) {
346         return;
347     }
348
349     std::string error_str = "ERROR: testLessThanOrEqualTo():\t in ";
350     error_str += file;
351     error_str += "\tline ";
352     error_str += std::to_string(line);
353     error_str += ":\t\n";
354     error_str += std::to_string(x);
355     error_str += " is not less than or equal to ";
356     error_str += std::to_string(y);
357     error_str += "\n";
358
359     #ifdef _WIN32
360         std::cout << error_str << std::endl;
361     #endif
362
363     throw std::runtime_error(error_str);
364     return;
365 } /* testLessThanOrEqualTo() */

```

5.49.3.10 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__").

```
392 {  
393     if (statement) {  
394         return;  
395     }  
396  
397     std::string error_str = "ERROR: testTruth():\t in ";  
398     error_str += file;  
399     error_str += "\tline ";  
400     error_str += std::to_string(line);  
401     error_str += ":\t\n";  
402     error_str += "Given statement is not true";  
403  
404     #ifdef _WIN32  
405         std::cout << error_str << std::endl;  
406     #endif  
407  
408     throw std::runtime_error(error_str);  
409     return;  
410 } /* testTruth() */
```

Bibliography

- Dr. B. Buckham, Dr. C. Crawford, Dr. I. Beya Marshall, and Dr. B. Whitby. Wei Wai Kum Tidal Prefeasibility Study - Tidal Resource Assessment. Technical report, PRIMED, 2023. Internal: P2202E_BRKLYG+WEI WAI KUM_R01_V20230613v3. 183
- CIMAC. Guide to Diesel Exhaust Emissions Control of NOx, SOx, Particulates, Smoke, and CO2. Technical report, Conseil International des Machines à Combustion, 2008. Included: docs/refs/diesel_emissions_ref_2.pdf. 55
- HOMER. Capital Recovery Factor, 2023a. URL https://www.homerenergy.com/products/pro/docs/latest/capital_recovery_factor.html. 125, 170
- HOMER. Discount Factor, 2023b. URL https://www.homerenergy.com/products/pro/docs/latest/discount_factor.html. 15, 125, 126, 168, 170
- HOMER. Fuel Curve, 2023c. URL https://www.homerenergy.com/products/pro/docs/latest/fuel_curve.html. 47, 55
- HOMER. Generator Fuel Curve Intercept Coefficient, 2023d. URL https://www.homerenergy.com/products/pro/docs/latest/generator_fuel_curve_intercept_coefficient.html. 47, 55
- HOMER. Generator Fuel Curve Slope, 2023e. URL https://www.homerenergy.com/products/pro/docs/latest/generator_fuel_curve_slope.html. 47, 55
- HOMER. How HOMER Calculates the PV Array Power Output, 2023f. URL https://www.homerenergy.com/products/pro/docs/latest/how_homer_calculates_the_pv_array_power_output.html. 160
- HOMER. Levelized Cost of Energy, 2023g. URL https://www.homerenergy.com/products/pro/docs/latest/levelized_cost_of_energy.html. 125, 170
- HOMER. Real Discount Rate, 2023h. URL https://www.homerenergy.com/products/pro/docs/latest/real_discount_rate.html. 126, 168
- HOMER. Total Annualized Cost, 2023i. URL https://www.homerenergy.com/products/pro/docs/latest/total_annualized_cost.html. 125, 170
- Dr. S.L. MacDougall. Commercial Potential of Marine Renewables in British Columbia. Technical report, S.L. MacDougall Research & Consulting, 2019. Submitted to Natural Resources Canada. 185, 200, 201
- NRCan. Auto\$mart Learn the facts: Emissions from your vehicle. Technical report, Natural Resources Canada, 2014. Included: docs/refs/diesel_emissions_ref_1.pdf. 55
- Dr. B. Robertson, Dr. H. Bailey, M. Leary, and Dr. B. Buckham. A methodology for architecture agnostic and time flexible representations of wave energy converter performance. *Applied Energy*, 287, 2021. doi:10.1016/j.apenergy.2021.116588. 199
- A. Truelove. Battery Degradation Modelling For Implementation in PGMcpp. Technical report, PRIMED, 2023. Included: docs/refs/battery_degradation.pdf. 83, 84, 86, 97
- A. Truelove, Dr. B. Buckham, Dr. C. Crawford, and C. Hiles. Scaling Technology Models for HOMER Pro: Wind, Tidal Stream, and Wave. Technical report, PRIMED, 2019. Included: docs/refs/wind_tidal_wave.pdf. 184, 197, 213

Index

- __applyCycleChargingControl_CHARGING
Controller, [26](#)
- __applyCycleChargingControl_DISCHARGING
Controller, [26](#)
- __applyLoadFollowingControl_CHARGING
Controller, [28](#)
- __applyLoadFollowingControl_DISCHARGING
Controller, [28](#)
- __checkDataKey1D
Interpolator, [67](#)
- __checkDataKey2D
Interpolator, [67](#)
- __checkInputs
Combustion, [13](#)
Diesel, [45](#)
Lilon, [81](#)
Model, [104](#)
Production, [123](#)
Renewable, [136](#)
Solar, [156](#)
Storage, [167](#)
Tidal, [182](#)
Wave, [196](#)
Wind, [213](#)
- __checkResourceKey1D
Resources, [144](#)
- __checkResourceKey2D
Resources, [144](#)
- __checkTimePoint
Resources, [145](#)
- __computeCubicProductionkW
Tidal, [183](#)
- __computeEconomics
Model, [105](#)
- __computeExponentialProductionkW
Tidal, [183](#)
Wind, [213](#)
- __computeFuelAndEmissions
Model, [105](#)
- __computeGaussianProductionkW
Wave, [197](#)
- __computeLevellizedCostOfEnergy
Model, [105](#)
- __computeLookupProductionkW
Tidal, [184](#)
Wave, [198](#)
Wind, [214](#)
- __computeNetLoad
Controller, [29](#)
- __computeNetPresentCost
Model, [106](#)
- __computeParaboloidProductionkW
Wave, [198](#)
- __computeRealDiscountAnnual
Storage, [168](#)
- __constructCombustionMap
Controller, [30](#)
- __getBcal
Lilon, [83](#)
- __getDataStringMatrix
Interpolator, [68](#)
- __getEacal
Lilon, [84](#)
- __getGenericCapitalCost
Diesel, [46](#)
Lilon, [84](#)
Solar, [156](#)
Tidal, [185](#)
Wave, [200](#)
Wind, [214](#)
- __getGenericFuelIntercept
Diesel, [47](#)
- __getGenericFuelSlope
Diesel, [47](#)
- __getGenericOpMaintCost
Diesel, [47](#)
Lilon, [84](#)
Solar, [156](#)
Tidal, [185](#)
Wave, [200](#)
Wind, [215](#)
- __getRenewableProduction
Controller, [32](#)
- __handleCombustionDispatch
Controller, [33](#)
- __handleDegradation
Lilon, [85](#)
- __handleStartStop
Diesel, [48](#)
Renewable, [136](#)
- __handleStorageCharging
Controller, [34](#), [35](#)
- __handleStorageDischarging
Controller, [36](#)
- __isNonNumeric
Interpolator, [68](#)
- __modelDegradation
Lilon, [85](#)

- __readData1D
 - Interpolator, 69
- __readData2D
 - Interpolator, 69
- __readSolarResource
 - Resources, 146
- __readTidalResource
 - Resources, 147
- __readWaveResource
 - Resources, 147
- __readWindResource
 - Resources, 148
- __splitCommaSeparatedString
 - Interpolator, 71
- __throwLengthError
 - Resources, 149
- __throwReadError
 - Interpolator, 71
- __toggleDepleted
 - Lilon, 87
- __writeSummary
 - Combustion, 14
 - Diesel, 49
 - Lilon, 87
 - Model, 107
 - Renewable, 137
 - Solar, 157
 - Storage, 169
 - Tidal, 185
 - Wave, 201
 - Wind, 215
- __writeTimeSeries
 - Combustion, 14
 - Diesel, 50
 - Lilon, 89
 - Model, 109
 - Renewable, 137
 - Solar, 158
 - Storage, 169
 - Tidal, 186
 - Wave, 202
 - Wind, 216
- ~Combustion
 - Combustion, 13
- ~Controller
 - Controller, 25
- ~Diesel
 - Diesel, 44
- ~ElectricalLoad
 - ElectricalLoad, 60
- ~Interpolator
 - Interpolator, 66
- ~Lilon
 - Lilon, 80
- ~Model
 - Model, 104
- ~Production
 - Production, 122
- ~Renewable
 - Renewable, 136
- ~Resources
 - Resources, 143
- ~Solar
 - Solar, 155
- ~Storage
 - Storage, 167
- ~Tidal
 - Tidal, 182
- ~Wave
 - Wave, 196
- ~Wind
 - Wind, 212
- addData1D
 - Interpolator, 72
- addData2D
 - Interpolator, 72
- addDiesel
 - Model, 110
- addLilon
 - Model, 110
- addResource
 - Model, 111
 - Resources, 150
- addSolar
 - Model, 111
- addTidal
 - Model, 112
- addWave
 - Model, 112
- addWind
 - Model, 112
- applyDispatchControl
 - Controller, 37
- capacity_kW
 - Production, 126
 - ProductionInputs, 132
- capital_cost
 - DieselInputs, 56
 - LilonInputs, 98
 - Production, 127
 - SolarInputs, 162
 - Storage, 172
 - TidalInputs, 191
 - WaveInputs, 208
 - WindInputs, 221
- capital_cost_vec
 - Production, 127
 - Storage, 172
- CH4_emissions_intensity_kgL
 - Combustion, 19
 - DieselInputs, 56
- CH4_emissions_vec_kg
 - Combustion, 19
- CH4_kg
 - Emissions, 64

- charge_kWh
 - Storage, [172](#)
- charge_vec_kWh
 - Storage, [173](#)
- charging_efficiency
 - Lilon, [93](#)
 - LilonInputs, [98](#)
- charging_power_vec_kW
 - Storage, [173](#)
- clear
 - Controller, [38](#)
 - ElectricalLoad, [60](#)
 - Model, [113](#)
 - Resources, [151](#)
- CO2_emissions_intensity_kgL
 - Combustion, [19](#)
 - DieselInputs, [56](#)
- CO2_emissions_vec_kg
 - Combustion, [19](#)
- CO2_kg
 - Emissions, [64](#)
- CO_emissions_intensity_kgL
 - Combustion, [19](#)
 - DieselInputs, [56](#)
- CO_emissions_vec_kg
 - Combustion, [19](#)
- CO_kg
 - Emissions, [64](#)
- Combustion, [9](#)
 - __checkInputs, [13](#)
 - __writeSummary, [14](#)
 - __writeTimeSeries, [14](#)
 - ~Combustion, [13](#)
 - CH4_emissions_intensity_kgL, [19](#)
 - CH4_emissions_vec_kg, [19](#)
 - CO2_emissions_intensity_kgL, [19](#)
 - CO2_emissions_vec_kg, [19](#)
 - CO_emissions_intensity_kgL, [19](#)
 - CO_emissions_vec_kg, [19](#)
 - Combustion, [12](#)
 - commit, [14](#)
 - computeEconomics, [15](#)
 - computeFuelAndEmissions, [16](#)
 - fuel_consumption_vec_L, [20](#)
 - fuel_cost_L, [20](#)
 - fuel_cost_vec, [20](#)
 - getEmissionskg, [16](#)
 - getFuelConsumptionL, [16](#)
 - handleReplacement, [17](#)
 - linear_fuel_intercept_LkWh, [20](#)
 - linear_fuel_slope_LkWh, [20](#)
 - nominal_fuel_escalation_annual, [20](#)
 - NOx_emissions_intensity_kgL, [21](#)
 - NOx_emissions_vec_kg, [21](#)
 - PM_emissions_intensity_kgL, [21](#)
 - PM_emissions_vec_kg, [21](#)
 - real_fuel_escalation_annual, [21](#)
 - requestProductionkW, [17](#)
 - SOx_emissions_intensity_kgL, [21](#)
 - SOx_emissions_vec_kg, [22](#)
 - total_emissions, [22](#)
 - total_fuel_consumed_L, [22](#)
 - type, [22](#)
 - writeResults, [18](#)
- Combustion.h
 - CombustionType, [229](#)
 - DIESEL, [229](#)
 - N_COMBUSTION_TYPES, [229](#)
- combustion_inputs
 - DieselInputs, [56](#)
- combustion_map
 - Controller, [40](#)
- combustion_ptr_vec
 - Model, [115](#)
- CombustionInputs, [23](#)
 - nominal_fuel_escalation_annual, [23](#)
 - production_inputs, [23](#)
- CombustionType
 - Combustion.h, [229](#)
- commit
 - Combustion, [14](#)
 - Diesel, [51](#)
 - Production, [124](#)
 - Renewable, [137](#)
 - Solar, [159](#)
 - Tidal, [187](#)
 - Wave, [203](#)
 - Wind, [217](#)
- commitCharge
 - Lilon, [89](#)
 - Storage, [169](#)
- commitDischarge
 - Lilon, [90](#)
 - Storage, [169](#)
- computeEconomics
 - Combustion, [15](#)
 - Production, [125](#)
 - Renewable, [138](#)
 - Storage, [169](#)
- computeFuelAndEmissions
 - Combustion, [16](#)
- computeProductionkW
 - Renewable, [138](#), [139](#)
 - Solar, [159](#)
 - Tidal, [188](#)
 - Wave, [204](#)
 - Wind, [218](#)
- computeRealDiscountAnnual
 - Production, [125](#)
- control_mode
 - Controller, [40](#)
 - ModelInputs, [118](#)
- control_string
 - Controller, [40](#)
- Controller, [24](#)
 - __applyCycleChargingControl_CHARGING, [26](#)

- __applyCycleChargingControl_DISCHARGING, 26
- __applyLoadFollowingControl_CHARGING, 28
- __applyLoadFollowingControl_DISCHARGING, 28
- __computeNetLoad, 29
- __constructCombustionMap, 30
- __getRenewableProduction, 32
- __handleCombustionDispatch, 33
- __handleStorageCharging, 34, 35
- __handleStorageDischarging, 36
- ~Controller, 25
- applyDispatchControl, 37
- clear, 38
- combustion_map, 40
- control_mode, 40
- control_string, 40
- Controller, 25
- init, 39
- missed_load_vec_kW, 40
- net_load_vec_kW, 40
- setControlMode, 39
- controller
 - Model, 116
- Controller.h
 - ControlMode, 224
 - CYCLE_CHARGING, 224
 - LOAD_FOLLOWING, 224
 - N_CONTROL_MODES, 224
- ControlMode
 - Controller.h, 224
- curtailment_vec_kW
 - Production, 127
- CYCLE_CHARGING
 - Controller.h, 224
- degradation_a_cal
 - Lilon, 93
 - LilonInputs, 98
- degradation_alpha
 - Lilon, 93
 - LilonInputs, 98
- degradation_B_hat_cal_0
 - Lilon, 93
 - LilonInputs, 98
- degradation_beta
 - Lilon, 93
 - LilonInputs, 98
- degradation_Ea_cal_0
 - Lilon, 94
 - LilonInputs, 99
- degradation_r_cal
 - Lilon, 94
 - LilonInputs, 99
- degradation_s_cal
 - Lilon, 94
 - LilonInputs, 99
- derating
 - Solar, 161
 - SolarInputs, 162
- design_energy_period_s
 - Wave, 205
 - WaveInputs, 208
- design_significant_wave_height_m
 - Wave, 206
 - WaveInputs, 208
- design_speed_ms
 - Tidal, 190
 - TidalInputs, 191
 - Wind, 219
 - WindInputs, 221
- DIESEL
 - Combustion.h, 229
- Diesel, 41
 - __checkInputs, 45
 - __getGenericCapitalCost, 46
 - __getGenericFuelIntercept, 47
 - __getGenericFuelSlope, 47
 - __getGenericOpMaintCost, 47
 - __handleStartStop, 48
 - __writeSummary, 49
 - __writeTimeSeries, 50
 - ~Diesel, 44
 - commit, 51
 - Diesel, 43
 - handleReplacement, 52
 - minimum_load_ratio, 53
 - minimum_runtime_hrs, 54
 - requestProductionkW, 53
 - time_since_last_start_hrs, 54
- DieselInputs, 54
 - capital_cost, 56
 - CH4_emissions_intensity_kgL, 56
 - CO2_emissions_intensity_kgL, 56
 - CO_emissions_intensity_kgL, 56
 - combustion_inputs, 56
 - fuel_cost_L, 56
 - linear_fuel_intercept_LkWh, 57
 - linear_fuel_slope_LkWh, 57
 - minimum_load_ratio, 57
 - minimum_runtime_hrs, 57
 - NOx_emissions_intensity_kgL, 57
 - operation_maintenance_cost_kWh, 58
 - PM_emissions_intensity_kgL, 58
 - replace_running_hrs, 58
 - SOx_emissions_intensity_kgL, 58
- discharging_efficiency
 - Lilon, 94
 - LilonInputs, 99
- discharging_power_vec_kW
 - Storage, 173
- dispatch_vec_kW
 - Production, 127
- dt_vec_hrs
 - ElectricalLoad, 62
- dynamic_energy_capacity_kWh
 - Lilon, 94
- electrical_load
 - Model, 116

- ElectricalLoad, 58
 - ~ElectricalLoad, 60
 - clear, 60
 - dt_vec_hrs, 62
 - ElectricalLoad, 59, 60
 - load_vec_kW, 62
 - max_load_kW, 62
 - mean_load_kW, 62
 - min_load_kW, 62
 - n_points, 63
 - n_years, 63
 - path_2_electrical_load_time_series, 63
 - readLoadData, 61
 - time_vec_hrs, 63
- Emissions, 63
 - CH4_kg, 64
 - CO2_kg, 64
 - CO_kg, 64
 - NOx_kg, 64
 - PM_kg, 65
 - SOx_kg, 65
- energy_capacity_kWh
 - Storage, 173
 - StorageInputs, 177
- expectedErrorNotDetected
 - testing_utils.cpp, 308
 - testing_utils.h, 315
- FLOAT_TOLERANCE
 - testing_utils.h, 315
- fuel_consumption_vec_L
 - Combustion, 20
- fuel_cost_L
 - Combustion, 20
 - DieselInputs, 56
- fuel_cost_vec
 - Combustion, 20
- gas_constant_JmolK
 - Lilon, 94
 - LilonInputs, 99
- getAcceptablekW
 - Lilon, 91
 - Storage, 170
- getAvailablekW
 - Lilon, 92
 - Storage, 170
- getEmissionskg
 - Combustion, 16
- getFuelConsumptionL
 - Combustion, 16
- handleReplacement
 - Combustion, 17
 - Diesel, 52
 - Lilon, 92
 - Production, 126
 - Renewable, 139
 - Solar, 160
- Storage, 171
 - Tidal, 189
 - Wave, 205
 - Wind, 219
- header/Controller.h, 223
- header/ElectricalLoad.h, 225
- header/Interpolator.h, 226
- header/Model.h, 226
- header/Production/Combustion/Combustion.h, 228
- header/Production/Combustion/Diesel.h, 229
- header/Production/Production.h, 230
- header/Production/Renewable/Renewable.h, 231
- header/Production/Renewable/Solar.h, 232
- header/Production/Renewable/Tidal.h, 233
- header/Production/Renewable/Wave.h, 235
- header/Production/Renewable/Wind.h, 236
- header/Resources.h, 238
- header/std_includes.h, 239
- header/Storage/Lilon.h, 239
- header/Storage/Storage.h, 240
- hysteresis_SOC
 - Lilon, 95
 - LilonInputs, 99
- init
 - Controller, 39
- init_SOC
 - Lilon, 95
 - LilonInputs, 100
- interp1D
 - Interpolator, 73
- interp2D
 - Interpolator, 73
- interp_map_1D
 - Interpolator, 73
- interp_map_2D
 - Interpolator, 73
- Interpolator, 65
 - __checkDataKey1D, 67
 - __checkDataKey2D, 67
 - __getDataStringMatrix, 68
 - __isNonNumeric, 68
 - __readData1D, 69
 - __readData2D, 69
 - __splitCommaSeparatedString, 71
 - __throwReadError, 71
 - ~Interpolator, 66
 - addData1D, 72
 - addData2D, 72
 - interp1D, 73
 - interp2D, 73
 - interp_map_1D, 73
 - interp_map_2D, 73
 - Interpolator, 66
 - path_map_1D, 73
 - path_map_2D, 73
- interpolator
 - Production, 127
 - Storage, 173

- InterpolatorStruct1D, 74
 - n_points, 74
 - x_vec, 74
 - y_vec, 75
- InterpolatorStruct2D, 75
 - n_cols, 75
 - n_rows, 76
 - x_vec, 76
 - y_vec, 76
 - z_matrix, 76
- is_depleted
 - Storage, 173
- is_running
 - Production, 127
- is_running_vec
 - Production, 128
- is_sunk
 - Production, 128
 - ProductionInputs, 132
 - Storage, 174
 - StorageInputs, 177
- levellized_cost_of_energy_kWh
 - Model, 116
 - Production, 128
 - Storage, 174
- LIION
 - Storage.h, 241
- Lilon, 77
 - __checkInputs, 81
 - __getBcal, 83
 - __getEacal, 84
 - __getGenericCapitalCost, 84
 - __getGenericOpMaintCost, 84
 - __handleDegradation, 85
 - __modelDegradation, 85
 - __toggleDepleted, 87
 - __writeSummary, 87
 - __writeTimeSeries, 89
 - ~Lilon, 80
 - charging_efficiency, 93
 - commitCharge, 89
 - commitDischarge, 90
 - degradation_a_cal, 93
 - degradation_alpha, 93
 - degradation_B_hat_cal_0, 93
 - degradation_beta, 93
 - degradation_Ea_cal_0, 94
 - degradation_r_cal, 94
 - degradation_s_cal, 94
 - discharging_efficiency, 94
 - dynamic_energy_capacity_kWh, 94
 - gas_constant_JmolK, 94
 - getAcceptablekW, 91
 - getAvailablekW, 92
 - handleReplacement, 92
 - hysteresis_SOC, 95
 - init_SOC, 95
 - Lilon, 79
 - max_SOC, 95
 - min_SOC, 95
 - replace_SOH, 95
 - SOH, 95
 - SOH_vec, 96
 - temperature_K, 96
- LilonInputs, 96
 - capital_cost, 98
 - charging_efficiency, 98
 - degradation_a_cal, 98
 - degradation_alpha, 98
 - degradation_B_hat_cal_0, 98
 - degradation_beta, 98
 - degradation_Ea_cal_0, 99
 - degradation_r_cal, 99
 - degradation_s_cal, 99
 - discharging_efficiency, 99
 - gas_constant_JmolK, 99
 - hysteresis_SOC, 99
 - init_SOC, 100
 - max_SOC, 100
 - min_SOC, 100
 - operation_maintenance_cost_kWh, 100
 - replace_SOH, 100
 - storage_inputs, 100
 - temperature_K, 101
- linear_fuel_intercept_LkWh
 - Combustion, 20
 - DiesellInputs, 57
- linear_fuel_slope_LkWh
 - Combustion, 20
 - DiesellInputs, 57
- LOAD_FOLLOWING
 - Controller.h, 224
- load_vec_kW
 - ElectricalLoad, 62
- main
 - test_Combustion.cpp, 252
 - test_Controller.cpp, 285
 - test_Diesel.cpp, 255
 - test_ElectricalLoad.cpp, 286
 - test_Interpolator.cpp, 289
 - test_Lilon.cpp, 279
 - test_Model.cpp, 293
 - test_Production.cpp, 277
 - test_Renewable.cpp, 260
 - test_Resources.cpp, 301
 - test_Solar.cpp, 262
 - test_Storage.cpp, 282
 - test_Tidal.cpp, 265
 - test_Wave.cpp, 269
 - test_Wind.cpp, 273
- max_load_kW
 - ElectricalLoad, 62
- max_SOC
 - Lilon, 95
 - LilonInputs, 100
- mean_load_kW

- ElectricalLoad, 62
- min_load_kW
 - ElectricalLoad, 62
- min_SOC
 - Lilon, 95
 - LilonInputs, 100
- minimum_load_ratio
 - Diesel, 53
 - DieselInputs, 57
- minimum_runtime_hrs
 - Diesel, 54
 - DieselInputs, 57
- missed_load_vec_kW
 - Controller, 40
- Model, 101
 - __checkInputs, 104
 - __computeEconomics, 105
 - __computeFuelAndEmissions, 105
 - __computeLevellizedCostOfEnergy, 105
 - __computeNetPresentCost, 106
 - __writeSummary, 107
 - __writeTimeSeries, 109
 - ~Model, 104
 - addDiesel, 110
 - addLilon, 110
 - addResource, 111
 - addSolar, 111
 - addTidal, 112
 - addWave, 112
 - addWind, 112
 - clear, 113
 - combustion_ptr_vec, 115
 - controller, 116
 - electrical_load, 116
 - levellized_cost_of_energy_kWh, 116
 - Model, 103
 - net_present_cost, 116
 - renewable_ptr_vec, 116
 - reset, 113
 - resources, 116
 - run, 114
 - storage_ptr_vec, 117
 - total_dispatch_discharge_kWh, 117
 - total_emissions, 117
 - total_fuel_consumed_L, 117
 - writeResults, 114
- ModelInputs, 117
 - control_mode, 118
 - path_2_electrical_load_time_series, 118
- n_cols
 - InterpolatorStruct2D, 75
- N_COMBUSTION_TYPES
 - Combustion.h, 229
- N_CONTROL_MODES
 - Controller.h, 224
- n_points
 - ElectricalLoad, 63
 - InterpolatorStruct1D, 74
- Production, 128
- Storage, 174
- N_RENEWABLE_TYPES
 - Renewable.h, 232
- n_replacements
 - Production, 128
 - Storage, 174
- n_rows
 - InterpolatorStruct2D, 76
- n_starts
 - Production, 128
- N_STORAGE_TYPES
 - Storage.h, 241
- N_TIDAL_POWER_PRODUCTION_MODELS
 - Tidal.h, 234
- N_WAVE_POWER_PRODUCTION_MODELS
 - Wave.h, 236
- N_WIND_POWER_PRODUCTION_MODELS
 - Wind.h, 237
- n_years
 - ElectricalLoad, 63
 - Production, 129
 - Storage, 174
- net_load_vec_kW
 - Controller, 40
- net_present_cost
 - Model, 116
 - Production, 129
 - Storage, 174
- nominal_discount_annual
 - Production, 129
 - ProductionInputs, 132
 - Storage, 175
 - StorageInputs, 177
- nominal_fuel_escalation_annual
 - Combustion, 20
 - CombustionInputs, 23
- nominal_inflation_annual
 - Production, 129
 - ProductionInputs, 132
 - Storage, 175
 - StorageInputs, 178
- NOx_emissions_intensity_kgL
 - Combustion, 21
 - DieselInputs, 57
- NOx_emissions_vec_kg
 - Combustion, 21
- NOx_kg
 - Emissions, 64
- operation_maintenance_cost_kWh
 - DieselInputs, 58
 - LilonInputs, 100
 - Production, 129
 - SolarInputs, 162
 - Storage, 175
 - TidalInputs, 191
 - WaveInputs, 208
 - WindInputs, 221

- operation_maintenance_cost_vec
 - Production, [129](#)
 - Storage, [175](#)
- path_2_electrical_load_time_series
 - ElectricalLoad, [63](#)
 - ModelInputs, [118](#)
- path_map_1D
 - Interpolator, [73](#)
 - Resources, [151](#)
- path_map_2D
 - Interpolator, [73](#)
 - Resources, [152](#)
- PM_emissions_intensity_kgL
 - Combustion, [21](#)
 - DieselInputs, [58](#)
- PM_emissions_vec_kg
 - Combustion, [21](#)
- PM_kg
 - Emissions, [65](#)
- power_capacity_kW
 - Storage, [175](#)
 - StorageInputs, [178](#)
- power_kW
 - Storage, [175](#)
- power_model
 - Tidal, [190](#)
 - TidalInputs, [192](#)
 - Wave, [206](#)
 - WaveInputs, [208](#)
 - Wind, [220](#)
 - WindInputs, [222](#)
- power_model_string
 - Tidal, [190](#)
 - Wave, [206](#)
 - Wind, [220](#)
- print_flag
 - Production, [130](#)
 - ProductionInputs, [132](#)
 - Storage, [176](#)
 - StorageInputs, [178](#)
- printGold
 - testing_utils.cpp, [309](#)
 - testing_utils.h, [315](#)
- printGreen
 - testing_utils.cpp, [309](#)
 - testing_utils.h, [316](#)
- printRed
 - testing_utils.cpp, [309](#)
 - testing_utils.h, [316](#)
- Production, [119](#)
 - __checkInputs, [123](#)
 - ~Production, [122](#)
 - capacity_kW, [126](#)
 - capital_cost, [127](#)
 - capital_cost_vec, [127](#)
 - commit, [124](#)
 - computeEconomics, [125](#)
 - computeRealDiscountAnnual, [125](#)
 - curtailment_vec_kW, [127](#)
 - dispatch_vec_kW, [127](#)
 - handleReplacement, [126](#)
 - interpolator, [127](#)
 - is_running, [127](#)
 - is_running_vec, [128](#)
 - is_sunk, [128](#)
 - levellized_cost_of_energy_kWh, [128](#)
 - n_points, [128](#)
 - n_replacements, [128](#)
 - n_starts, [128](#)
 - n_years, [129](#)
 - net_present_cost, [129](#)
 - nominal_discount_annual, [129](#)
 - nominal_inflation_annual, [129](#)
 - operation_maintenance_cost_kWh, [129](#)
 - operation_maintenance_cost_vec, [129](#)
 - print_flag, [130](#)
 - Production, [121](#)
 - production_vec_kW, [130](#)
 - real_discount_annual, [130](#)
 - replace_running_hrs, [130](#)
 - running_hours, [130](#)
 - storage_vec_kW, [130](#)
 - total_dispatch_kWh, [131](#)
 - type_str, [131](#)
- production_inputs
 - CombustionInputs, [23](#)
 - RenewableInputs, [141](#)
- production_vec_kW
 - Production, [130](#)
- ProductionInputs, [131](#)
 - capacity_kW, [132](#)
 - is_sunk, [132](#)
 - nominal_discount_annual, [132](#)
 - nominal_inflation_annual, [132](#)
 - print_flag, [132](#)
 - replace_running_hrs, [132](#)
- PYBIND11_MODULE
 - PYBIND11_PGM.cpp, [242](#)
- PYBIND11_PGM.cpp
 - PYBIND11_MODULE, [242](#)
- pybindings/PYBIND11_PGM.cpp, [242](#)
- readLoadData
 - ElectricalLoad, [61](#)
- real_discount_annual
 - Production, [130](#)
 - Storage, [176](#)
- real_fuel_escalation_annual
 - Combustion, [21](#)
- Renewable, [133](#)
 - __checkInputs, [136](#)
 - __handleStartStop, [136](#)
 - __writeSummary, [137](#)
 - __writeTimeSeries, [137](#)
 - ~Renewable, [136](#)
 - commit, [137](#)
 - computeEconomics, [138](#)

- computeProductionkW, 138, 139
- handleReplacement, 139
- Renewable, 135
- resource_key, 140
- type, 140
- writeResults, 139
- Renewable.h
 - N_RENEWABLE_TYPES, 232
 - RenewableType, 232
 - SOLAR, 232
 - TIDAL, 232
 - WAVE, 232
 - WIND, 232
- renewable_inputs
 - SolarInputs, 163
 - TidalInputs, 192
 - WaveInputs, 209
 - WindInputs, 222
- renewable_ptr_vec
 - Model, 116
- RenewableInputs, 141
 - production_inputs, 141
- RenewableType
 - Renewable.h, 232
- replace_running_hrs
 - DieselInputs, 58
 - Production, 130
 - ProductionInputs, 132
- replace_SOH
 - Lilon, 95
 - LilonInputs, 100
- requestProductionkW
 - Combustion, 17
 - Diesel, 53
- reset
 - Model, 113
- resource_key
 - Renewable, 140
 - SolarInputs, 163
 - TidalInputs, 192
 - WaveInputs, 209
 - WindInputs, 222
- resource_map_1D
 - Resources, 152
- resource_map_2D
 - Resources, 152
- Resources, 142
 - __checkResourceKey1D, 144
 - __checkResourceKey2D, 144
 - __checkTimePoint, 145
 - __readSolarResource, 146
 - __readTidalResource, 147
 - __readWaveResource, 147
 - __readWindResource, 148
 - __throwLengthError, 149
 - ~Resources, 143
 - addResource, 150
 - clear, 151
 - path_map_1D, 151
 - path_map_2D, 152
 - resource_map_1D, 152
 - resource_map_2D, 152
 - Resources, 143
 - string_map_1D, 152
 - string_map_2D, 152
- resources
 - Model, 116
- run
 - Model, 114
- running_hours
 - Production, 130
- setControlMode
 - Controller, 39
- SOH
 - Lilon, 95
- SOH_vec
 - Lilon, 96
- SOLAR
 - Renewable.h, 232
- Solar, 153
 - __checkInputs, 156
 - __getGenericCapitalCost, 156
 - __getGenericOpMaintCost, 156
 - __writeSummary, 157
 - __writeTimeSeries, 158
 - ~Solar, 155
 - commit, 159
 - computeProductionkW, 159
 - derating, 161
 - handleReplacement, 160
 - Solar, 154, 155
- SolarInputs, 161
 - capital_cost, 162
 - derating, 162
 - operation_maintenance_cost_kWh, 162
 - renewable_inputs, 163
 - resource_key, 163
- source/Controller.cpp, 243
- source/ElectricalLoad.cpp, 244
- source/Interpolator.cpp, 245
- source/Model.cpp, 245
- source/Production/Combustion/Combustion.cpp, 246
- source/Production/Combustion/Diesel.cpp, 246
- source/Production/Production.cpp, 247
- source/Production/Renewable/Renewable.cpp, 247
- source/Production/Renewable/Solar.cpp, 248
- source/Production/Renewable/Tidal.cpp, 248
- source/Production/Renewable/Wave.cpp, 249
- source/Production/Renewable/Wind.cpp, 250
- source/Resources.cpp, 250
- source/Storage/Lilon.cpp, 251
- source/Storage/Storage.cpp, 251
- SOx_emissions_intensity_kgL
 - Combustion, 21
 - DieselInputs, 58
- SOx_emissions_vec_kg

- Combustion, 22
- SOx_kg
 - Emissions, 65
- Storage, 163
 - __checkInputs, 167
 - __computeRealDiscountAnnual, 168
 - __writeSummary, 169
 - __writeTimeSeries, 169
 - ~Storage, 167
 - capital_cost, 172
 - capital_cost_vec, 172
 - charge_kWh, 172
 - charge_vec_kWh, 173
 - charging_power_vec_kW, 173
 - commitCharge, 169
 - commitDischarge, 169
 - computeEconomics, 169
 - discharging_power_vec_kW, 173
 - energy_capacity_kWh, 173
 - getAcceptablekW, 170
 - getAvailablekW, 170
 - handleReplacement, 171
 - interpolator, 173
 - is_depleted, 173
 - is_sunk, 174
 - levellized_cost_of_energy_kWh, 174
 - n_points, 174
 - n_replacements, 174
 - n_years, 174
 - net_present_cost, 174
 - nominal_discount_annual, 175
 - nominal_inflation_annual, 175
 - operation_maintenance_cost_kWh, 175
 - operation_maintenance_cost_vec, 175
 - power_capacity_kW, 175
 - power_kW, 175
 - print_flag, 176
 - real_discount_annual, 176
 - Storage, 166
 - total_discharge_kWh, 176
 - type, 176
 - type_str, 176
 - writeResults, 171
- Storage.h
 - LIION, 241
 - N_STORAGE_TYPES, 241
 - StorageType, 241
- storage_inputs
 - LilonInputs, 100
- storage_ptr_vec
 - Model, 117
- storage_vec_kW
 - Production, 130
- StorageInputs, 177
 - energy_capacity_kWh, 177
 - is_sunk, 177
 - nominal_discount_annual, 177
 - nominal_inflation_annual, 178
 - power_capacity_kW, 178
 - print_flag, 178
- StorageType
 - Storage.h, 241
- string_map_1D
 - Resources, 152
- string_map_2D
 - Resources, 152
- temperature_K
 - Lilon, 96
 - LilonInputs, 101
- test/source/Production/Combustion/test_Combustion.cpp, 252
- test/source/Production/Combustion/test_Diesel.cpp, 254
- test/source/Production/Renewable/test_Renewable.cpp, 259
- test/source/Production/Renewable/test_Solar.cpp, 261
- test/source/Production/Renewable/test_Tidal.cpp, 265
- test/source/Production/Renewable/test_Wave.cpp, 268
- test/source/Production/Renewable/test_Wind.cpp, 272
- test/source/Production/test_Production.cpp, 276
- test/source/Storage/test_Lilon.cpp, 279
- test/source/Storage/test_Storage.cpp, 282
- test/source/test_Controller.cpp, 284
- test/source/test_ElectricalLoad.cpp, 286
- test/source/test_Interpolator.cpp, 288
- test/source/test_Model.cpp, 292
- test/source/test_Resources.cpp, 301
- test/utls/testing_utils.cpp, 307
- test/utls/testing_utils.h, 313
- test_Combustion.cpp
 - main, 252
- test_Controller.cpp
 - main, 285
- test_Diesel.cpp
 - main, 255
- test_ElectricalLoad.cpp
 - main, 286
- test_Interpolator.cpp
 - main, 289
- test_Lilon.cpp
 - main, 279
- test_Model.cpp
 - main, 293
- test_Production.cpp
 - main, 277
- test_Renewable.cpp
 - main, 260
- test_Resources.cpp
 - main, 301
- test_Solar.cpp
 - main, 262
- test_Storage.cpp
 - main, 282
- test_Tidal.cpp
 - main, 265
- test_Wave.cpp

- main, [269](#)
- test_Wind.cpp
 - main, [273](#)
- testFloatEquals
 - testing_utils.cpp, [310](#)
 - testing_utils.h, [316](#)
- testGreaterThan
 - testing_utils.cpp, [310](#)
 - testing_utils.h, [317](#)
- testGreaterThanOrEqual
 - testing_utils.cpp, [311](#)
 - testing_utils.h, [318](#)
- testing_utils.cpp
 - expectedErrorNotDetected, [308](#)
 - printGold, [309](#)
 - printGreen, [309](#)
 - printRed, [309](#)
 - testFloatEquals, [310](#)
 - testGreaterThan, [310](#)
 - testGreaterThanOrEqualTo, [311](#)
 - testLessThan, [312](#)
 - testLessThanOrEqualTo, [312](#)
 - testTruth, [313](#)
- testing_utils.h
 - expectedErrorNotDetected, [315](#)
 - FLOAT_TOLERANCE, [315](#)
 - printGold, [315](#)
 - printGreen, [316](#)
 - printRed, [316](#)
 - testFloatEquals, [316](#)
 - testGreaterThan, [317](#)
 - testGreaterThanOrEqualTo, [318](#)
 - testLessThan, [318](#)
 - testLessThanOrEqualTo, [319](#)
 - testTruth, [319](#)
- testLessThan
 - testing_utils.cpp, [312](#)
 - testing_utils.h, [318](#)
- testLessThanOrEqual
 - testing_utils.cpp, [312](#)
 - testing_utils.h, [319](#)
- testTruth
 - testing_utils.cpp, [313](#)
 - testing_utils.h, [319](#)
- TIDAL
 - Renewable.h, [232](#)
- Tidal, [179](#)
 - __checkInputs, [182](#)
 - __computeCubicProductionkW, [183](#)
 - __computeExponentialProductionkW, [183](#)
 - __computeLookupProductionkW, [184](#)
 - __getGenericCapitalCost, [185](#)
 - __getGenericOpMaintCost, [185](#)
 - __writeSummary, [185](#)
 - __writeTimeSeries, [186](#)
 - ~Tidal, [182](#)
 - commit, [187](#)
 - computeProductionkW, [188](#)
 - design_speed_ms, [190](#)
 - handleReplacement, [189](#)
 - power_model, [190](#)
 - power_model_string, [190](#)
 - Tidal, [181](#)
- Tidal.h
 - N_TIDAL_POWER_PRODUCTION_MODELS, [234](#)
 - TIDAL_POWER_CUBIC, [234](#)
 - TIDAL_POWER_EXPONENTIAL, [234](#)
 - TIDAL_POWER_LOOKUP, [234](#)
 - TidalPowerProductionModel, [234](#)
- TIDAL_POWER_CUBIC
 - Tidal.h, [234](#)
- TIDAL_POWER_EXPONENTIAL
 - Tidal.h, [234](#)
- TIDAL_POWER_LOOKUP
 - Tidal.h, [234](#)
- TidalInputs, [190](#)
 - capital_cost, [191](#)
 - design_speed_ms, [191](#)
 - operation_maintenance_cost_kWh, [191](#)
 - power_model, [192](#)
 - renewable_inputs, [192](#)
 - resource_key, [192](#)
- TidalPowerProductionModel
 - Tidal.h, [234](#)
- time_since_last_start_hrs
 - Diesel, [54](#)
- time_vec_hrs
 - ElectricalLoad, [63](#)
- total_discharge_kWh
 - Storage, [176](#)
- total_dispatch_discharge_kWh
 - Model, [117](#)
- total_dispatch_kWh
 - Production, [131](#)
- total_emissions
 - Combustion, [22](#)
 - Model, [117](#)
- total_fuel_consumed_L
 - Combustion, [22](#)
 - Model, [117](#)
- type
 - Combustion, [22](#)
 - Renewable, [140](#)
 - Storage, [176](#)
- type_str
 - Production, [131](#)
 - Storage, [176](#)
- WAVE
 - Renewable.h, [232](#)
- Wave, [193](#)
 - __checkInputs, [196](#)
 - __computeGaussianProductionkW, [197](#)
 - __computeLookupProductionkW, [198](#)
 - __computeParaboloidProductionkW, [198](#)
 - __getGenericCapitalCost, [200](#)

- __getGenericOpMaintCost, 200
- __writeSummary, 201
- __writeTimeSeries, 202
- ~Wave, 196
- commit, 203
- computeProductionkW, 204
- design_energy_period_s, 205
- design_significant_wave_height_m, 206
- handleReplacement, 205
- power_model, 206
- power_model_string, 206
- Wave, 195
- Wave.h
 - N_WAVE_POWER_PRODUCTION_MODELS, 236
 - WAVE_POWER_GAUSSIAN, 236
 - WAVE_POWER_LOOKUP, 236
 - WAVE_POWER_PARABOLOID, 236
 - WavePowerProductionModel, 236
- WAVE_POWER_GAUSSIAN
 - Wave.h, 236
- WAVE_POWER_LOOKUP
 - Wave.h, 236
- WAVE_POWER_PARABOLOID
 - Wave.h, 236
- WaveInputs, 207
 - capital_cost, 208
 - design_energy_period_s, 208
 - design_significant_wave_height_m, 208
 - operation_maintenance_cost_kWh, 208
 - power_model, 208
 - renewable_inputs, 209
 - resource_key, 209
- WavePowerProductionModel
 - Wave.h, 236
- WIND
 - Renewable.h, 232
- Wind, 209
 - __checkInputs, 213
 - __computeExponentialProductionkW, 213
 - __computeLookupProductionkW, 214
 - __getGenericCapitalCost, 214
 - __getGenericOpMaintCost, 215
 - __writeSummary, 215
 - __writeTimeSeries, 216
 - ~Wind, 212
 - commit, 217
 - computeProductionkW, 218
 - design_speed_ms, 219
 - handleReplacement, 219
 - power_model, 220
 - power_model_string, 220
 - Wind, 211
- Wind.h
 - N_WIND_POWER_PRODUCTION_MODELS, 237
 - WIND_POWER_EXPONENTIAL, 237
 - WIND_POWER_LOOKUP, 237
 - WindPowerProductionModel, 237
- WIND_POWER_EXPONENTIAL
 - Wind.h, 237
- WIND_POWER_LOOKUP
 - Wind.h, 237
- WindInputs, 220
 - capital_cost, 221
 - design_speed_ms, 221
 - operation_maintenance_cost_kWh, 221
 - power_model, 222
 - renewable_inputs, 222
 - resource_key, 222
- WindPowerProductionModel
 - Wind.h, 237
- writeResults
 - Combustion, 18
 - Model, 114
 - Renewable, 139
 - Storage, 171
- x_vec
 - InterpolatorStruct1D, 74
 - InterpolatorStruct2D, 76
- y_vec
 - InterpolatorStruct1D, 75
 - InterpolatorStruct2D, 76
- z_matrix
 - InterpolatorStruct2D, 76