

PGMcpp: PRIMED Grid Modelling (in C++)

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Chapter 1

Hierarchical Index

1.1 Class Hierarchy

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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	7
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 . . .	20
Controller	A class which contains a various dispatch control logic. Intended to serve as a component class of Model	21
Diesel	A derived class of the Combustion branch of Production which models production using a diesel generator	36
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 . . .	49
ElectricalLoad	A class which contains time and electrical load data. Intended to serve as a component class of Model	53
Emissions	A structure which bundles the emitted masses of various emissions chemistries	58
Lilon	A derived class of Storage which models energy storage by way of lithium-ion batteries	60
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	67
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	70
ModelInputs	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)	85
Production	The base class of the Production hierarchy. This hierarchy contains derived classes which model the production of energy, be it renewable or otherwise	86

ProductionInputs	A structure which bundles the necessary inputs for the Production constructor. Provides default values for every necessary input	98
Renewable	The root of the Renewable branch of the Production hierarchy. This branch contains derived classes which model the renewable production of energy	100
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 . . .	108
Resources	A class which contains renewable resource data. Intended to serve as a component class of Model	109
Solar	A derived class of the Renewable branch of Production which models solar production	120
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	128
Storage	The base class of the Storage hierarchy. This hierarchy contains derived classes which model the storage of energy	130
StorageInputs	A structure which bundles the necessary inputs for the Storage constructor. Provides default values for every necessary input	141
Tidal	A derived class of the Renewable branch of Production which models tidal production	143
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	154
Wave	A derived class of the Renewable branch of Production which models wave production	157
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	170
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Chapter 4

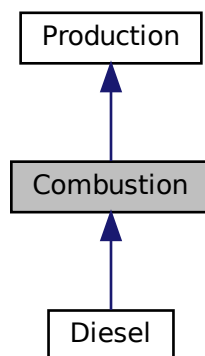
Class Documentation

4.1 Combustion Class Reference

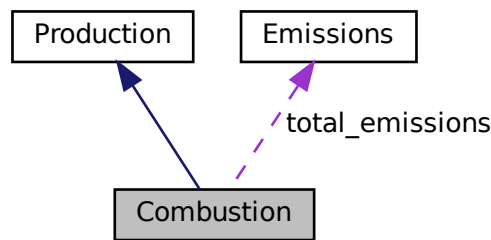
The root of the [Combustion](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the production of energy by way of combustibles.

```
#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 [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

<i>n_points</i>	The number of points in the modelling time series.
<i>n_years</i>	The number of years being modelled.
<i>combustion_inputs</i>	A structure of Combustion 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
106     this->linear_fuel_slope_LkWh = 0;
107     this->linear_fuel_intercept_LkWh = 0;
108
109     this->CO2_emissions_intensity_kgL = 0;
110     this->CO_emissions_intensity_kgL = 0;
111     this->NOx_emissions_intensity_kgL = 0;
112     this->SOx_emissions_intensity_kgL = 0;
113     this->CH4_emissions_intensity_kgL = 0;
114     this->PM_emissions_intensity_kgL = 0;
115
116     this->total_fuel_consumed_L = 0;
117
118     this->fuel_consumption_vec_L.resize(this->n_points, 0);
119     this->fuel_cost_vec.resize(this->n_points, 0);
120
121     this->CO2_emissions_vec_kg.resize(this->n_points, 0);
122     this->CO_emissions_vec_kg.resize(this->n_points, 0);
123     this->NOx_emissions_vec_kg.resize(this->n_points, 0);
124     this->SOx_emissions_vec_kg.resize(this->n_points, 0);
125     this->CH4_emissions_vec_kg.resize(this->n_points, 0);
126     this->PM_emissions_vec_kg.resize(this->n_points, 0);
```

```

127
128     // 3. construction print
129     if (this->print_flag) {
130         std::cout << "Combustion object constructed at " << this << std::endl;
131     }
132
133     return;
134 } /* Combustion() */

```

4.1.2.3 ~Combustion()

```

Combustion::~Combustion (
    void ) [virtual]

```

Destructor for the [Combustion](#) class.

```

439 {
440     // 1. destruction print
441     if (this->print_flag) {
442         std::cout << "Combustion object at " << this << " destroyed" << std::endl;
443     }
444
445     return;
446 } /* ~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](#).

```

85 {return;}

```

4.1.3.3 __writeTimeSeries()

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

Reimplemented in [Diesel](#).

```
90         {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](#).

```
262 {
263     // 1. invoke base class method
264     load_kW = Production::commit(
265         timestep,
266         dt_hrs,
267         production_kW,
268         load_kW
269     );
270
271
272     if (this->is_running) {
273         // 2. compute and record fuel consumption
274         double fuel_consumed_L = this->getFuelConsumptionL(dt_hrs, production_kW);
275         this->fuel_consumption_vec_L[timestep] = fuel_consumed_L;
276
277         // 3. compute and record emissions
278         Emissions emissions = this->getEmissionskg(fuel_consumed_L);
279         this->CO2_emissions_vec_kg[timestep] = emissions.CO2_kg;
280         this->CO_emissions_vec_kg[timestep] = emissions.CO_kg;
281         this->NOx_emissions_vec_kg[timestep] = emissions.NOx_kg;
282         this->SOx_emissions_vec_kg[timestep] = emissions.SOx_kg;
283         this->CH4_emissions_vec_kg[timestep] = emissions.CH4_kg;
284         this->PM_emissions_vec_kg[timestep] = emissions.PM_kg;
285
286         // 4. incur fuel costs
```

```

287         this->fuel_cost_vec[timestep] = fuel_consumed_L * this->fuel_cost_L;
288     }
289
290     return load_kW;
291 } /* 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.

Parameters

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

Reimplemented from [Production](#).

```

206 {
207     // 1. account for fuel costs in net present cost
208     double t_hrs = 0;
209     double real_discount_scalar = 0;
210
211     for (int i = 0; i < this->n_points; i++) {
212         t_hrs = time_vec_hrs_ptr->at(i);
213
214         real_discount_scalar = 1.0 / pow(
215             1 + this->real_discount_annual,
216             t_hrs / 8760
217         );
218
219         this->net_present_cost += real_discount_scalar * this->fuel_cost_vec[i];
220     }
221
222     // 2. invoke base class method
223     Production :: computeEconomics(time_vec_hrs_ptr);
224
225     return;
226 } /* computeEconomics() */

```

4.1.3.6 computeFuelAndEmissions()

```

void Combustion::computeFuelAndEmissions (
    void )

```

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

```

176 {
177     for (int i = 0; i < n_points; i++) {
178         this->total_fuel_consumed_L += this->fuel_consumption_vec_L[i];
179
180         this->total_emissions.CO2_kg += this->CO2_emissions_vec_kg[i];
181         this->total_emissions.CO_kg += this->CO_emissions_vec_kg[i];
182         this->total_emissions.NOx_kg += this->NOx_emissions_vec_kg[i];
183         this->total_emissions.SOx_kg += this->SOx_emissions_vec_kg[i];
184         this->total_emissions.CH4_kg += this->CH4_emissions_vec_kg[i];
185         this->total_emissions.PM_kg += this->PM_emissions_vec_kg[i];
186     }
187
188     return;
189 } /* 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.

```
339                                     {
340     Emissions emissions;
341
342     emissions.CO2_kg = this->CO2_emissions_intensity_kgL * fuel_consumed_L;
343     emissions.CO_kg = this->CO_emissions_intensity_kgL * fuel_consumed_L;
344     emissions.NOx_kg = this->NOx_emissions_intensity_kgL * fuel_consumed_L;
345     emissions.SOx_kg = this->SOx_emissions_intensity_kgL * fuel_consumed_L;
346     emissions.CH4_kg = this->CH4_emissions_intensity_kgL * fuel_consumed_L;
347     emissions.PM_kg = this->PM_emissions_intensity_kgL * fuel_consumed_L;
348
349     return emissions;
350 } /* 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].

```
313 {
314     double fuel_consumed_L = (
315         this->linear_fuel_slope_LkWh * production_kW +
316         this->linear_fuel_intercept_LkWh * this->capacity_kW
317     ) * dt_hrs;
318
319     return fuel_consumed_L;
320 } /* 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](#).

```
152 {
153     // 1. reset attributes
154     //...
155
156     // 2. invoke base class method
157     Production::handleReplacement(timestep);
158
159     return;
160 } /* __handleReplacement() */
```

4.1.3.10 requestProductionkW()

```
virtual double Combustion::requestProductionkW (
    int ,
    double ,
    double ) [inline], [virtual]
```

Reimplemented in [Diesel](#).

```
131 {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 time_vec_hrs 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.

```

386 {
387     // 1. handle sentinel
388     if (max_lines < 0) {
389         max_lines = this->n_points;
390     }
391
392     // 2. create subdirectories
393     write_path += "Production/";
394     if (not std::filesystem::is_directory(write_path)) {
395         std::filesystem::create_directory(write_path);
396     }
397
398     write_path += "Combustion/";
399     if (not std::filesystem::is_directory(write_path)) {
400         std::filesystem::create_directory(write_path);
401     }
402
403     write_path += this->type_str;
404     write_path += "_";
405     write_path += std::to_string(int(ceil(this->capacity_kW)));
406     write_path += "kW_idx";
407     write_path += std::to_string(combustion_index);
408     write_path += "/";
409     std::filesystem::create_directory(write_path);
410
411     // 3. write summary
412     this->__writeSummary(write_path);
413
414     // 4. write time series
415     if (max_lines > this->n_points) {
416         max_lines = this->n_points;
417     }
418
419     if (max_lines > 0) {
420         this->__writeTimeSeries(write_path, time_vec_hrs_ptr, max_lines);
421     }
422
423     return;
424 } /* 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 NOx_emissions_intensity_kgL

```
double Combustion::NOx_emissions_intensity_kgL
```

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

4.1.4.13 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.

4.1.4.14 PM_emissions_intensity_kgL

```
double Combustion::PM_emissions_intensity_kgL
```

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

4.1.4.15 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.

4.1.4.16 SOx_emissions_intensity_kgL

```
double Combustion::SOx_emissions_intensity_kgL
```

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

4.1.4.17 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.

4.1.4.18 total_emissions

```
Emissions Combustion::total_emissions
```

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

4.1.4.19 total_fuel_consumed_L

```
double Combustion::total_fuel_consumed_L
```

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

4.1.4.20 type

```
CombustionType Combustion::type
```

The type (CombustionType) of the asset.

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

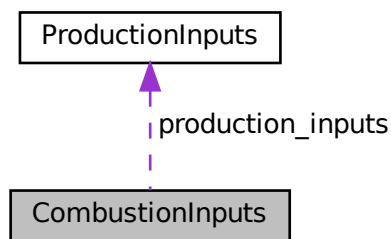
- [header/Production/Combustion/Combustion.h](#)
- [source/Production/Combustion/Combustion.cpp](#)

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.

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 `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](#) * >)

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

- void [__handleStorageCharging](#) (int, double, std::vector< [Storage](#) * > *)

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)

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.

- 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.

```
812 {
813     return;
814 } /* Controller() */
```

4.3.2.2 ~Controller()

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

Destructor for the [Controller](#) class.

```
1041 {
1042     this->clear();
1043
1044     return;
1045 } /* ~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 .

```
384 {
385     // 1. default to load following
386     this->__applyLoadFollowingControl_CHARGING(
387         timestep,
388         electrical_load_ptr,
389         combustion_ptr_vec_ptr,
390         renewable_ptr_vec_ptr,
391         storage_ptr_vec_ptr
392     );
393
394     return;
395 } /* __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

```

434 {
435     // 1. get dt_hrs, net load
436     double dt_hrs = electrical_load_ptr->dt_vec_hrs[timestep];
437     double net_load_kW = this->net_load_vec_kW[timestep];
438
439     // 2. partition Storage assets into depleted and non-depleted
440     std::list<Storage*> depleted_storage_ptr_list;
441     std::list<Storage*> nondepleted_storage_ptr_list;
442
443     Storage* storage_ptr;
444     for (size_t i = 0; i < storage_ptr_vec_ptr->size(); i++) {
445         storage_ptr = storage_ptr_vec_ptr->at(i);
446
447         //...
448     }
449
450     // 3. discharge non-depleted storage assets
451     net_load_kW = this->__handleStorageDischarging(
452         timestep,
453         dt_hrs,
454         net_load_kW,
455         nondepleted_storage_ptr_list
456     );
457
458     // 4. request optimal production from all Combustion assets
459     //     default to load following if no depleted storage
460     if (depleted_storage_ptr_list.empty()) {
461         net_load_kW = this->__handleCombustionDispatch(
462             timestep,
463             dt_hrs,
464             net_load_kW,
465             combustion_ptr_vec_ptr,
466             false // is_cycle_charging
467         );
468     }
469
470     else {
471         net_load_kW = this->__handleCombustionDispatch(
472             timestep,
473             dt_hrs,
474             net_load_kW,
475             combustion_ptr_vec_ptr,
476             true // is_cycle_charging
477         );
478     }
479
480     // 5. attempt to charge depleted Storage assets using any and all available
481     //     charge priority is Combustion, then Renewable
482     this->__handleStorageCharging(timestep, dt_hrs, depleted_storage_ptr_list);
483
484     // 6. record any missed load
485     if (net_load_kW > 1e-6) {
486         this->missed_load_vec_kW[timestep] = net_load_kW;
487     }
488
489     return;
490 }
491 } /* __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 .

Parameters

<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 .

```

245 {
246     // 1. get dt_hrs, set net load
247     double dt_hrs = electrical_load_ptr->dt_vec_hrs[timestep];
248     double net_load_kW = 0;
249
250     // 2. request zero production from all Combustion assets
251     this->__handleCombustionDispatch(
252         timestep,
253         dt_hrs,
254         net_load_kW,
255         combustion_ptr_vec_ptr,
256         false // is_cycle_charging
257     );
258
259     // 3. attempt to charge all Storage assets using any and all available curtailment
260     // charge priority is Combustion, then Renewable
261     this->__handleStorageCharging(timestep, dt_hrs, storage_ptr_vec_ptr);
262
263     return;
264 } /* __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

```

302 {
303     // 1. get dt_hrs, net load
304     double dt_hrs = electrical_load_ptr->dt_vec_hrs[timestep];
305     double net_load_kW = this->net_load_vec_kW[timestep];
306
307     // 2. partition Storage assets into depleted and non-depleted
308     std::list<Storage*> depleted_storage_ptr_list;
309     std::list<Storage*> nondepleted_storage_ptr_list;
310
311     Storage* storage_ptr;
312     for (size_t i = 0; i < storage_ptr_vec_ptr->size(); i++) {
313         storage_ptr = storage_ptr_vec_ptr->at(i);
314
315         //...
316     }
317
318     // 3. discharge non-depleted storage assets

```

```

319     net_load_kW = this->__handleStorageDischarging(
320         timestep,
321         dt_hrs,
322         net_load_kW,
323         nondepleted_storage_ptr_list
324     );
325
326     // 4. request optimal production from all Combustion assets
327     net_load_kW = this->__handleCombustionDispatch(
328         timestep,
329         dt_hrs,
330         net_load_kW,
331         combustion_ptr_vec_ptr,
332         false // is_cycle_charging
333     );
334
335     // 5. attempt to charge depleted Storage assets using any and all available
336     // charge priority is Combustion, then Renewable
337     this->__handleStorageCharging(timestep, dt_hrs, depleted_storage_ptr_list);
338
339     // 6. record any missed load
340     if (net_load_kW > 1e-6) {
341         this->missed_load_vec_kW[timestep] = net_load_kW;
342     }
343
344     return;
345 } /* __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
95     this->net_load_vec_kW[i] = net_load_kW;
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

<i>combustion_ptr_vec_ptr</i>	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 // 4. test print
182 /*
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 */
205
206 return;
207 } /* __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.

```

595 {
596     double production_kW = 0;

```

```

597
598     switch (renewable_ptr->type) {
599         case (RenewableType :: SOLAR): {
600             production_kW = renewable_ptr->computeProductionkW(
601                 timestep,
602                 dt_hrs,
603                 resources_ptr->resource_map_1D[renewable_ptr->resource_key][timestep]
604             );
605             break;
606         }
607
608         case (RenewableType :: TIDAL): {
609             production_kW = renewable_ptr->computeProductionkW(
610                 timestep,
611                 dt_hrs,
612                 resources_ptr->resource_map_1D[renewable_ptr->resource_key][timestep]
613             );
614             break;
615         }
616
617         case (RenewableType :: WAVE): {
618             production_kW = renewable_ptr->computeProductionkW(
619                 timestep,
620                 dt_hrs,
621                 resources_ptr->resource_map_2D[renewable_ptr->resource_key][timestep][0],
622                 resources_ptr->resource_map_2D[renewable_ptr->resource_key][timestep][1]
623             );
624             break;
625         }
626
627         case (RenewableType :: WIND): {
628             production_kW = renewable_ptr->computeProductionkW(
629                 timestep,
630                 dt_hrs,
631                 resources_ptr->resource_map_1D[renewable_ptr->resource_key][timestep]
632             );
633             break;
634         }
635
636         default: {
637             std::string error_str = "ERROR: Controller::__getRenewableProduction(): ";
638             error_str += "renewable type ";
639             error_str += std::to_string(renewable_ptr->type);
640             error_str += " not recognized";
641
642             #ifdef _WIN32
643                 std::cout << error_str << std::endl;
644             #endif
645
646             throw std::runtime_error(error_str);
647
648             break;
649         }
650     }
651
652     return production_kW;
653 } /* __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]

```

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.

bool is_cycle_charging)

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.

```

699 {
700     // 1. get minimal Combustion dispatch
701     double target_production_kW = 1.2 * net_load_kW;
702     double total_capacity_kW = 0;
703
704     std::map<double, std::vector<bool>>::iterator iter = this->combustion_map.begin();
705     while (iter != std::prev(this->combustion_map.end(), 1)) {
706         if (target_production_kW <= total_capacity_kW) {
707             break;
708         }
709         iter++;
710         total_capacity_kW = iter->first;
711     }
712
713     // 2. share load proportionally (by rated capacity) over active diesels
714     Combustion* combustion_ptr;
715     double production_kW = 0;
716     double request_kW = 0;
717     double _net_load_kW = net_load_kW;
718
719     for (size_t i = 0; i < this->combustion_map[total_capacity_kW].size(); i++) {
720         combustion_ptr = combustion_ptr_vec_ptr->at(i);
721
722         if (total_capacity_kW > 0) {
723             request_kW =
724                 int(this->combustion_map[total_capacity_kW][i]) *
725                 net_load_kW *
726                 (combustion_ptr->capacity_kW / total_capacity_kW);
727         }
728         else {
729             request_kW = 0;
730         }
731
732         if (is_cycle_charging and request_kW > 0) {
733             if (request_kW < 0.85 * combustion_ptr->capacity_kW) {
734                 request_kW = 0.85 * combustion_ptr->capacity_kW;
735             }
736         }
737
738         production_kW = combustion_ptr->requestProductionkW(
739             timestep,
740             dt_hrs,
741             request_kW
742         );
743
744         _net_load_kW = combustion_ptr->commit(
745             timestep,
746             dt_hrs,
747             production_kW,
748             _net_load_kW
749         );
750     }
751     return _net_load_kW;
752 }
753
754 /* __handleCombustionDispatch() */
755 }

```

4.3.3.9 __handleStorageCharging() [1/2]

```

void Controller::__handleStorageCharging (
    int timestep,

```



```
double dt_hrs,
std::list< Storage * > storage_ptr_list ) [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.

```
521 {
522     //...
523
524     return;
525 } /* __handleStorageCharging() */
```

4.3.3.10 __handleStorageCharging() [2/2]

```
void Controller::__handleStorageCharging (
    int timestep,
    double dt_hrs,
    std::vector< Storage * > * storage_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.

```
555 {
556     //...
557
558     return;
559 } /* __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.

```

789 {
790     ///...
791
792     return net_load_kW;
793 } /* __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 .

```

936 {
937     for (int i = 0; i < electrical_load_ptr->n_points; i++) {
938         switch (this->control_mode) {
939             case (ControlMode :: LOAD_FOLLOWING): {
940                 if (this->net_load_vec_kW[i] <= 0) {
941                     this->__applyLoadFollowingControl_CHARGING(
942                         i,
943                         electrical_load_ptr,
944                         combustion_ptr_vec_ptr,
945                         renewable_ptr_vec_ptr,
946                         storage_ptr_vec_ptr
947                     );
948                 }
949             }
950             else {
951                 this->__applyLoadFollowingControl_DISCHARGING(
952                     i,
953                     electrical_load_ptr,
954                     combustion_ptr_vec_ptr,
955                     renewable_ptr_vec_ptr,
956                     storage_ptr_vec_ptr
957                 );
958             }
959         }
960         break;
961     }
962
963     case (ControlMode :: CYCLE_CHARGING): {
964         if (this->net_load_vec_kW[i] <= 0) {
965             this->__applyCycleChargingControl_CHARGING(
966                 i,
967                 electrical_load_ptr,
968                 combustion_ptr_vec_ptr,
969                 renewable_ptr_vec_ptr,
970                 storage_ptr_vec_ptr
971             );
972         }
973     }
974     else {
975         this->__applyCycleChargingControl_DISCHARGING(
976             i,
977             electrical_load_ptr,
978             combustion_ptr_vec_ptr,
979             renewable_ptr_vec_ptr,

```

```

980             storage_ptr_vec_ptr
981         );
982     }
983
984     break;
985 }
986
987 default: {
988     std::string error_str = "ERROR: Controller :: applyDispatchControl(): ";
989     error_str += "control mode ";
990     error_str += std::to_string(this->control_mode);
991     error_str += " not recognized";
992
993     #ifdef _WIN32
994         std::cout << error_str << std::endl;
995     #endif
996
997     throw std::runtime_error(error_str);
998
999     break;
1000 }
1001 }
1002 }
1003
1004 return;
1005 } /* applyDispatchControl() */

```

4.3.3.13 clear()

```

void Controller::clear (
    void )

```

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

```

1020 {
1021     this->net_load_vec_kW.clear();
1022     this->missed_load_vec_kW.clear();
1023     this->combustion_map.clear();
1024
1025     return;
1026 } /* 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 .

```

895 {
896     // 1. compute net load
897     this->__computeNetLoad(electrical_load_ptr, renewable_ptr_vec_ptr, resources_ptr);

```

```

898
899 // 2. construct Combustion table
900 this->__constructCombustionMap(combustion_ptr_vec_ptr);
901
902 return;
903 } /* 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 .
---------------------	---

```

829 {
830     this->control_mode = control_mode;
831
832     switch(control_mode) {
833         case (ControlMode :: LOAD_FOLLOWING): {
834             this->control_string = "LOAD_FOLLOWING";
835
836             break;
837         }
838
839         case (ControlMode :: CYCLE_CHARGING): {
840             this->control_string = "CYCLE_CHARGING";
841
842             break;
843         }
844
845         default: {
846             std::string error_str = "ERROR: Controller :: setControlMode(): ";
847             error_str += "control mode ";
848             error_str += std::to_string(control_mode);
849             error_str += " not recognized";
850
851             #ifdef _WIN32
852                 std::cout << error_str << std::endl;
853             #endif
854
855             throw std::runtime_error(error_str);
856
857             break;
858         }
859     }
860
861     return;
862 } /* 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:

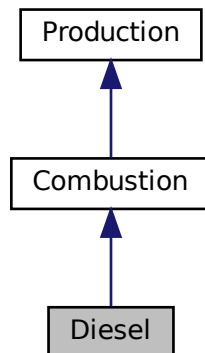
- header/[Controller.h](#)
- source/[Controller.cpp](#)

4.4 Diesel Class Reference

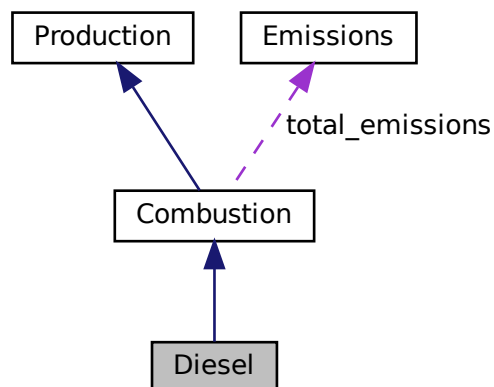
A derived class of the [Combustion](#) branch of [Production](#) which models production using a diesel generator.

```
#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.

```
571 {
572     return;
573 } /* 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.

```
601 :
602 Combustion(
603     n_points,
604     n_years,
605     diesel_inputs.combustion_inputs
606 )
607 {
608     // 1. check inputs
609     this->__checkInputs(diesel_inputs);
610
611     // 2. set attributes
612     this->type = CombustionType :: DIESEL;
613     this->type_str = "DIESEL";
614
615     this->replace_running_hrs = diesel_inputs.replace_running_hrs;
616
617     this->fuel_cost_L = diesel_inputs.fuel_cost_L;
618
619     this->minimum_load_ratio = diesel_inputs.minimum_load_ratio;
620     this->minimum_runtime_hrs = diesel_inputs.minimum_runtime_hrs;
621     this->time_since_last_start_hrs = 0;
622
623     this->CO2_emissions_intensity_kgL = diesel_inputs.CO2_emissions_intensity_kgL;
624     this->CO_emissions_intensity_kgL = diesel_inputs.CO_emissions_intensity_kgL;
625     this->NOx_emissions_intensity_kgL = diesel_inputs.NOx_emissions_intensity_kgL;
626     this->SOx_emissions_intensity_kgL = diesel_inputs.SOx_emissions_intensity_kgL;
627     this->CH4_emissions_intensity_kgL = diesel_inputs.CH4_emissions_intensity_kgL;
628     this->PM_emissions_intensity_kgL = diesel_inputs.PM_emissions_intensity_kgL;
629
630     if (diesel_inputs.linear_fuel_slope_LkWh < 0) {
631         this->linear_fuel_slope_LkWh = this->__getGenericFuelSlope();
632     }
633
634     if (diesel_inputs.linear_fuel_intercept_LkWh < 0) {
```



```

635         this->linear_fuel_intercept_LkWh = this->__getGenericFuelIntercept();
636     }
637
638     if (diesel_inputs.capital_cost < 0) {
639         this->capital_cost = this->__getGenericCapitalCost();
640     }
641
642     if (diesel_inputs.operation_maintenance_cost_kWh < 0) {
643         this->operation_maintenance_cost_kWh = this->__getGenericOpMaintCost();
644     }
645
646     if (not this->is_sunk) {
647         this->capital_cost_vec[0] = this->capital_cost;
648     }
649
650     // 3. construction print
651     if (this->print_flag) {
652         std::cout << "Diesel object constructed at " << this << std::endl;
653     }
654
655     return;
656 } /* Diesel() */

```

4.4.2.3 ~Diesel()

```

Diesel::~~Diesel (
    void )

```

Destructor for the [Diesel](#) class.

```

811 {
812     // 1. destruction print
813     if (this->print_flag) {
814         std::cout << "Diesel object at " << this << " destroyed" << std::endl;
815     }
816
817     return;
818 } /* ~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 << "\n";
384
385 ofs << "Linear Fuel Slope: " << this->linear_fuel_slope_LkWh << " L/kWh \n";
386 ofs << "Linear Fuel Intercept Coefficient: " << this->linear_fuel_intercept_LkWh
387     << " L/kWh \n";
388 ofs << "\n";
389
390 ofs << "Carbon Dioxide (CO2) Emissions Intensity: "
391     << this->CO2_emissions_intensity_kgL << " kg/L \n";
392
393 ofs << "Carbon Monoxide (CO) Emissions Intensity: "
394     << this->CO_emissions_intensity_kgL << " kg/L \n";
395
396 ofs << "Nitrogen Oxides (NOx) Emissions Intensity: "
397     << this->NOx_emissions_intensity_kgL << " kg/L \n";
398
399 ofs << "Sulfur Oxides (SOx) Emissions Intensity: "
400     << this->SOx_emissions_intensity_kgL << " kg/L \n";
401
402 ofs << "Methane (CH4) Emissions Intensity: "
403     << this->CH4_emissions_intensity_kgL << " kg/L \n";
404
405 ofs << "Particulate Matter (PM) Emissions Intensity: "
406     << this->PM_emissions_intensity_kgL << " kg/L \n";
407
408 ofs << "\n-----\n\n";
409
410 // 2.3. Diesel attributes
411 ofs << "## Diesel Attributes\n";
412 ofs << "\n";
413
414 ofs << "Minimum Load Ratio: " << this->minimum_load_ratio << " \n";
415 ofs << "Minimum Runtime: " << this->minimum_runtime_hrs << " hrs \n";
416
417 ofs << "\n-----\n\n";
418
419 // 2.4. Diesel Results
420 ofs << "## Results\n";
421 ofs << "\n";
422
423 ofs << "Net Present Cost: " << this->net_present_cost << " \n";
424 ofs << "\n";
425
426 ofs << "Total Dispatch: " << this->total_dispatch_kWh
427     << " kWh \n";
428
429 ofs << "Levellized Cost of Energy: " << this->levellized_cost_of_energy_kWh
430     << " per kWh dispatched \n";
431 ofs << "\n";
432
433 ofs << "Running Hours: " << this->running_hours << " \n";
434 ofs << "Starts: " << this->n_starts << " \n";
435 ofs << "Replacements: " << this->n_replacements << " \n";
436
437 ofs << "Total Fuel Consumed: " << this->total_fuel_consumed_L << " L "
438     << "(Annual Average: " << this->total_fuel_consumed_L / this->n_years
439     << " L/yr) \n";
440 ofs << "\n";
441
442 ofs << "Total Carbon Dioxide (CO2) Emissions: " <<
443     this->total_emissions.CO2_kg << " kg "
444     << "(Annual Average: " << this->total_emissions.CO2_kg / this->n_years
445     << " kg/yr) \n";
446
447 ofs << "Total Carbon Monoxide (CO) Emissions: " <<
448     this->total_emissions.CO_kg << " kg "
449     << "(Annual Average: " << this->total_emissions.CO_kg / this->n_years
450     << " kg/yr) \n";
451
452 ofs << "Total Nitrogen Oxides (NOx) Emissions: " <<

```

```

453         this->total_emissions.NOx_kg << " kg "
454         << "(Annual Average: " << this->total_emissions.NOx_kg / this->n_years
455         << " kg/yr) \n";
456
457     ofs << "Total Sulfur Oxides (SOx) Emissions: " <<
458     this->total_emissions.SOx_kg << " kg "
459     << "(Annual Average: " << this->total_emissions.SOx_kg / this->n_years
460     << " kg/yr) \n";
461
462     ofs << "Total Methane (CH4) Emissions: " << this->total_emissions.CH4_kg << " kg "
463     << "(Annual Average: " << this->total_emissions.CH4_kg / this->n_years
464     << " kg/yr) \n";
465
466     ofs << "Total Particulate Matter (PM) Emissions: " <<
467     this->total_emissions.PM_kg << " kg "
468     << "(Annual Average: " << this->total_emissions.PM_kg / this->n_years
469     << " kg/yr) \n";
470
471     ofs << "\n-----\n\n";
472
473     ofs.close();
474     return;
475 } /* __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 <i>time_vec_hrs</i> attribute of the ElectricalLoad .
<i>max_lines</i>	The maximum number of lines of output to write.

Reimplemented from [Combustion](#).

```

505 {
506     // 1. create filestream
507     write_path += "time_series_results.csv";
508     std::ofstream ofs;
509     ofs.open(write_path, std::ofstream::out);
510
511     // 2. write time series results (comma separated value)
512     ofs << "Time (since start of data) [hrs],";
513     ofs << "Production [kW],";
514     ofs << "Dispatch [kW],";
515     ofs << "Storage [kW],";
516     ofs << "Curtailement [kW],";
517     ofs << "Is Running (N = 0 / Y = 1),";
518     ofs << "Fuel Consumption [L],";
519     ofs << "Fuel Cost (actual),";
520     ofs << "Carbon Dioxide (CO2) Emissions [kg],";
521     ofs << "Carbon Monoxide (CO) Emissions [kg],";
522     ofs << "Nitrogen Oxides (NOx) Emissions [kg],";
523     ofs << "Sulfur Oxides (SOx) Emissions [kg],";
524     ofs << "Methane (CH4) Emissions [kg],";
525     ofs << "Particulate Matter (PM) Emissions [kg],";
526     ofs << "Capital Cost (actual),";
527     ofs << "Operation and Maintenance Cost (actual),";
528     ofs << "\n";
529
530     for (int i = 0; i < max_lines; i++) {
531         ofs << time_vec_hrs_ptr->at(i) << ",";
532         ofs << this->production_vec_kW[i] << ",";
533         ofs << this->dispatch_vec_kW[i] << ",";

```

```

534         ofs « this->storage_vec_kW[i] « ", ";
535         ofs « this->curtailment_vec_kW[i] « ", ";
536         ofs « this->is_running_vec[i] « ", ";
537         ofs « this->fuel_consumption_vec_L[i] « ", ";
538         ofs « this->fuel_cost_vec[i] « ", ";
539         ofs « this->CO2_emissions_vec_kg[i] « ", ";
540         ofs « this->CO_emissions_vec_kg[i] « ", ";
541         ofs « this->NOx_emissions_vec_kg[i] « ", ";
542         ofs « this->SOx_emissions_vec_kg[i] « ", ";
543         ofs « this->CH4_emissions_vec_kg[i] « ", ";
544         ofs « this->PM_emissions_vec_kg[i] « ", ";
545         ofs « this->capital_cost_vec[i] « ", ";
546         ofs « this->operation_maintenance_cost_vec[i] « ", ";
547         ofs « "\n";
548     }
549
550     ofs.close();
551     return;
552 } /* __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](#).

```

769 {
770     // 1. handle start/stop, enforce minimum runtime constraint
771     this->__handleStartStop(timestep, dt_hrs, production_kW);
772
773     // 2. invoke base class method
774     load_kW = Combustion::commit(
775         timestep,
776         dt_hrs,
777         production_kW,
778         load_kW
779     );
780
781     if (this->is_running) {
782         // 3. log time since last start
783         this->time_since_last_start_hrs += dt_hrs;
784
785         // 4. correct operation and maintenance costs (should be non-zero if idling)
786         if (production_kW <= 0) {
787             double produced_kWh = 0.01 * this->capacity_kW * dt_hrs;
788
789             double operation_maintenance_cost =
790                 this->operation_maintenance_cost_kWh * produced_kWh;

```



```

791         this->operation_maintenance_cost_vec[timestep] = operation_maintenance_cost;
792     }
793 }
794
795     return load_kW;
796 } /* 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](#).

```

674 {
675     // 1. reset attributes
676     this->time_since_last_start_hrs = 0;
677
678     // 2. invoke base class method
679     Combustion :: handleReplacement(timestep);
680
681     return;
682 } /* __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](#).

```

714 {
715     // 1. return on request of zero

```

```
716     if (request_kW <= 0) {
717         return 0;
718     }
719
720     double deliver_kW = request_kW;
721
722     // 2. enforce capacity constraint
723     if (deliver_kW > this->capacity_kW) {
724         deliver_kW = this->capacity_kW;
725     }
726
727     // 3. enforce minimum load ratio
728     if (deliver_kW < this->minimum_load_ratio * this->capacity_kW) {
729         deliver_kW = this->minimum_load_ratio * this->capacity_kW;
730     }
731
732     return deliver_kW;
733 } /* 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:

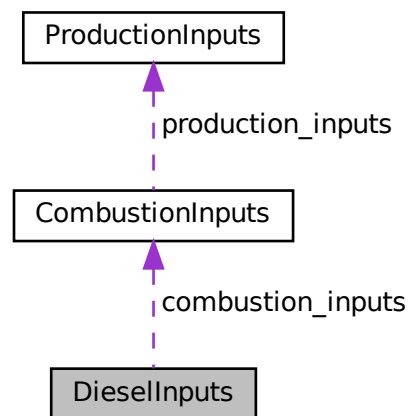
- header/Production/Combustion/[Diesel.h](#)
- source/Production/Combustion/[Diesel.cpp](#)

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:

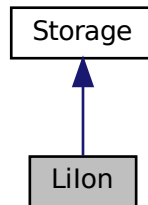
- [header/Production/Combustion/Combustion.h](#)

4.8 Lilon Class Reference

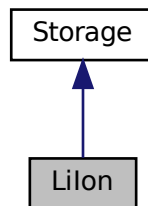
A derived class of [Storage](#) which models energy storage by way of lithium-ion batteries.

```
#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](#) (int)
Method to get the discharge power currently available from the asset.
- double [getAcceptablekW](#) (int)
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)
- [~Lilon](#) (void)
Destructor for the [Lilon](#) class.

Public Attributes

- bool [is_depleted](#)
A boolean which indicates whether or not the asset is currently considered depleted.
- double [dynamic_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 [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.

Private Member Functions

- void [__checkInputs](#) ([LilonInputs](#))

4.8.1 Detailed Description

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

4.8.2 Constructor & Destructor Documentation

4.8.2.1 Lilon() [1/2]

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

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

```
73 {
74     return;
75 } /* LiIon() */
```

4.8.2.2 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.

```

103 :
104 Storage(
105     n_points,
106     n_years,
107     liion_inputs.storage_inputs
108 )
109 {
110     // 1. check inputs
111     this->__checkInputs(liion_inputs);
112
113     // 2. set attributes
114     this->is_depleted = false;
115
116     this->dynamic_capacity_kWh = this->capacity_kWh;
117     this->SOH = 1;
118     this->replace_SOH = liion_inputs.replace_SOH;
119
120     this->init_SOC = liion_inputs.init_SOC;
121
122     this->min_SOC = liion_inputs.min_SOC;
123     this->hysteresis_SOC = liion_inputs.hysteresis_SOC;
124     this->max_SOC = liion_inputs.max_SOC;
125
126     this->charging_efficiency = liion_inputs.charging_efficiency;
127     this->discharging_efficiency = liion_inputs.discharging_efficiency;
128
129     // 3. construction print
130     if (this->print_flag) {
131         std::cout << "LiIon object constructed at " << this << std::endl;
132     }
133
134     return;
135 } /* LiIon() */

```

4.8.2.3 ~Lilion()

```

LiIon::~LiIon (
    void )

```

Destructor for the [Lilion](#) class.

```

305 {
306     // 1. destruction print
307     if (this->print_flag) {
308         std::cout << "LiIon object at " << this << " destroyed" << std::endl;
309     }
310
311     return;
312 } /* ~LiIon() */

```

4.8.3 Member Function Documentation

4.8.3.1 __checkInputs()

```

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

```


Parameters

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

```

37 {
38     //...
39
40     /*
41     this->replace_SOH = lilon_inputs.replace_SOH;
42
43     this->init_SOC = lilon_inputs.init_SOC;
44
45     this->min_SOC = lilon_inputs.min_SOC;
46     this->hysteresis_SOC = lilon_inputs.hysteresis_SOC;
47     this->max_SOC = lilon_inputs.max_SOC;
48
49     this->charging_efficiency = lilon_inputs.charging_efficiency;
50     this->discharging_efficiency = lilon_inputs.discharging_efficiency;
51     */
52
53     return;
54 } /* __checkInputs() */

```

4.8.3.2 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](#).

```

243 {
244     //...
245
246     return;
247 } /* commitCharge() */

```

4.8.3.3 commitDischarge()

```

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

```

Reimplemented from [Storage](#).

```

277 {
278     // 1. record discharging power
279     this->discharging_power_vec_kW[timestep] = discharging_kW;

```

```

280
281     // 2. update charge and record
282     //...
283
284     // 3. update load
285     load_kW -= discharging_kW;
286
287     //...
288
289     return load_kW;
290 } /* commitDischarge() */

```

4.8.3.4 getAcceptablekW()

```

double LiIon::getAcceptablekW (
    int timestep ) [virtual]

```

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

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
-----------------	---

Returns

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

Reimplemented from [Storage](#).

```

209 {
210     //...
211
212     return 0;
213 } /* getAcceptablekW() */

```

4.8.3.5 getAvailablekW()

```

double LiIon::getAvailablekW (
    int timestep ) [virtual]

```

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

Parameters

<i>timestep</i>	The timestep (i.e., time series index) for the request.
-----------------	---

Returns

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

Reimplemented from [Storage](#).

```

186 {

```

```

187     //...
188
189     return 0;
190 } /* getAvailablekW() */

```

4.8.3.6 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.
-----------------	---

1. invoke base class method

Reimplemented from [Storage](#).

```

153 {
154     // 1. reset attributes
155     this->is_depleted = false;
156
157     this->dynamic_capacity_kWh = this->capacity_kWh;
158     this->SOH = 1;
159
160     Storage::handleReplacement(timestep);
161
162     // 3. correct attributes
163     this->charge_kWh = this->init_SOC * this->capacity_kWh;
164
165     return;
166 } /* __handleReplacement() */

```

4.8.4 Member Data Documentation

4.8.4.1 charging_efficiency

```
double LiIon::charging_efficiency
```

The charging efficiency of the asset.

4.8.4.2 discharging_efficiency

```
double LiIon::discharging_efficiency
```

The discharging efficiency of the asset.

4.8.4.3 dynamic_capacity_kWh

```
double LiIon::dynamic_capacity_kWh
```

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

4.8.4.4 hysteresis_SOC

```
double LiIon::hysteresis_SOC
```

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

4.8.4.5 init_SOC

```
double LiIon::init_SOC
```

The initial state of charge of the asset.

4.8.4.6 is_depleted

```
bool LiIon::is_depleted
```

A boolean which indicates whether or not the asset is currently considered depleted.

4.8.4.7 max_SOC

```
double LiIon::max_SOC
```

The maximum state of charge of the asset.

4.8.4.8 min_SOC

```
double LiIon::min_SOC
```

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

4.8.4.9 replace_SOH

```
double LiIon::replace_SOH
```

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

4.8.4.10 SOH

```
double LiIon::SOH
```

The state of health of the asset.

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

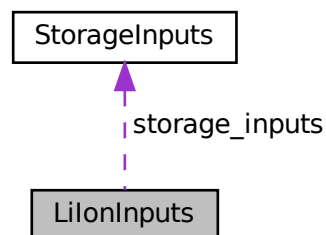
- header/Storage/[Lilon.h](#)
- source/Storage/[Lilon.cpp](#)

4.9 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 [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.

4.9.1 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](#).

4.9.2 Member Data Documentation

4.9.2.1 charging_efficiency

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

The charging efficiency of the asset.

4.9.2.2 discharging_efficiency

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

The discharging efficiency of the asset.

4.9.2.3 hysteresis_SOC

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

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

4.9.2.4 init_SOC

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

The initial state of charge of the asset.

4.9.2.5 max_SOC

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

The maximum state of charge of the asset.

4.9.2.6 min_SOC

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

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

4.9.2.7 replace_SOH

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

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

4.9.2.8 storage_inputs

```
StorageInputs LiIonInputs::storage_inputs
```

An encapsulated [StorageInputs](#) instance.

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

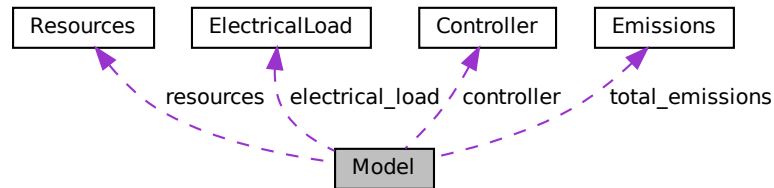
- header/Storage/[Lilon.h](#)

4.10 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 [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](#) ([ModellInputs](#))
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](#).

4.10.1 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.

4.10.2 Constructor & Destructor Documentation

4.10.2.1 Model() [1/2]

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

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

```
466 {
467     return;
468 } /* Model() */
```

4.10.2.2 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.
---------------------	--

```
485 {
486     // 1. check inputs
487     this->__checkInputs(model_inputs);
488
489     // 2. read in electrical load data
490     this->electrical_load.readLoadData(model_inputs.path_2_electrical_load_time_series);
491
492     // 3. set control mode
493     this->controller.setControlMode(model_inputs.control_mode);
494
495     // 4. set public attributes
496     this->total_fuel_consumed_L = 0;
497     this->net_present_cost = 0;
498     this->total_dispatch_discharge_kWh = 0;
499     this->levellized_cost_of_energy_kWh = 0;
500
501     return;
502 } /* Model() */
```

4.10.2.3 ~Model()

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

Destructor for the [Model](#) class.

```
904 {
905     this->clear();
906     return;
907 } /* ~Model() */
```

4.10.3 Member Function Documentation

4.10.3.1 `__checkInputs()`

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

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

Parameters

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

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

4.10.3.2 `__computeEconomics()`

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

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

```
206 {
207     this->__computeNetPresentCost();
208     this->__computeLevellizedCostOfEnergy();
209
210     return;
211 } /* __computeEconomics() */
```

4.10.3.3 `__computeFuelAndEmissions()`

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

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

```
60 {
61     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
62         this->combustion_ptr_vec[i]->computeFuelAndEmissions();
63
64         this->total_fuel_consumed_L +=
65             this->combustion_ptr_vec[i]->total_fuel_consumed_L;
66
67         this->total_emissions.CO2_kg +=
68             this->combustion_ptr_vec[i]->total_emissions.CO2_kg;
69
70         this->total_emissions.CO_kg +=
71             this->combustion_ptr_vec[i]->total_emissions.CO_kg;
72
73         this->total_emissions.NOx_kg +=
74             this->combustion_ptr_vec[i]->total_emissions.NOx_kg;
75
76         this->total_emissions.SOx_kg +=
77             this->combustion_ptr_vec[i]->total_emissions.SOx_kg;
```

```

78
79         this->total_emissions.CH4_kg +=
80             this->combustion_ptr_vec[i]->total_emissions.CH4_kg;
81
82         this->total_emissions.PM_kg +=
83             this->combustion_ptr_vec[i]->total_emissions.PM_kg;
84     }
85
86     return;
87 } /* __computeFuelAndEmissions() */

```

4.10.3.4 __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.

```

160 {
161     // 1. account for Combustion economics in levellized cost of energy
162     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
163         this->levellized_cost_of_energy_kWh +=
164             (
165                 this->combustion_ptr_vec[i]->levellized_cost_of_energy_kWh *
166                 this->combustion_ptr_vec[i]->total_dispatch_kWh
167             ) / this->total_dispatch_discharge_kWh;
168     }
169
170     // 2. account for Renewable economics in levellized cost of energy
171     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
172         this->levellized_cost_of_energy_kWh +=
173             (
174                 this->renewable_ptr_vec[i]->levellized_cost_of_energy_kWh *
175                 this->renewable_ptr_vec[i]->total_dispatch_kWh
176             ) / this->total_dispatch_discharge_kWh;
177     }
178
179     // 3. account for Storage economics in levellized cost of energy
180     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
181         /*
182         this->levellized_cost_of_energy_kWh +=
183             (
184                 this->storage_ptr_vec[i]->levellized_cost_of_energy_kWh *
185                 this->storage_ptr_vec[i]->total_dispatch_kWh
186             ) / this->total_dispatch_discharge_kWh;
187         */
188     }
189
190     return;
191 } /* __computeLevellizedCostOfEnergy() */

```

4.10.3.5 __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.

```

103 {
104     // 1. account for Combustion economics in net present cost
105     // increment total dispatch
106     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
107         this->combustion_ptr_vec[i]->computeEconomics(
108             &(this->electrical_load.time_vec_hrs)
109         );
110
111         this->net_present_cost += this->combustion_ptr_vec[i]->net_present_cost;
112
113         this->total_dispatch_discharge_kWh +=
114             this->combustion_ptr_vec[i]->total_dispatch_kWh;

```

```

115     }
116
117     // 2. account for Renewable economics in net present cost,
118     // increment total dispatch
119     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
120         this->renewable_ptr_vec[i]->computeEconomics(
121             &(this->electrical_load.time_vec_hrs)
122         );
123
124         this->net_present_cost += this->renewable_ptr_vec[i]->net_present_cost;
125
126         this->total_dispatch_discharge_kWh +=
127             this->renewable_ptr_vec[i]->total_dispatch_kWh;
128     }
129
130     // 3. account for Storage economics in net present cost
131     // increment total dispatch
132     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
133         this->storage_ptr_vec[i]->computeEconomics(
134             &(this->electrical_load.time_vec_hrs)
135         );
136
137         this->net_present_cost += this->storage_ptr_vec[i]->net_present_cost;
138
139         this->total_dispatch_discharge_kWh +=
140             this->storage_ptr_vec[i]->total_discharge_kWh;
141     }
142
143     return;
144 } /* __computeNetPresentCost() */

```

4.10.3.6 __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.
-------------------	--

```

229 {
230     // 1. create subdirectory
231     write_path += "Model/";
232     std::filesystem::create_directory(write_path);
233
234     // 2. create filestream
235     write_path += "summary_results.md";
236     std::ofstream ofs;
237     ofs.open(write_path, std::ofstream::out);
238
239     // 3. write summary results (markdown)
240     ofs << "# Model Summary Results\n";
241     ofs << "\n-----\n\n";
242
243     // 3.1. ElectricalLoad
244     ofs << "## Electrical Load\n";
245     ofs << "\n";
246     ofs << "Path: " <<
247         this->electrical_load.path_2_electrical_load_time_series << " \n";
248     ofs << "Data Points: " << this->electrical_load.n_points << " \n";
249     ofs << "Years: " << this->electrical_load.n_years << " \n";
250     ofs << "Min: " << this->electrical_load.min_load_kW << " kW \n";
251     ofs << "Mean: " << this->electrical_load.mean_load_kW << " kW \n";
252     ofs << "Max: " << this->electrical_load.max_load_kW << " kW \n";
253     ofs << "\n-----\n\n";
254
255     // 3.2. Controller
256     ofs << "## Controller\n";
257     ofs << "\n";
258     ofs << "Control Mode: " << this->controller.control_string << " \n";
259     ofs << "\n-----\n\n";

```

```

260
261 // 3.3. Resources (1D)
262 ofs << "## 1D Renewable Resources\n";
263 ofs << "\n";
264
265 std::map<int, std::string>::iterator string_map_1D_iter =
266 this->resources.string_map_1D.begin();
267 std::map<int, std::string>::iterator path_map_1D_iter =
268 this->resources.path_map_1D.begin();
269
270 while (
271     string_map_1D_iter != this->resources.string_map_1D.end() and
272     path_map_1D_iter != this->resources.path_map_1D.end()
273 ) {
274     ofs << "Resource Key: " << string_map_1D_iter->first << " \n";
275     ofs << "Type: " << string_map_1D_iter->second << " \n";
276     ofs << "Path: " << path_map_1D_iter->second << " \n";
277     ofs << "\n";
278
279     string_map_1D_iter++;
280     path_map_1D_iter++;
281 }
282
283 ofs << "\n-----\n\n";
284
285 // 3.4. Resources (2D)
286 ofs << "## 2D Renewable Resources\n";
287 ofs << "\n";
288
289 std::map<int, std::string>::iterator string_map_2D_iter =
290 this->resources.string_map_2D.begin();
291 std::map<int, std::string>::iterator path_map_2D_iter =
292 this->resources.path_map_2D.begin();
293
294 while (
295     string_map_2D_iter != this->resources.string_map_2D.end() and
296     path_map_2D_iter != this->resources.path_map_2D.end()
297 ) {
298     ofs << "Resource Key: " << string_map_2D_iter->first << " \n";
299     ofs << "Type: " << string_map_2D_iter->second << " \n";
300     ofs << "Path: " << path_map_2D_iter->second << " \n";
301     ofs << "\n";
302
303     string_map_2D_iter++;
304     path_map_2D_iter++;
305 }
306
307 ofs << "\n-----\n\n";
308
309 // 3.5. Combustion
310 ofs << "## Combustion Assets\n";
311 ofs << "\n";
312
313 for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
314     ofs << "Asset Index: " << i << " \n";
315     ofs << "Type: " << this->combustion_ptr_vec[i]->type_str << " \n";
316     ofs << "Capacity: " << this->combustion_ptr_vec[i]->capacity_kW << " kW \n";
317     ofs << "\n";
318 }
319
320 ofs << "\n-----\n\n";
321
322 // 3.6. Renewable
323 ofs << "## Renewable Assets\n";
324 ofs << "\n";
325
326 for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
327     ofs << "Asset Index: " << i << " \n";
328     ofs << "Type: " << this->renewable_ptr_vec[i]->type_str << " \n";
329     ofs << "Capacity: " << this->renewable_ptr_vec[i]->capacity_kW << " kW \n";
330     ofs << "\n";
331 }
332
333 ofs << "\n-----\n\n";
334
335 // 3.7. Storage
336 ofs << "## Storage Assets\n";
337 ofs << "\n";
338
339 for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
340     //...
341 }
342
343 ofs << "\n-----\n\n";
344
345 // 3.8. Model Results
346 ofs << "## Results\n";

```

```

347     ofs << "\n";
348
349     ofs << "Net Present Cost: " << this->net_present_cost << " \n";
350     ofs << "\n";
351
352     ofs << "Total Dispatch + Discharge: " << this->total_dispatch_discharge_kWh
353         << " kWh \n";
354
355     ofs << "Levellized Cost of Energy: " << this->levellized_cost_of_energy_kWh
356         << " per kWh dispatched/discharged \n";
357     ofs << "\n";
358
359     ofs << "Total Fuel Consumed: " << this->total_fuel_consumed_L << " L "
360         << "(Annual Average: " <<
361             this->total_fuel_consumed_L / this->electrical_load.n_years
362         << " L/yr) \n";
363     ofs << "\n";
364
365     ofs << "Total Carbon Dioxide (CO2) Emissions: " <<
366         this->total_emissions.CO2_kg << " kg "
367         << "(Annual Average: " <<
368             this->total_emissions.CO2_kg / this->electrical_load.n_years
369         << " kg/yr) \n";
370
371     ofs << "Total Carbon Monoxide (CO) Emissions: " <<
372         this->total_emissions.CO_kg << " kg "
373         << "(Annual Average: " <<
374             this->total_emissions.CO_kg / this->electrical_load.n_years
375         << " kg/yr) \n";
376
377     ofs << "Total Nitrogen Oxides (NOx) Emissions: " <<
378         this->total_emissions.NOx_kg << " kg "
379         << "(Annual Average: " <<
380             this->total_emissions.NOx_kg / this->electrical_load.n_years
381         << " kg/yr) \n";
382
383     ofs << "Total Sulfur Oxides (SOx) Emissions: " <<
384         this->total_emissions.SOx_kg << " kg "
385         << "(Annual Average: " <<
386             this->total_emissions.SOx_kg / this->electrical_load.n_years
387         << " kg/yr) \n";
388
389     ofs << "Total Methane (CH4) Emissions: " << this->total_emissions.CH4_kg << " kg "
390         << "(Annual Average: " <<
391             this->total_emissions.CH4_kg / this->electrical_load.n_years
392         << " kg/yr) \n";
393
394     ofs << "Total Particulate Matter (PM) Emissions: " <<
395         this->total_emissions.PM_kg << " kg "
396         << "(Annual Average: " <<
397             this->total_emissions.PM_kg / this->electrical_load.n_years
398         << " kg/yr) \n";
399
400     ofs << "\n-----\n\n";
401
402     ofs.close();
403     return;
404 } /* __writeSummary() */

```

4.10.3.7 __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.

```

424 {
425     // 1. create filestream
426     write_path += "Model/time_series_results.csv";
427     std::ofstream ofs;
428     ofs.open(write_path, std::ofstream::out);
429
430     // 2. write time series results (comma separated value)
431     ofs << "Time (since start of data) [hrs],";
432     ofs << "Electrical Load [kW],";
433     ofs << "Net Load [kW],";
434     ofs << "Missed Load [kW],";
435     ofs << "\n";
436
437     for (int i = 0; i < max_lines; i++) {
438         ofs << this->electrical_load.time_vec_hrs[i] << ",";
439         ofs << this->electrical_load.load_vec_kW[i] << ",";
440         ofs << this->controller.net_load_vec_kW[i] << ",";
441         ofs << this->controller.missed_load_vec_kW[i] << ",";
442         ofs << "\n";
443     }
444
445     ofs.close();
446     return;
447 } /* __writeTimeSeries() */

```

4.10.3.8 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.
----------------------	---

```

519 {
520     Combustion* diesel_ptr = new Diesel(
521         this->electrical_load.n_points,
522         this->electrical_load.n_years,
523         diesel_inputs
524     );
525
526     this->combustion_ptr_vec.push_back(diesel_ptr);
527
528     return;
529 } /* addDiesel() */

```

4.10.3.9 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.


```

558 {
559     resources.addResource (
560         renewable_type,
561         path_2_resource_data,
562         resource_key,
563         &(this->electrical_load)
564     );
565
566     return;
567 } /* addResource() */

```

4.10.3.10 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.
---------------------	--

```

584 {
585     Renewable* solar_ptr = new Solar (
586         this->electrical_load.n_points,
587         this->electrical_load.n_years,
588         solar_inputs
589     );
590
591     this->renewable_ptr_vec.push_back(solar_ptr);
592
593     return;
594 } /* addSolar() */

```

4.10.3.11 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.
---------------------	--

```

611 {
612     Renewable* tidal_ptr = new Tidal (
613         this->electrical_load.n_points,
614         this->electrical_load.n_years,
615         tidal_inputs
616     );
617
618     this->renewable_ptr_vec.push_back(tidal_ptr);
619
620     return;
621 } /* addTidal() */

```

4.10.3.12 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.
--------------------	---

```
638 {
639     Renewable* wave_ptr = new Wave(
640         this->electrical_load.n_points,
641         this->electrical_load.n_years,
642         wave_inputs
643     );
644
645     this->renewable_ptr_vec.push_back(wave_ptr);
646
647     return;
648 } /* addWave() */
```

4.10.3.13 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.
--------------------	---

```
665 {
666     Renewable* wind_ptr = new Wind(
667         this->electrical_load.n_points,
668         this->electrical_load.n_years,
669         wind_inputs
670     );
671
672     this->renewable_ptr_vec.push_back(wind_ptr);
673
674     return;
675 } /* addWind() */
```

4.10.3.14 clear()

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

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

```
781 {
782     // 1. reset
783     this->reset();
784
785     // 2. clear components
786     controller.clear();
787     electrical_load.clear();
```

```

788     resources.clear();
789
790     return;
791 } /* clear() */

```

4.10.3.15 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.

```

732 {
733     // 1. clear combustion_ptr_vec
734     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
735         delete this->combustion_ptr_vec[i];
736     }
737     this->combustion_ptr_vec.clear();
738
739     // 2. clear renewable_ptr_vec
740     for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
741         delete this->renewable_ptr_vec[i];
742     }
743     this->renewable_ptr_vec.clear();
744
745     // 3. clear storage_ptr_vec
746     for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
747         delete this->storage_ptr_vec[i];
748     }
749     this->storage_ptr_vec.clear();
750
751     // 4. reset attributes
752     this->total_fuel_consumed_L = 0;
753
754     this->total_emissions.CO2_kg = 0;
755     this->total_emissions.CO_kg = 0;
756     this->total_emissions.NOx_kg = 0;
757     this->total_emissions.SOx_kg = 0;
758     this->total_emissions.CH4_kg = 0;
759     this->total_emissions.PM_kg = 0;
760
761     this->net_present_cost = 0;
762     this->total_dispatch_discharge_kWh = 0;
763     this->levellized_cost_of_energy_kWh = 0;
764
765     return;
766 } /* reset() */

```

4.10.3.16 run()

```

void Model::run (
    void )

```

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

```

690 {
691     // 1. init Controller
692     this->controller.init(
693         &(this->electrical_load),
694         &(this->renewable_ptr_vec),
695         &(this->resources),
696         &(this->combustion_ptr_vec)
697     );
698
699     // 2. apply dispatch control
700     this->controller.applyDispatchControl(
701         &(this->electrical_load),
702         &(this->combustion_ptr_vec),

```

```

703         &(this->renewable_ptr_vec),
704         &(this->storage_ptr_vec)
705     );
706
707     // 3. compute total fuel consumption and emissions
708     this->__computeFuelAndEmissions();
709
710     // 4. compute key economic metrics
711     this->__computeEconomics();
712
713     return;
714 } /* run() */

```

4.10.3.17 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.

```

819 {
820     // 1. handle sentinel
821     if (max_lines < 0) {
822         max_lines = this->electrical_load.n_points;
823     }
824
825     // 2. check for pre-existing, warn (and remove), then create
826     if (write_path.back() != '/') {
827         write_path += '/';
828     }
829
830     if (std::filesystem::is_directory(write_path)) {
831         std::string warning_str = "WARNING: Model::writeResults(): ";
832         warning_str += write_path;
833         warning_str += " already exists, contents will be overwritten!";
834
835         std::cout << warning_str << std::endl;
836
837         std::filesystem::remove_all(write_path);
838     }
839
840     std::filesystem::create_directory(write_path);
841
842     // 3. write summary
843     this->__writeSummary(write_path);
844
845     // 4. write time series
846     if (max_lines > this->electrical_load.n_points) {
847         max_lines = this->electrical_load.n_points;
848     }
849
850     if (max_lines > 0) {
851         this->__writeTimeSeries(write_path, max_lines);
852     }
853
854     // 5. call out to Combustion :: writeResults()
855     for (size_t i = 0; i < this->combustion_ptr_vec.size(); i++) {
856         this->combustion_ptr_vec[i]->writeResults(
857             write_path,
858             &(this->electrical_load.time_vec_hrs),
859             i,
860             max_lines
861         );
862     }

```

```

863
864 // 6. call out to Renewable :: writeResults()
865 for (size_t i = 0; i < this->renewable_ptr_vec.size(); i++) {
866     this->renewable_ptr_vec[i]->writeResults(
867         write_path,
868         &(this->electrical_load.time_vec_hrs),
869         &(this->resources.resource_map_1D),
870         &(this->resources.resource_map_2D),
871         i,
872         max_lines
873     );
874 }
875
876 // 7. call out to Storage :: writeResults()
877 for (size_t i = 0; i < this->storage_ptr_vec.size(); i++) {
878     /*
879     this->storage_ptr_vec[i]->writeResults(
880         write_path,
881         &(this->electrical_load.time_vec_hrs),
882         i,
883         max_lines
884     );
885     */
886 }
887
888 return;
889 } /* writeResults() */

```

4.10.4 Member Data Documentation

4.10.4.1 combustion_ptr_vec

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

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

4.10.4.2 controller

`Controller Model::controller`

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

4.10.4.3 electrical_load

`ElectricalLoad Model::electrical_load`

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

4.10.4.4 levellized_cost_of_energy_kWh

```
double Model::levellized_cost_of_energy_kWh
```

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

4.10.4.5 net_present_cost

```
double Model::net_present_cost
```

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

4.10.4.6 renewable_ptr_vec

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

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

4.10.4.7 resources

```
Resources Model::resources
```

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

4.10.4.8 storage_ptr_vec

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

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

4.10.4.9 total_dispatch_discharge_kWh

```
double Model::total_dispatch_discharge_kWh
```

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

4.10.4.10 total_emissions

`Emissions` `Model::total_emissions`

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

4.10.4.11 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](#)

4.11 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.

4.11.1 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).

4.11.2 Member Data Documentation

4.11.2.1 control_mode

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

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

4.11.2.2 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:

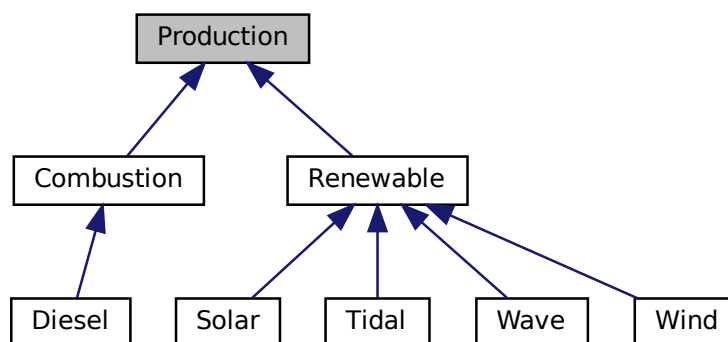
- [header/Model.h](#)

4.12 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:



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.
- 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

- 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.
- 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.

4.12.1 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.

4.12.2 Constructor & Destructor Documentation

4.12.2.1 Production() [1/2]

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

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

```
149 {
150     return;
151 } /* Production() */
```

4.12.2.2 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.

```
180 {
181     // 1. check inputs
182     this->__checkInputs(n_points, n_years, production_inputs);
183
184     // 2. set attributes
185     this->print_flag = production_inputs.print_flag;
186     this->is_running = false;
187     this->is_sunk = production_inputs.is_sunk;
188
189     this->n_points = n_points;
190     this->n_starts = 0;
191     this->n_replacements = 0;
192
193     this->n_years = n_years;
194
195     this->running_hours = 0;
196     this->replace_running_hrs = production_inputs.replace_running_hrs;
197
198     this->capacity_kW = production_inputs.capacity_kW;
199
200     this->nominal_inflation_annual = production_inputs.nominal_inflation_annual;
201     this->nominal_discount_annual = production_inputs.nominal_discount_annual;
202     this->real_discount_annual = this->__computeRealDiscountAnnual(
203         production_inputs.nominal_inflation_annual,
204         production_inputs.nominal_discount_annual
205     );
206     this->capital_cost = 0;
207     this->operation_maintenance_cost_kWh = 0;
208     this->net_present_cost = 0;
209     this->total_dispatch_kWh = 0;
210     this->levelized_cost_of_energy_kWh = 0;
211
212     this->is_running_vec.resize(this->n_points, 0);
213
214     this->production_vec_kW.resize(this->n_points, 0);
215     this->dispatch_vec_kW.resize(this->n_points, 0);
216     this->storage_vec_kW.resize(this->n_points, 0);
217     this->curtailment_vec_kW.resize(this->n_points, 0);
218
219     this->capital_cost_vec.resize(this->n_points, 0);
220     this->operation_maintenance_cost_vec.resize(this->n_points, 0);
221
222     // 3. construction print
223     if (this->print_flag) {
```

```

224         std::cout << "Production object constructed at " << this << std::endl;
225     }
226
227     return;
228 } /* Production() */

```

4.12.2.3 ~Production()

```

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

```

Destructor for the [Production](#) class.

```

409 {
410     // 1. destruction print
411     if (this->print_flag) {
412         std::cout << "Production object at " << this << " destroyed" << std::endl;
413     }
414
415     return;
416 } /* ~Production() */

```

4.12.3 Member Function Documentation

4.12.3.1 __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() */

```

4.12.3.2 __computeRealDiscountAnnual()

```

double Production::__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.

```

125 {
126     double real_discount_annual = nominal_discount_annual - nominal_inflation_annual;
127     real_discount_annual /= 1 + nominal_inflation_annual;
128
129     return real_discount_annual;
130 } /* __computeRealDiscountAnnual() */

```

4.12.3.3 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](#).

```
350 {
351     // 1. record production
352     this->production_vec_kW[timestep] = production_kW;
353
354     // 2. compute and record dispatch and curtailment
355     double dispatch_kW = 0;
356     double curtailment_kW = 0;
357
358     if (production_kW > load_kW) {
359         dispatch_kW = load_kW;
360         curtailment_kW = production_kW - dispatch_kW;
361     }
362
363     else {
364         dispatch_kW = production_kW;
365     }
366
367     this->dispatch_vec_kW[timestep] = dispatch_kW;
368     this->total_dispatch_kWh += dispatch_kW * dt_hrs;
369     this->curtailment_vec_kW[timestep] = curtailment_kW;
370
371     // 3. update load
372     load_kW -= dispatch_kW;
373
374     // 4. update and log running attributes
375     if (this->is_running) {
376         // 4.1. log running state, running hours
377         this->is_running_vec[timestep] = this->is_running;
378         this->running_hours += dt_hrs;
379
380         // 4.2. incur operation and maintenance costs
381         double produced_kWh = production_kW * dt_hrs;
382
383         double operation_maintenance_cost =
384             this->operation_maintenance_cost_kWh * produced_kWh;
385         this->operation_maintenance_cost_vec[timestep] = operation_maintenance_cost;
386     }
387
388     // 5. trigger replacement, if applicable
389     if (this->running_hours >= (this->n_replacements + 1) * this->replace_running_hrs) {
390         this->handleReplacement(timestep);
391     }
392
393     return load_kW;
394 } /* commit() */
```

4.12.3.4 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 levlized cost of energy (per unit dispatched)

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

```

279 {
280     // 1. compute net present cost
281     double t_hrs = 0;
282     double real_discount_scalar = 0;
283
284     for (int i = 0; i < this->n_points; i++) {
285         t_hrs = time_vec_hrs_ptr->at(i);
286
287         real_discount_scalar = 1.0 / pow(
288             1 + this->real_discount_annual,
289             t_hrs / 8760
290         );
291
292         this->net_present_cost += real_discount_scalar * this->capital_cost_vec[i];
293
294         this->net_present_cost +=
295             real_discount_scalar * this->operation_maintenance_cost_vec[i];
296     }
297
298     // assuming 8,760 hours per year
299     double n_years = time_vec_hrs_ptr->at(this->n_points - 1) / 8760;
300
301     double capital_recovery_factor =
302         (this->real_discount_annual * pow(1 + this->real_discount_annual, n_years)) /
303         (pow(1 + this->real_discount_annual, n_years) - 1);
304
305     double total_annualized_cost = capital_recovery_factor *
306         this->net_present_cost;
307
308     this->levellized_cost_of_energy_kWh =
309         (n_years * total_annualized_cost) /
310         this->total_dispatch_kWh;
311
312     return;
313 } /* computeEconomics() */

```

4.12.3.5 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](#).

```

246 {
247     // 1. reset attributes
248     this->is_running = false;
249
250     // 2. log replacement
251     this->n_replacements++;
252
253     // 3. incur capital cost in timestep
254     this->capital_cost_vec[timestep] = this->capital_cost;
255
256     return;
257 } /* __handleReplacement() */

```

4.12.4 Member Data Documentation

4.12.4.1 capacity_kW

```
double Production::capacity_kW
```

The rated production capacity [kW] of the asset.

4.12.4.2 capital_cost

```
double Production::capital_cost
```

The capital cost of the asset (undefined currency).

4.12.4.3 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).

4.12.4.4 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.

4.12.4.5 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.

4.12.4.6 is_running

```
bool Production::is_running
```

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

4.12.4.7 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.

4.12.4.8 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).

4.12.4.9 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.

4.12.4.10 n_points

```
int Production::n_points
```

The number of points in the modelling time series.

4.12.4.11 n_replacements

```
int Production::n_replacements
```

The number of times the asset has been replaced.

4.12.4.12 n_starts

```
int Production::n_starts
```

The number of times the asset has been started.

4.12.4.13 n_years

```
double Production::n_years
```

The number of years being modelled.

4.12.4.14 net_present_cost

```
double Production::net_present_cost
```

The net present cost of this asset.

4.12.4.15 nominal_discount_annual

```
double Production::nominal_discount_annual
```

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

4.12.4.16 nominal_inflation_annual

```
double Production::nominal_inflation_annual
```

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

4.12.4.17 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.

4.12.4.18 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).

4.12.4.19 print_flag

```
bool Production::print_flag
```

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

4.12.4.20 production_vec_kW

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

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

4.12.4.21 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.

4.12.4.22 replace_running_hrs

```
double Production::replace_running_hrs
```

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

4.12.4.23 running_hours

```
double Production::running_hours
```

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

4.12.4.24 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.

4.12.4.25 total_dispatch_kWh

```
double Production::total_dispatch_kWh
```

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

4.12.4.26 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](#)

4.13 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.

4.13.1 Detailed Description

A structure which bundles the necessary inputs for the `Production` constructor. Provides default values for every necessary input.

4.13.2 Member Data Documentation

4.13.2.1 `capacity_kW`

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

The rated production capacity [kW] of the asset.

4.13.2.2 `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).

4.13.2.3 `nominal_discount_annual`

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

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

4.13.2.4 nominal_inflation_annual

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

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

4.13.2.5 print_flag

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

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

4.13.2.6 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:

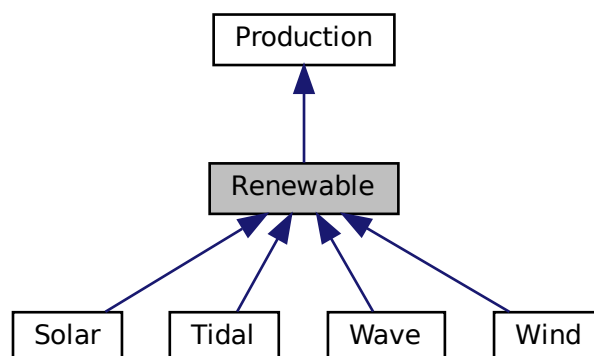
- header/Production/[Production.h](#)

4.14 Renewable Class Reference

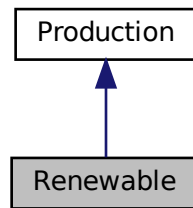
The root of the [Renewable](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the renewable production of energy.

```
#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)

4.14.1 Detailed Description

The root of the [Renewable](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the renewable production of energy.

4.14.2 Constructor & Destructor Documentation

4.14.2.1 Renewable() [1/2]

```
Renewable::Renewable (
    void )
```

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

```
92 {
93     //...
94
95     return;
96 } /* Renewable() */
```

4.14.2.2 Renewable() [2/2]

```
Renewable::Renewable (
    int n_points,
    double n_years,
    RenewableInputs renewable_inputs )
```

Constructor (intended) for the [Renewable](#) 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>renewable_inputs</i>	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() */
```


4.14.2.3 ~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() */
```

4.14.3 Member Function Documentation

4.14.3.1 __checkInputs()

```
void Renewable::__checkInputs (
    RenewableInputs renewable_inputs ) [private]
```

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

```
37 {
38     //...
39
40     return;
41 } /* __checkInputs() */
```

4.14.3.2 __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() */
```

4.14.3.3 `__writeSummary()`

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

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

```
72 {return;}
```

4.14.3.4 `__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;}
```

4.14.3.5 `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() */

```

4.14.3.6 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() */

```

4.14.3.7 computeProductionkW() [1/2]

```

virtual double Renewable::computeProductionkW (
    int ,
    double ,
    double ) [inline], [virtual]

```

Reimplemented in [Wind](#), [Tidal](#), and [Solar](#).

```

96 {return 0;}

```

4.14.3.8 computeProductionkW() [2/2]

```

virtual double Renewable::computeProductionkW (
    int ,
    double ,
    double ,
    double ) [inline], [virtual]

```

Reimplemented in [Wave](#).

```

97 {return 0;}

```

4.14.3.9 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() */
```

4.14.3.10 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 <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>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() */

```

4.14.4 Member Data Documentation

4.14.4.1 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.

4.14.4.2 type

`RenewableType Renewable::type`

The type (`RenewableType`) of the asset.

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

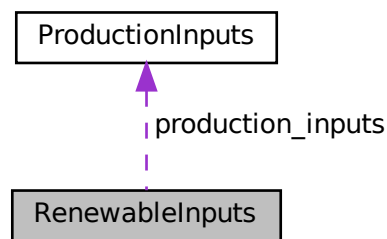
- header/Production/Renewable/[Renewable.h](#)
- source/Production/Renewable/[Renewable.cpp](#)

4.15 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.

4.15.1 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](#).

4.15.2 Member Data Documentation

4.15.2.1 `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`

4.16 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> 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> 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](#).

4.16.1 Detailed Description

A class which contains renewable resource data. Intended to serve as a component class of [Model](#).

4.16.2 Constructor & Destructor Documentation

4.16.2.1 Resources()

```
Resources::Resources (
    void )
```

Constructor for the [Resources](#) class.

```
577 {
578     return;
579 } /* Resources() */
```

4.16.2.2 ~Resources()

```
Resources::~~Resources (
    void )
```

Destructor for the [Resources](#) class.

```
721 {
722     this->clear();
723     return;
724 } /* ~Resources() */
```

4.16.3 Member Function Documentation

4.16.3.1 __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() */

```

4.16.3.2 __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() */

```

4.16.3.3 __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() */

```

4.16.3.4 __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() */

```

4.16.3.5 __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
362     // 3. read in resource data, check against time series (point-wise and length)
363     int n_points = 0;
364     double time_hrs = 0;
365     double time_expected_hrs = 0;
366     double tidal_resource_ms = 0;
367
368     while (CSV.read_row(time_hrs, tidal_resource_ms)) {
369         if (n_points > electrical_load_ptr->n_points) {
370             this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
371         }
372
373         time_expected_hrs = electrical_load_ptr->time_vec_hrs[n_points];
374         this->__checkTimePoint(
375             time_hrs,
376             time_expected_hrs,
377             path_2_resource_data,
378             electrical_load_ptr
379         );
380
381         this->resource_map_1D[resource_key][n_points] = tidal_resource_ms;
382
383         n_points++;
384     }
385
386     // 4. check data length
387     if (n_points != electrical_load_ptr->n_points) {
388         this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
389     }
390
391     return;
392 } /* __readTidalResource() */

```

4.16.3.6 __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
445     // 3. read in resource data, check against time series (point-wise and length)
446     int n_points = 0;
447     double time_hrs = 0;
448     double time_expected_hrs = 0;
449     double significant_wave_height_m = 0;
450     double energy_period_s = 0;
451
452     while (CSV.read_row(time_hrs, significant_wave_height_m, energy_period_s)) {
453         if (n_points > electrical_load_ptr->n_points) {
454             this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
455         }
456
457         time_expected_hrs = electrical_load_ptr->time_vec_hrs[n_points];
458         this->__checkTimePoint(
459             time_hrs,
460             time_expected_hrs,
461             path_2_resource_data,
462             electrical_load_ptr
463         );
464
465         this->resource_map_2D[resource_key][n_points][0] = significant_wave_height_m;
466         this->resource_map_2D[resource_key][n_points][1] = energy_period_s;
467
468         n_points++;
469     }
470
471     // 4. check data length
472     if (n_points != electrical_load_ptr->n_points) {
473         this->__throwLengthError(path_2_resource_data, electrical_load_ptr);
474     }
475
476     return;
477 } /* __readWaveResource() */

```

4.16.3.7 __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() */

```

4.16.3.8 __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() */

```

4.16.3.9 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->__checkResourceKey1D(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->__checkResourceKey1D(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() */

```

4.16.3.10 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() */

```

4.16.4 Member Data Documentation

4.16.4.1 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.

4.16.4.2 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.

4.16.4.3 resource_map_1D

```
std::map<int, std::vector<double> > Resources::resource_map_1D
```

A map <int, vector> of given 1D renewable resource time series.

4.16.4.4 resource_map_2D

```
std::map<int, std::vector<std::vector<double> > > Resources::resource_map_2D
```

A map <int, vector> of given 2D renewable resource time series.

4.16.4.5 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.

4.16.4.6 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:

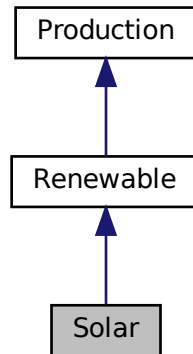
- header/[Resources.h](#)
- source/[Resources.cpp](#)

4.17 Solar Class Reference

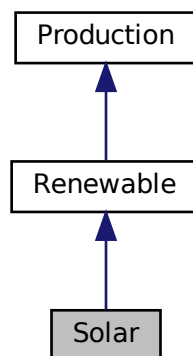
A derived class of the [Renewable](#) branch of [Production](#) which models solar production.

```
#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](#).

4.17.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models solar production.

4.17.2 Constructor & Destructor Documentation

4.17.2.1 [Solar\(\)](#) [1/2]

```
Solar::Solar (
    void )
```

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

```
281 {
282     //...
283
284     return;
285 } /* Solar() */
```

4.17.2.2 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() */
```

4.17.2.3 ~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() */
```

4.17.3 Member Function Documentation

4.17.3.1 `__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() */
```

4.17.3.2 `__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() */
```

4.17.3.3 `__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() */
```

4.17.3.4 __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     ofs << "\n-----\n\n";
162
163     // 2.3. Solar attributes
164     ofs << "## Solar Attributes\n";
165     ofs << "\n";
166
167     ofs << "Derating Factor: " << this->derating << " \n";
168     ofs << "\n-----\n\n";
169
170     // 2.4. Solar Results
171     ofs << "## Results\n";
172     ofs << "\n";
173
174     ofs << "Net Present Cost: " << this->net_present_cost << " \n";
175     ofs << "\n";
176
177     ofs << "Total Dispatch: " << this->total_dispatch_kWh
178         << " kWh \n";
179
180     ofs << "Levellized Cost of Energy: " << this->levellized_cost_of_energy_kWh
181         << " per kWh dispatched \n";
182     ofs << "\n";
183
184     ofs << "Running Hours: " << this->running_hours << " \n";
185     ofs << "Replacements: " << this->n_replacements << " \n";
186
187 }
```

```

188
189     ofs << "\n-----\n\n";
190
191     ofs.close();
192     return;
193 } /* __writeSummary() */

```

4.17.3.5 __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 << "Curtailement [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->curtailement_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() */

```

4.17.3.6 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
472     return load_kW;
473 } /* commit() */
```

4.17.3.7 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() */

```

4.17.3.8 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() */

```

4.17.4 Member Data Documentation**4.17.4.1 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:

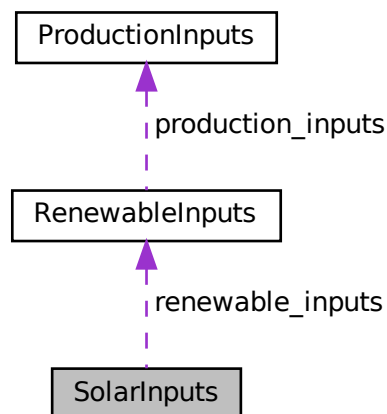
- header/Production/Renewable/[Solar.h](#)
- source/Production/Renewable/[Solar.cpp](#)

4.18 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.).

4.18.1 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](#).

4.18.2 Member Data Documentation

4.18.2.1 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].

4.18.2.2 derating

```
double SolarInputs::derating = 0.8
```

The derating of the solar PV array (i.e., shadowing, soiling, etc.).

4.18.2.3 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].

4.18.2.4 renewable_inputs

```
RenewableInputs SolarInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.18.2.5 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:

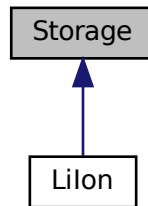
- `header/Production/Renewable/Solar.h`

4.19 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:



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](#) (int)
- virtual double [getAcceptablekW](#) (int)
- virtual void [commitCharge](#) (int, double, double)
- virtual double [commitDischarge](#) (int, double, double, double)
- virtual [~Storage](#) (void)
Destructor for the [Storage](#) class.

Public Attributes

- [StorageType](#) type
The type ([StorageType](#)) of the asset.
- bool [print_flag](#)
A flag which indicates whether or not object construct/destruction should be verbose.
- 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 `capacity_kW`
- The rated power capacity [kW] of the asset.*

 - double `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.*

4.19.1 Detailed Description

The base class of the [Storage](#) hierarchy. This hierarchy contains derived classes which model the storage of energy.

4.19.2 Constructor & Destructor Documentation

4.19.2.1 Storage() [1/2]

```
Storage::Storage (
    void )
```

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

```
149 {
150     return;
151 } /* Storage() */
```

4.19.2.2 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.

```
180 {
181     // 1. check inputs
182     this->__checkInputs(n_points, n_years, storage_inputs);
183
184     // 2. set attributes
185     this->print_flag = storage_inputs.print_flag;
186     this->is_sunk = storage_inputs.is_sunk;
187
188     this->n_points = n_points;
189     this->n_replacements = 0;
190
191     this->n_years = n_years;
192
193     this->capacity_kW = storage_inputs.capacity_kW;
194     this->capacity_kWh = storage_inputs.capacity_kWh;
195
196     this->charge_kWh = 0;
197     this->power_kW = 0;
198
199     this->nominal_inflation_annual = storage_inputs.nominal_inflation_annual;
200     this->nominal_discount_annual = storage_inputs.nominal_discount_annual;
201     this->real_discount_annual = this->__computeRealDiscountAnnual(
202         storage_inputs.nominal_inflation_annual,
203         storage_inputs.nominal_discount_annual
204     );
```

```

205     this->capital_cost = 0;
206     this->operation_maintenance_cost_kWh = 0;
207     this->net_present_cost = 0;
208     this->total_discharge_kWh = 0;
209     this->levellized_cost_of_energy_kWh = 0;
210
211     this->charge_vec_kWh.resize(this->n_points, 0);
212     this->charging_power_vec_kW.resize(this->n_points, 0);
213     this->discharging_power_vec_kW.resize(this->n_points, 0);
214
215     this->capital_cost_vec.resize(this->n_points, 0);
216     this->operation_maintenance_cost_vec.resize(this->n_points, 0);
217
218     // 3. construction print
219     if (this->print_flag) {
220         std::cout << "Storage object constructed at " << this << std::endl;
221     }
222
223     return;
224 } /* Storage() */

```

4.19.2.3 ~Storage()

```

Storage::~Storage (
    void ) [virtual]

```

Destructor for the [Storage](#) class.

```

326 {
327     // 1. destruction print
328     if (this->print_flag) {
329         std::cout << "Storage object at " << this << " destroyed" << std::endl;
330     }
331
332     return;
333 } /* ~Storage() */

```

4.19.3 Member Function Documentation

4.19.3.1 __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 capacity_kW
69     if (storage_inputs.capacity_kW <= 0) {
70         std::string error_str = "ERROR: Storage(): ";
71         error_str += "StorageInputs::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 capacity_kWh
81     if (storage_inputs.capacity_kWh <= 0) {
82         std::string error_str = "ERROR: Storage(): ";
83         error_str += "StorageInputs::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() */

```

4.19.3.2 __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.

```

125 {
126     double real_discount_annual = nominal_discount_annual - nominal_inflation_annual;
127     real_discount_annual /= 1 + nominal_inflation_annual;

```



```

128
129     return real_discount_annual;
130 } /* __computeRealDiscountAnnual() */

```

4.19.3.3 commitCharge()

```

virtual void Storage::commitCharge (
    int ,
    double ,
    double ) [inline], [virtual]

```

Reimplemented in [Lilon](#).

```

126 {return;}

```

4.19.3.4 commitDischarge()

```

virtual double Storage::commitDischarge (
    int ,
    double ,
    double ,
    double ) [inline], [virtual]

```

Reimplemented in [Lilon](#).

```

127 {return 0;}

```

4.19.3.5 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

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

1. compute levlized cost of energy (per unit discharged)

```

276 {
277     // 1. compute net present cost

```

```

278     double t_hrs = 0;
279     double real_discount_scalar = 0;
280
281     for (int i = 0; i < this->n_points; i++) {
282         t_hrs = time_vec_hrs_ptr->at(i);
283
284         real_discount_scalar = 1.0 / pow(
285             1 + this->real_discount_annual,
286             t_hrs / 8760
287         );
288
289         this->net_present_cost += real_discount_scalar * this->capital_cost_vec[i];
290
291         this->net_present_cost +=
292             real_discount_scalar * this->operation_maintenance_cost_vec[i];
293     }
294
295     // assuming 8,760 hours per year
296     double n_years = time_vec_hrs_ptr->at(this->n_points - 1) / 8760;
297
298     double capital_recovery_factor =
299         (this->real_discount_annual * pow(1 + this->real_discount_annual, n_years)) /
300         (pow(1 + this->real_discount_annual, n_years) - 1);
301
302     double total_annualized_cost = capital_recovery_factor *
303         this->net_present_cost;
304
305     this->levelized_cost_of_energy_kWh =
306         (n_years * total_annualized_cost) /
307         this->total_discharge_kWh;
308
309     return;
310 } /* computeEconomics() */

```

4.19.3.6 getAcceptablekW()

```

virtual double Storage::getAcceptablekW (
    int ) [inline], [virtual]

```

Reimplemented in [Lilon](#).

```

124 {return 0;}

```

4.19.3.7 getAvailablekW()

```

virtual double Storage::getAvailablekW (
    int ) [inline], [virtual]

```

Reimplemented in [Lilon](#).

```

123 {return 0;}

```

4.19.3.8 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](#).

```

242 {
243     // 1. reset attributes
244     this->charge_kWh = 0;
245     this->power_kW = 0;
246
247     // 2. log replacement
248     this->n_replacements++;
249
250     // 3. incur capital cost in timestep
251     this->capital_cost_vec[timestep] = this->capital_cost;
252
253     return;
254 } /* __handleReplacement() */

```

4.19.4 Member Data Documentation

4.19.4.1 capacity_kW

```
double Storage::capacity_kW
```

The rated power capacity [kW] of the asset.

4.19.4.2 capacity_kWh

```
double Storage::capacity_kWh
```

The rated energy capacity [kWh] of the asset.

4.19.4.3 capital_cost

```
double Storage::capital_cost
```

The capital cost of the asset (undefined currency).

4.19.4.4 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).

4.19.4.5 charge_kWh

```
double Storage::charge_kWh
```

The energy [kWh] stored in the asset.

4.19.4.6 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.

4.19.4.7 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.

4.19.4.8 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.

4.19.4.9 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).

4.19.4.10 levlized_cost_of_energy_kWh

```
double Storage::levellized_cost_of_energy_kWh
```

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

4.19.4.11 n_points

```
int Storage::n_points
```

The number of points in the modelling time series.

4.19.4.12 n_replacements

```
int Storage::n_replacements
```

The number of times the asset has been replaced.

4.19.4.13 n_years

```
double Storage::n_years
```

The number of years being modelled.

4.19.4.14 net_present_cost

```
double Storage::net_present_cost
```

The net present cost of this asset.

4.19.4.15 nominal_discount_annual

```
double Storage::nominal_discount_annual
```

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

4.19.4.16 nominal_inflation_annual

```
double Storage::nominal_inflation_annual
```

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

4.19.4.17 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.

4.19.4.18 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).

4.19.4.19 power_kW

```
double Storage::power_kW
```

The power [kW] currently being charged/discharged by the asset.

4.19.4.20 print_flag

```
bool Storage::print_flag
```

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

4.19.4.21 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.

4.19.4.22 total_discharge_kWh

```
double Storage::total_discharge_kWh
```

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

4.19.4.23 type

`StorageType` `Storage::type`

The type (`StorageType`) of the asset.

4.19.4.24 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](#)

4.20 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 [capacity_kW](#) = 100
The rated power capacity [kW] of the asset.
- double [capacity_kWh](#) = 100
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.

4.20.1 Detailed Description

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

4.20.2 Member Data Documentation

4.20.2.1 capacity_kW

```
double StorageInputs::capacity_kW = 100
```

The rated power capacity [kW] of the asset.

4.20.2.2 capacity_kWh

```
double StorageInputs::capacity_kWh = 100
```

The rated energy capacity [kWh] of the asset.

4.20.2.3 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).

4.20.2.4 nominal_discount_annual

```
double StorageInputs::nominal_discount_annual = 0.04
```

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

4.20.2.5 nominal_inflation_annual

```
double StorageInputs::nominal_inflation_annual = 0.02
```

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

4.20.2.6 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:

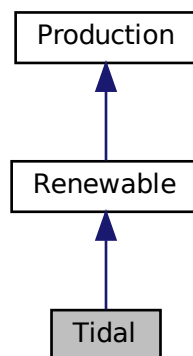
- [header/Storage/Storage.h](#)

4.21 Tidal Class Reference

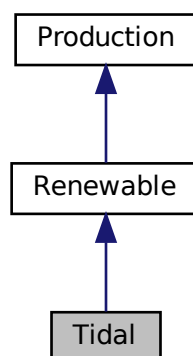
A derived class of the [Renewable](#) branch of [Production](#) which models tidal production.

```
#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](#).

4.21.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models tidal production.

4.21.2 Constructor & Destructor Documentation

4.21.2.1 Tidal() [1/2]

```
Tidal::Tidal (
    void )
```

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

```
427 {
428     return;
429 } /* Tidal() */
```

4.21.2.2 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() */

```

4.21.2.3 ~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() */

```

4.21.3 Member Function Documentation

4.21.3.1 __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() */

```

4.21.3.2 __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() */

```

4.21.3.3 `__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() */
```

4.21.3.4 `__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() */

```

4.21.3.5 __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() */

```

4.21.3.6 __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() */

```

4.21.3.7 __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() */

```


4.21.3.8 __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() */
```

4.21.3.9 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() */

```

4.21.3.10 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     return production_kW;
645 } /* computeProductionkW() */

```

4.21.3.11 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() */

```

4.21.4 Member Data Documentation

4.21.4.1 design_speed_ms

```
double Tidal::design_speed_ms
```

The tidal stream speed [m/s] at which the tidal turbine achieves its rated capacity.

4.21.4.2 power_model

```
TidalPowerProductionModel Tidal::power_model
```

The tidal power production model to be applied.

4.21.4.3 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:

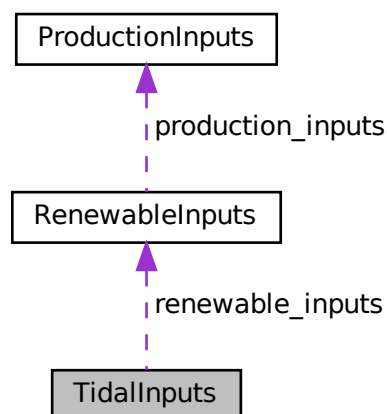
- [header/Production/Renewable/Tidal.h](#)
- [source/Production/Renewable/Tidal.cpp](#)

4.22 TidallInputs 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 TidallInputs:



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.

4.22.1 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](#).

4.22.2 Member Data Documentation

4.22.2.1 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].

4.22.2.2 design_speed_ms

```
double TidalInputs::design_speed_ms = 3
```

The tidal stream speed [m/s] at which the tidal turbine achieves its rated capacity.

4.22.2.3 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].

4.22.2.4 power_model

```
TidalPowerProductionModel TidalInputs::power_model = TidalPowerProductionModel :: TIDAL_POWER_CUBIC
```

The tidal power production model to be applied.

4.22.2.5 renewable_inputs

```
RenewableInputs TidalInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.22.2.6 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:

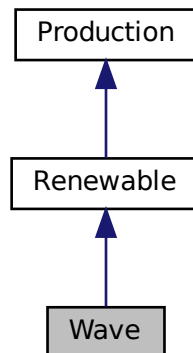
- [header/Production/Renewable/Tidal.h](#)

4.23 Wave Class Reference

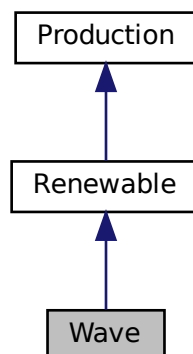
A derived class of the [Renewable](#) branch of [Production](#) which models wave production.

```
#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](#).

4.23.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models wave production.

4.23.2 Constructor & Destructor Documentation

4.23.2.1 Wave() [1/2]

```
Wave::Wave (
    void )
```

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

```
480 {
481     return;
482 } /* Wave() */
```

4.23.2.2 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     }
```

```

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() */

```

4.23.2.3 ~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() */

```

4.23.3 Member Function Documentation

4.23.3.1 __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() */

```

4.23.3.2 __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() */

```

4.23.3.3 __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() */

```

4.23.3.4 __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() */

```

4.23.3.5 __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() */

```

4.23.3.6 `__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() */
```

4.23.3.7 `__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() */

```

4.23.3.8 __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() */

```

4.23.3.9 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() */

```

4.23.3.10 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>signifiant_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() */

```

4.23.3.11 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() */

```

4.23.4 Member Data Documentation

4.23.4.1 design_energy_period_s

```
double Wave::design_energy_period_s
```

The energy period [s] at which the wave energy converter achieves its rated capacity.

4.23.4.2 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.

4.23.4.3 power_model

```
WavePowerProductionModel Wave::power_model
```

The wave power production model to be applied.

4.23.4.4 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:

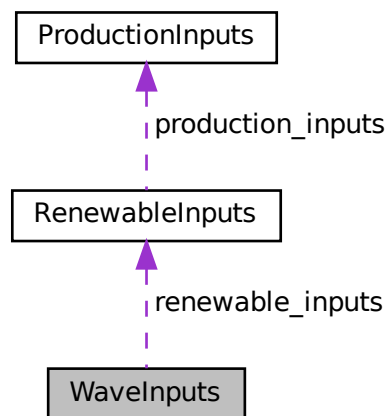
- [header/Production/Renewable/Wave.h](#)
- [source/Production/Renewable/Wave.cpp](#)

4.24 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.

4.24.1 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](#).

4.24.2 Member Data Documentation

4.24.2.1 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].

4.24.2.2 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.

4.24.2.3 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.

4.24.2.4 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].

4.24.2.5 power_model

```
WavePowerProductionModel WaveInputs::power_model = WavePowerProductionModel :: WAVE_POWER_PARABOLOID
```

The wave power production model to be applied.

4.24.2.6 renewable_inputs

```
RenewableInputs WaveInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.24.2.7 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:

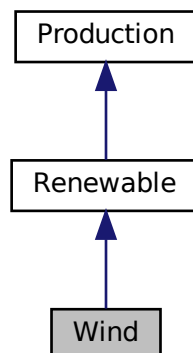
- [header/Production/Renewable/Wave.h](#)

4.25 Wind Class Reference

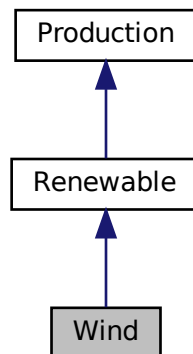
A derived class of the [Renewable](#) branch of [Production](#) which models wind production.

```
#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](#).

4.25.1 Detailed Description

A derived class of the [Renewable](#) branch of [Production](#) which models wind production.

4.25.2 Constructor & Destructor Documentation

4.25.2.1 `Wind()` [1/2]

```
Wind::Wind (
    void )
```

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

```
390 {
391     return;
392 } /* Wind() */
```

4.25.2.2 `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() */

```

4.25.2.3 ~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() */

```

4.25.3 Member Function Documentation

4.25.3.1 __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() */

```

4.25.3.2 __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() */

```

4.25.3.3 __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() */

```

4.25.3.4 __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() */

```

4.25.3.5 __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() */

```

4.25.3.6 __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() */

```

4.25.3.7 __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() */

```

4.25.3.8 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() */

```

4.25.3.9 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() */

```

4.25.3.10 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() */

```

4.25.4 Member Data Documentation

4.25.4.1 design_speed_ms

```
double Wind::design_speed_ms
```

The wind speed [m/s] at which the wind turbine achieves its rated capacity.

4.25.4.2 power_model

```
WindPowerProductionModel Wind::power_model
```

The wind power production model to be applied.

4.25.4.3 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:

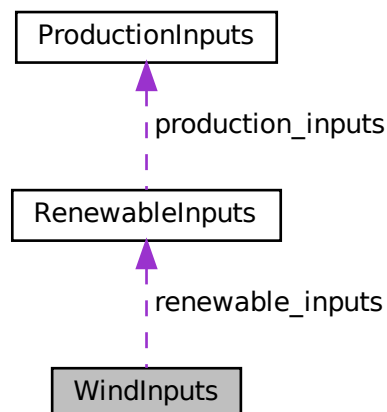
- header/Production/Renewable/[Wind.h](#)
- source/Production/Renewable/[Wind.cpp](#)

4.26 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.

4.26.1 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](#).

4.26.2 Member Data Documentation

4.26.2.1 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].

4.26.2.2 design_speed_ms

```
double WindInputs::design_speed_ms = 8
```

The wind speed [m/s] at which the wind turbine achieves its rated capacity.

4.26.2.3 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].

4.26.2.4 power_model

```
WindPowerProductionModel WindInputs::power_model = WindPowerProductionModel :: WIND_POWER_EXPONENTIAL
```

The wind power production model to be applied.

4.26.2.5 renewable_inputs

```
RenewableInputs WindInputs::renewable_inputs
```

An encapsulated [RenewableInputs](#) instance.

4.26.2.6 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

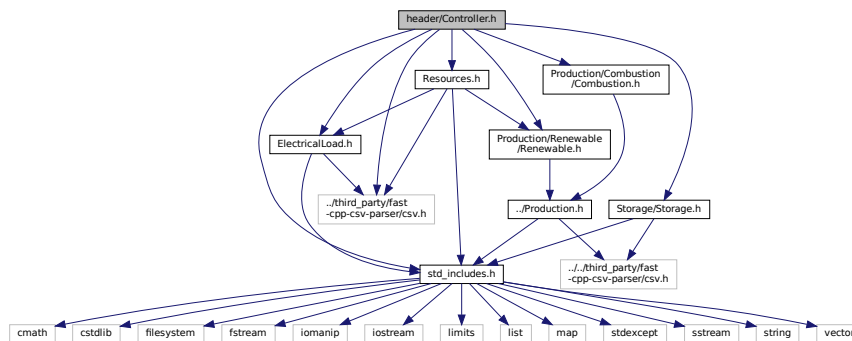
File Documentation

5.1 header/Controller.h File Reference

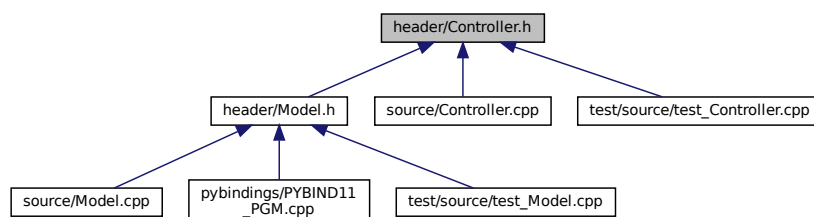
Header file the [Controller](#) class.

```
#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 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

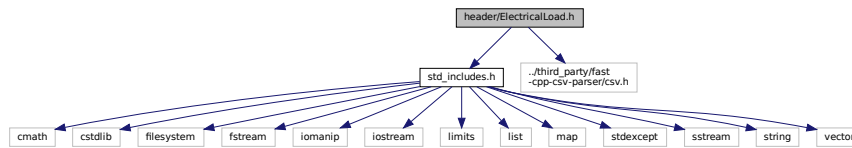
Header file the [ElectricalLoad](#) class.

```

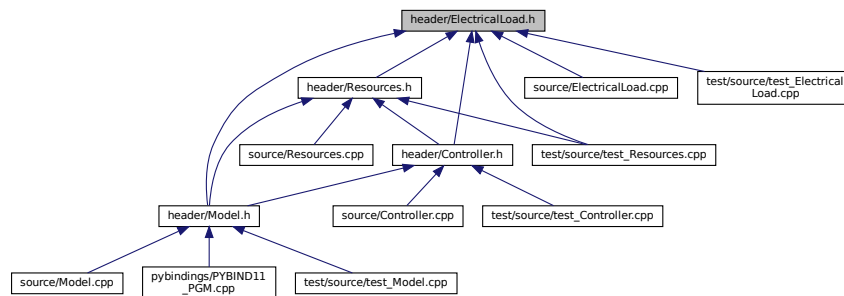
#include "std_includes.h"
#include "../third_party/fast-cpp-csv-parser/csv.h"

```

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 the [ElectricalLoad](#) class.

5.3 header/Model.h File Reference

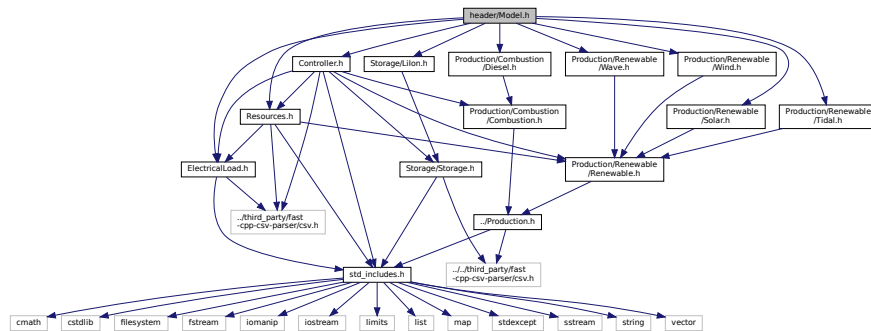
Header file the [Model](#) class.

```

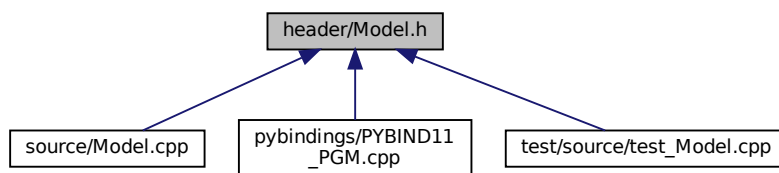
#include "Controller.h"
#include "ElectricalLoad.h"
#include "Resources.h"
#include "Production/Combustion/Diesel.h"
#include "Production/Renewable/Solar.h"
#include "Production/Renewable/Tidal.h"
#include "Production/Renewable/Wave.h"
#include "Production/Renewable/Wind.h"

```

```
#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.

5.3.1 Detailed Description

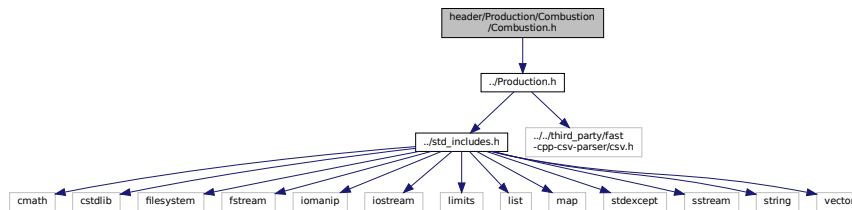
Header file the [Model](#) class.

5.4 header/Production/Combustion/Combustion.h File Reference

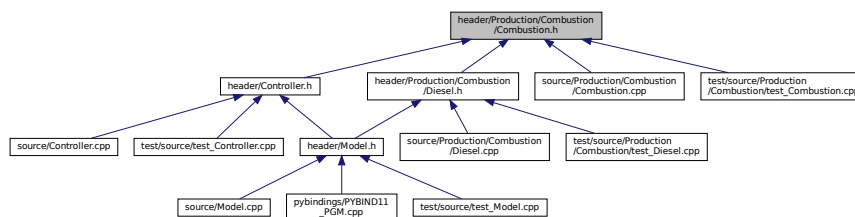
Header file the [Combustion](#) class.


```
#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.

5.4.1 Detailed Description

Header file the [Combustion](#) class.

5.4.2 Enumeration Type Documentation

5.4.2.1 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 };

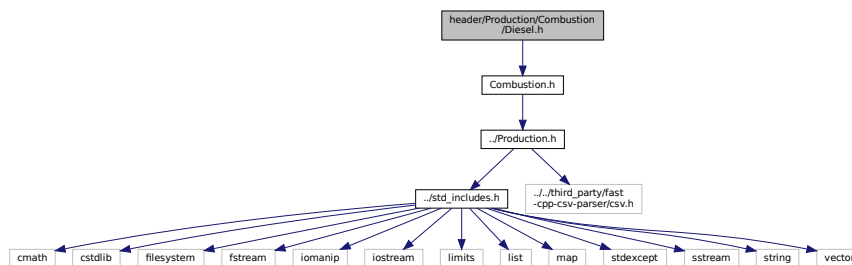
```

5.5 header/Production/Combustion/Diesel.h File Reference

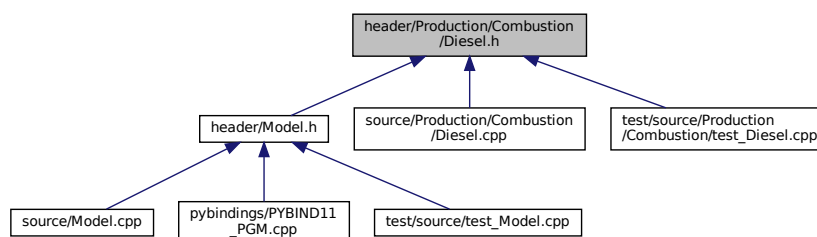
Header file the [Diesel](#) class.

```
#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.

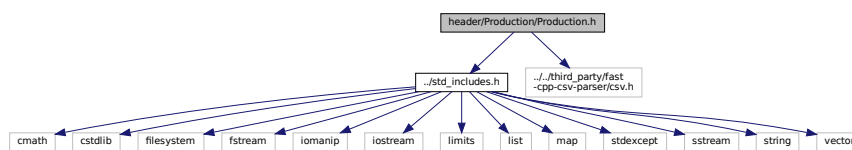
5.5.1 Detailed Description

Header file the [Diesel](#) class.

5.6 header/Production/Production.h File Reference

Header file the [Production](#) class.

```
#include "../std_includes.h"
#include "../../third_party/fast-cpp-csv-parser/csv.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.

5.6.1 Detailed Description

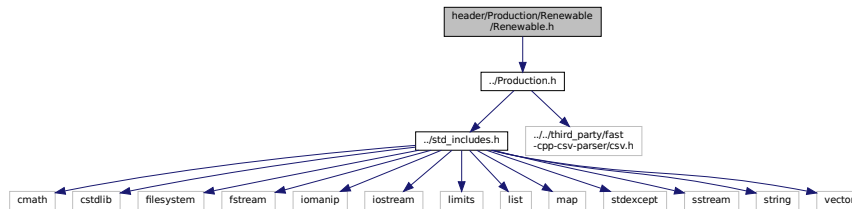
Header file the [Production](#) class.

5.7 header/Production/Renewable/Renewable.h File Reference

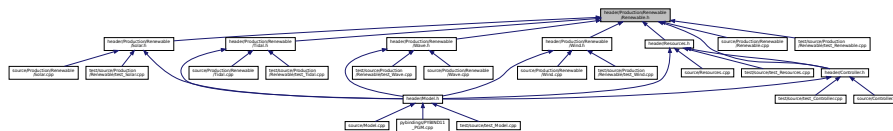
Header file the [Renewable](#) class.

```
#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.

5.7.1 Detailed Description

Header file the [Renewable](#) class.

5.7.2 Enumeration Type Documentation

5.7.2.1 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.

```

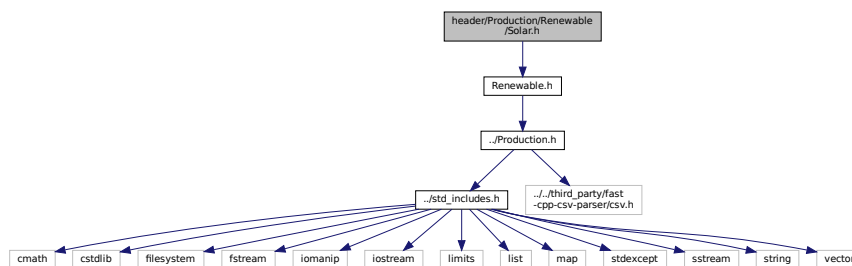
33     {
34     SOLAR,
35     TIDAL,
36     WAVE,
37     WIND,
38     N_RENEWABLE_TYPES
39 };

```

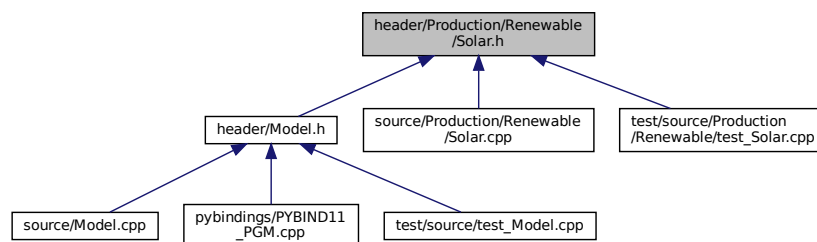
5.8 header/Production/Renewable/Solar.h File Reference

Header file 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.

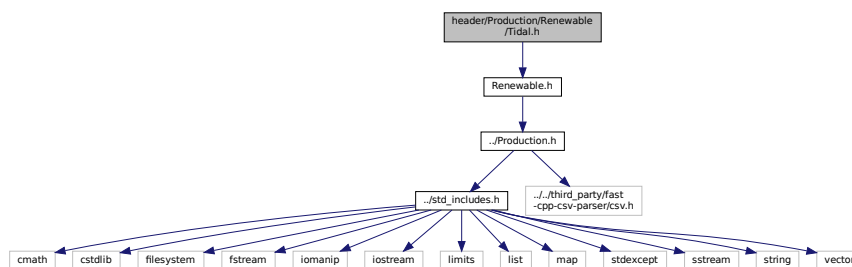
5.8.1 Detailed Description

Header file the [Solar](#) class.

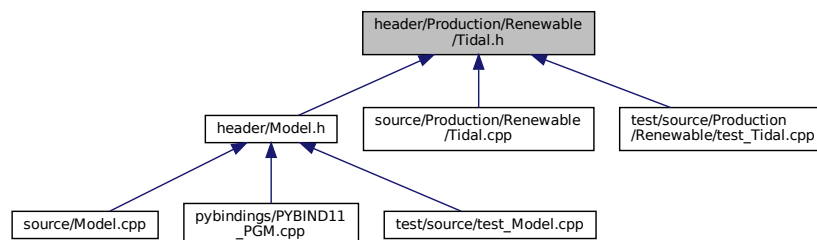
5.9 header/Production/Renewable/Tidal.h File Reference

Header file 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](#) }

5.9.1 Detailed Description

Header file the [Tidal](#) class.

5.9.2 Enumeration Type Documentation

5.9.2.1 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 };

```

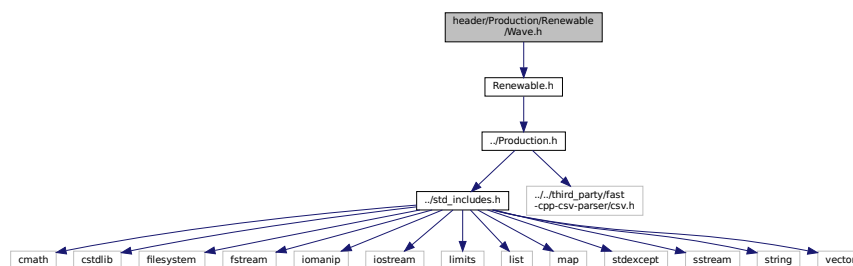
5.10 header/Production/Renewable/Wave.h File Reference

Header file the [Wave](#) class.

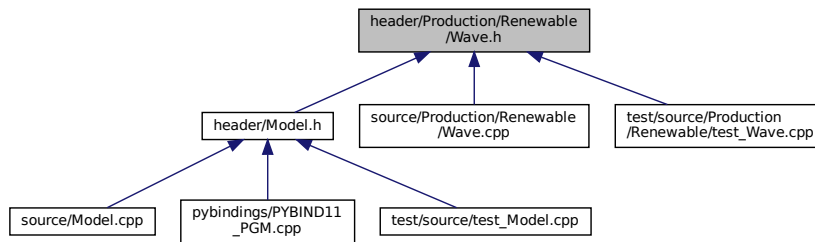
```

#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](#) }

5.10.1 Detailed Description

Header file the [Wave](#) class.

5.10.2 Enumeration Type Documentation

5.10.2.1 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 };

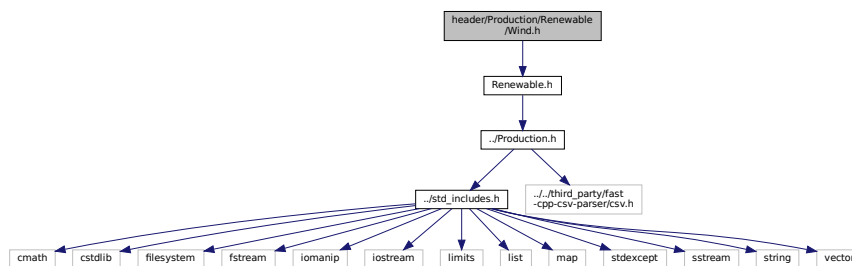
```

5.11 header/Production/Renewable/Wind.h File Reference

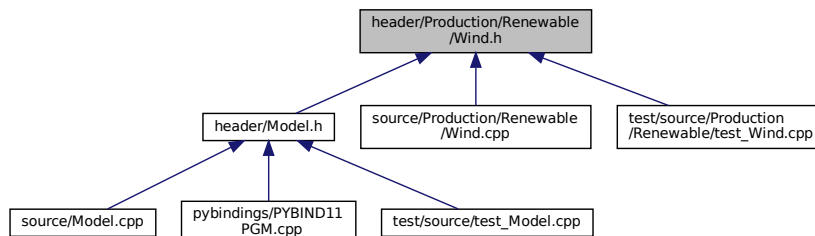
Header file the [Wind](#) class.

```
#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](#) }

5.11.1 Detailed Description

Header file the [Wind](#) class.

5.11.2 Enumeration Type Documentation

5.11.2.1 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     };

```

5.12 header/Resources.h File Reference

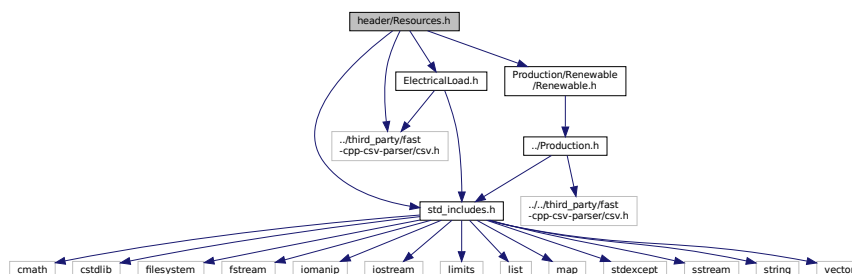
Header file the [Resources](#) class.

```

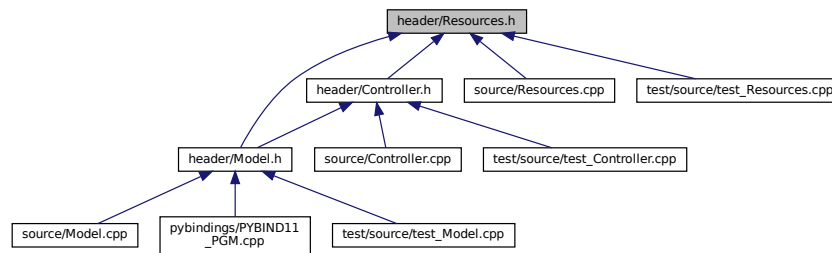
#include "std_includes.h"
#include "../third_party/fast-cpp-csv-parser/csv.h"
#include "ElectricalLoad.h"
#include "Production/Renewable/Renewable.h"

```

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](#).

5.12.1 Detailed Description

Header file the [Resources](#) class.

5.13 header/std_includes.h File Reference

Header file which simply batches together the usual, standard includes.

```

#include <cmath>
#include <cstdlib>
#include <filesystem>
#include <fstream>
#include <iomanip>
#include <iostream>
#include <limits>
#include <list>
#include <map>
#include <stdexcept>
#include <sstream>
#include <string>
#include <vector>
  
```

Include dependency graph for std_includes.h:



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



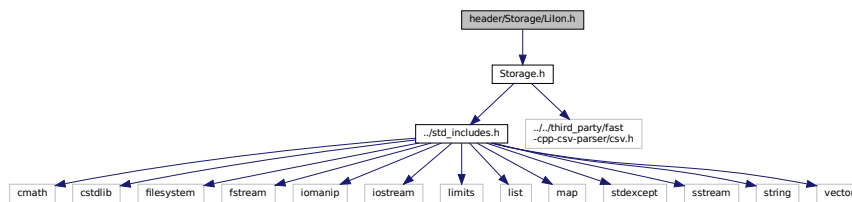
5.13.1 Detailed Description

Header file which simply batches together the usual, standard includes.

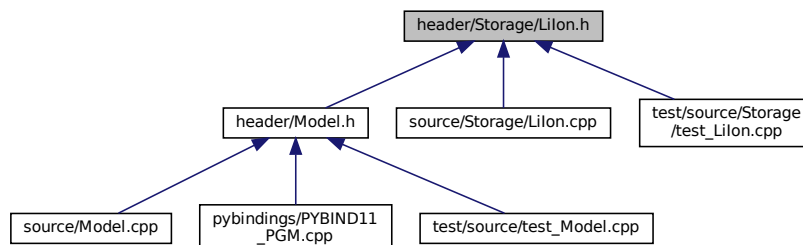
5.14 header/Storage/Lilon.h File Reference

Header file the [Lilon](#) class.

```
#include "Storage.h"
Include dependency graph for Lilon.h:
```



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.

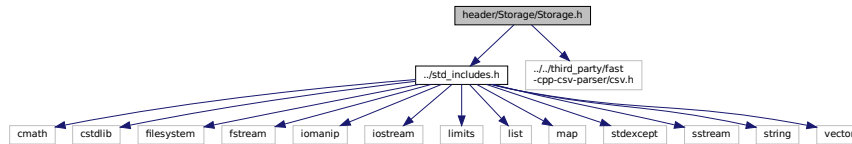
5.14.1 Detailed Description

Header file the [Lilon](#) class.

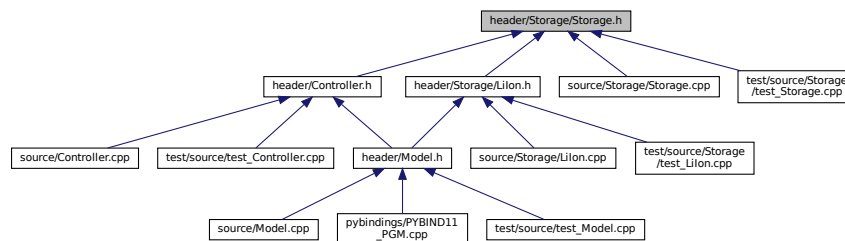
5.15 header/Storage/Storage.h File Reference

Header file the [Storage](#) class.

```
#include "../std_includes.h"
#include "../../third_party/fast-cpp-csv-parser/csv.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.

5.15.1 Detailed Description

Header file the [Storage](#) class.

5.15.2 Enumeration Type Documentation

5.15.2.1 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.

```

34         {
35     LIION,
36     N_STORAGE_TYPES
37 };

```

5.16 pybindings/PYBIND11_PGM.cpp File Reference

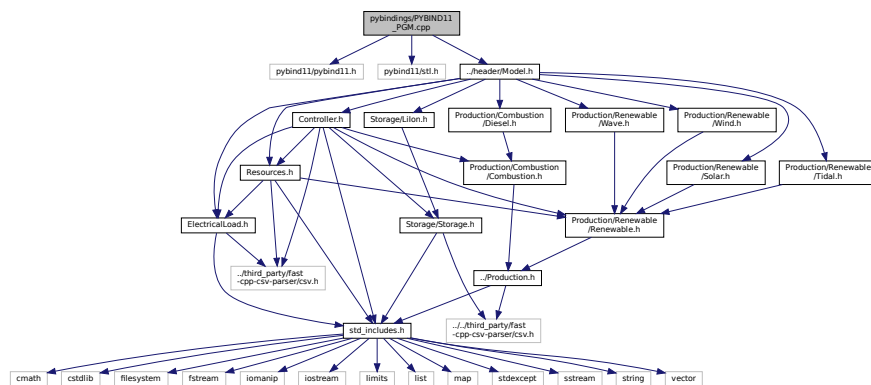
Python 3 bindings file for PGMcpp.

```

#include <pybind11/pybind11.h>
#include <pybind11/stl.h>
#include "../header/Model.h"

```

Include dependency graph for PYBIND11_PGM.cpp:



Functions

- [PYBIND11_MODULE](#) (PGMcpp, m)

5.16.1 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/>

5.16.2 Function Documentation

5.16.2.1 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() */

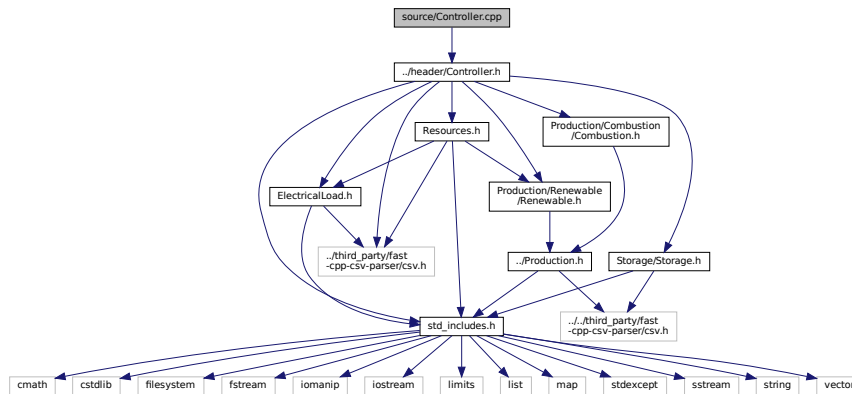
```

5.17 source/Controller.cpp File Reference

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


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

Include dependency graph for Controller.cpp:



5.17.1 Detailed Description

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

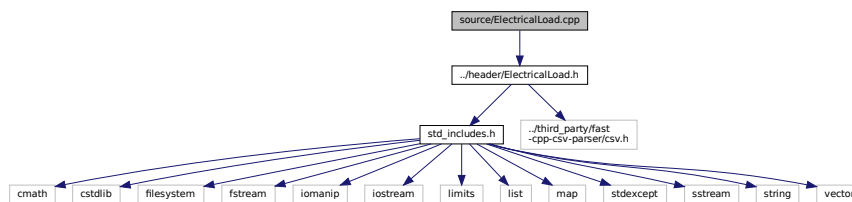
A class which contains a various dispatch control logic. Intended to serve as a component class of [Controller](#).

5.18 source/ElectricalLoad.cpp File Reference

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

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

Include dependency graph for ElectricalLoad.cpp:



5.18.1 Detailed Description

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

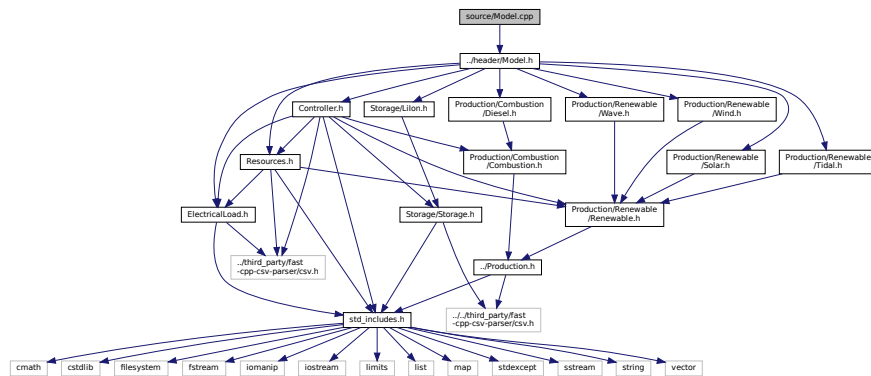
A class which contains time and electrical load data. Intended to serve as a component class of [Model](#).

5.19 source/Model.cpp File Reference

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

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

Include dependency graph for Model.cpp:



5.19.1 Detailed Description

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

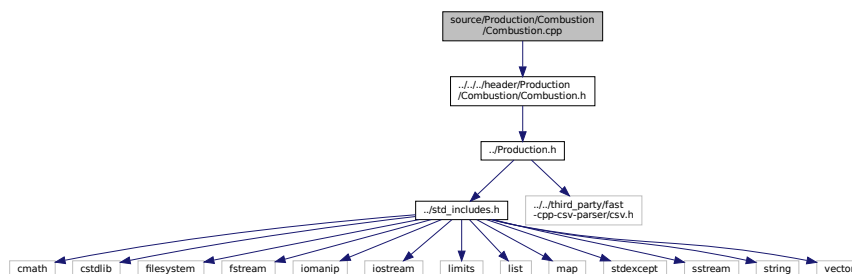
A container class which forms the centre of PGMcpp. The [Model](#) class is intended to serve as the primary user interface with the functionality of PGMcpp, and as such it contains all other classes.

5.20 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:



5.20.1 Detailed Description

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

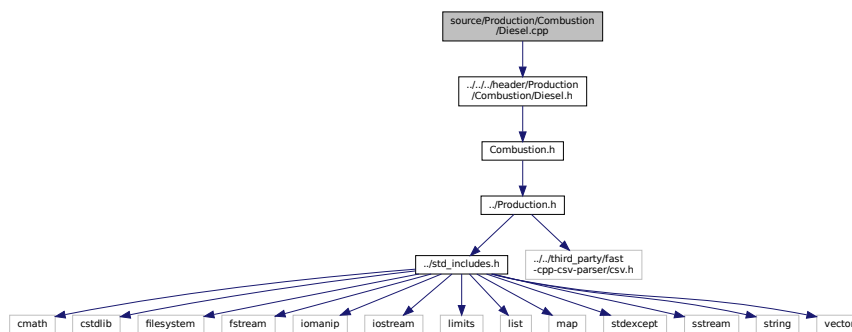
The root of the [Combustion](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the production of energy by way of combustibles.

5.21 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:



5.21.1 Detailed Description

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

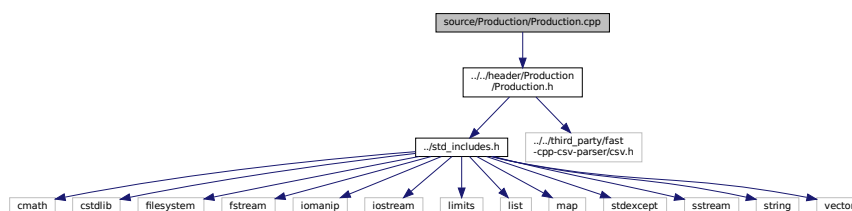
A derived class of the [Combustion](#) branch of [Production](#) which models production using a diesel generator.

5.22 source/Production/Production.cpp File Reference

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

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

Include dependency graph for Production.cpp:



5.22.1 Detailed Description

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

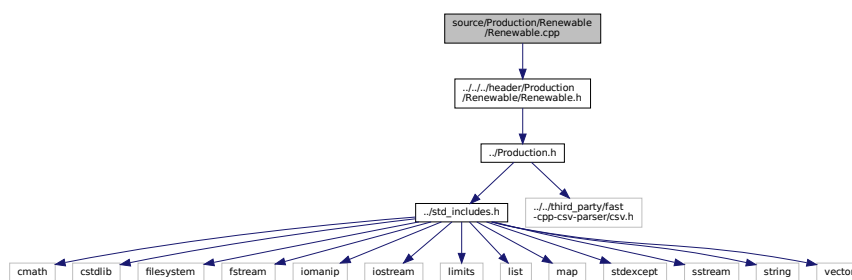
The base class of the [Production](#) hierarchy. This hierarchy contains derived classes which model the production of energy, be it renewable or otherwise.

5.23 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:



5.23.1 Detailed Description

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

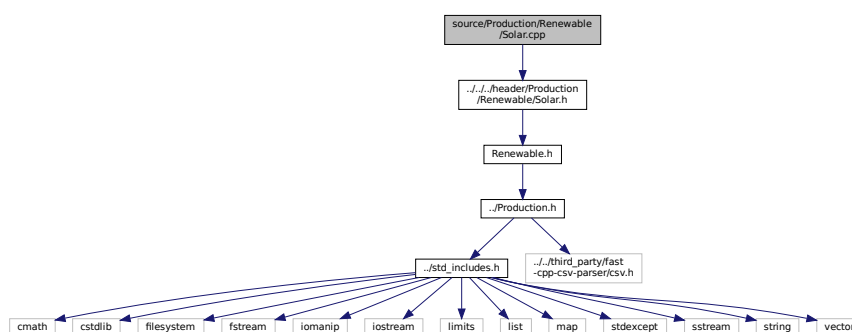
The root of the [Renewable](#) branch of the [Production](#) hierarchy. This branch contains derived classes which model the renewable production of energy.

5.24 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:



5.24.1 Detailed Description

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

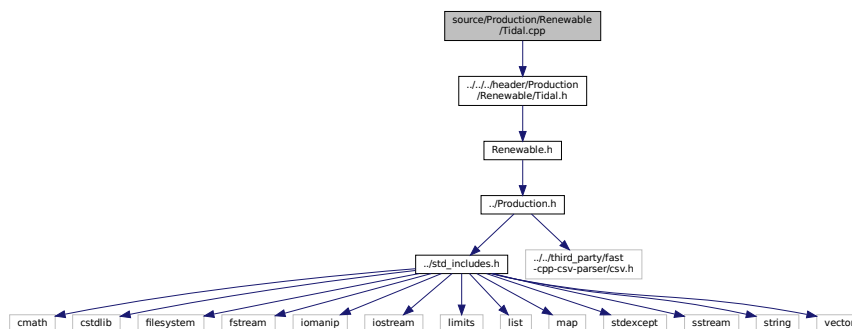
A derived class of the [Renewable](#) branch of [Production](#) which models solar production.

5.25 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:



5.25.1 Detailed Description

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

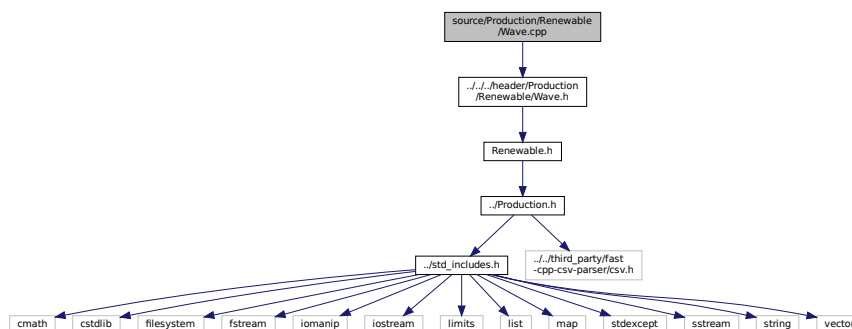
A derived class of the [Renewable](#) branch of [Production](#) which models tidal production.

5.26 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:



5.26.1 Detailed Description

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

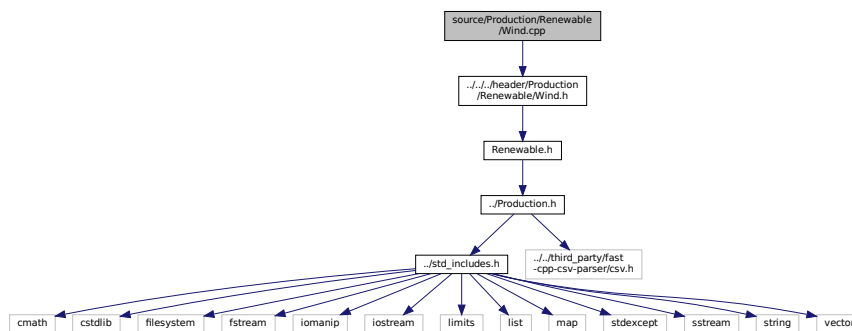
A derived class of the [Renewable](#) branch of [Production](#) which models wave production.

5.27 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:



5.27.1 Detailed Description

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

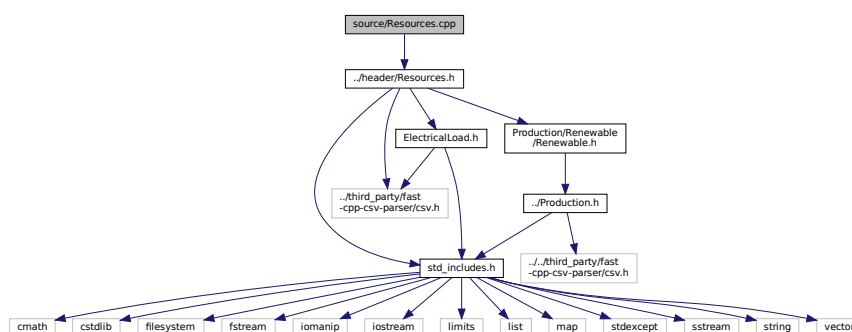
A derived class of the [Renewable](#) branch of [Production](#) which models wind production.

5.28 source/Resources.cpp File Reference

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

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

Include dependency graph for Resources.cpp:



5.28.1 Detailed Description

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

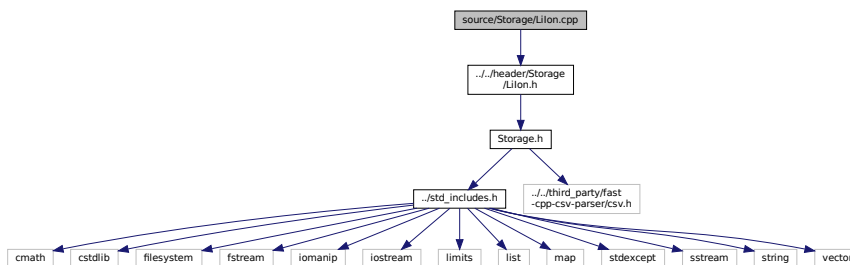
A class which contains renewable resource data. Intended to serve as a component class of [Model](#).

5.29 source/Storage/Lilon.cpp File Reference

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

```
#include "../..//header/Storage/LiIon.h"
```

Include dependency graph for Lilon.cpp:



5.29.1 Detailed Description

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

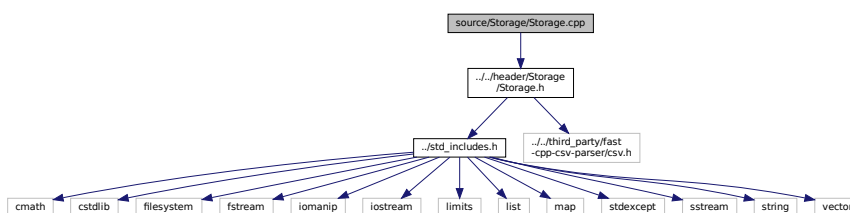
A derived class of [Storage](#) which models energy storage by way of lithium-ion batteries.

5.30 source/Storage/Storage.cpp File Reference

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

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

Include dependency graph for Storage.cpp:



5.30.1 Detailed Description

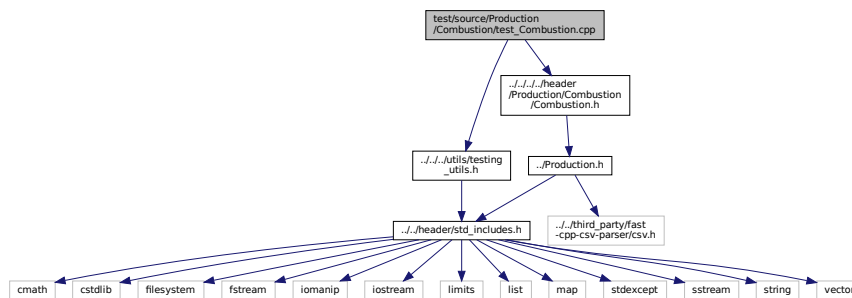
Implementation file for the [Storage](#) class.

The base class of the [Storage](#) hierarchy. This hierarchy contains derived classes which model the storage of energy.

5.31 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)

5.31.1 Detailed Description

Testing suite for [Combustion](#) class.

A suite of tests for the [Combustion](#) class.

5.31.2 Function Documentation

5.31.2.1 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() */

```

5.32 test/source/Production/Combustion/test_Diesel.cpp File Reference

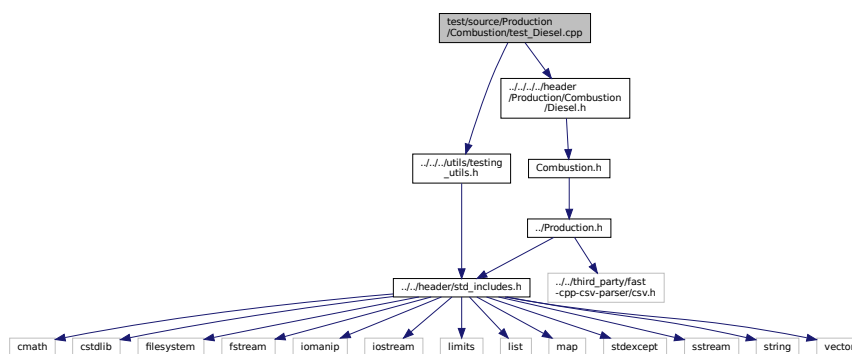
Testing suite for [Diesel](#) class.

```

#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)

5.32.1 Detailed Description

Testing suite for [Diesel](#) class.

A suite of tests for the [Diesel](#) class.

5.32.2 Function Documentation

5.32.2.1 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
59         DieselInputs diesel_inputs;
60
61         test_diesel_ptr = new Diesel(8760, 1, diesel_inputs);
62
63
64         // ===== END CONSTRUCTION ===== //
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() */

```

5.33 test/source/Production/Renewable/test_Renewable.cpp File Reference

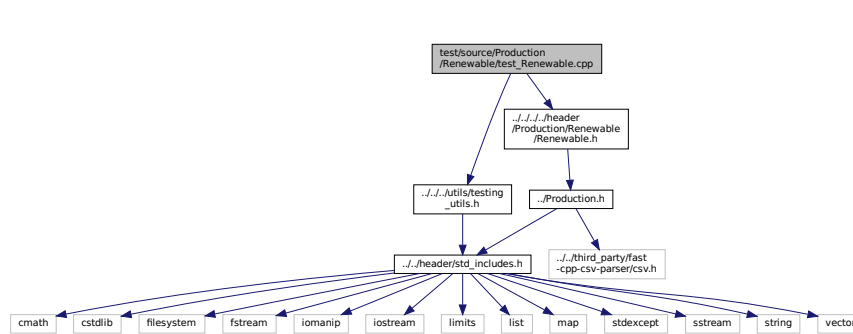
Testing suite for [Renewable](#) class.

```

#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)

5.33.1 Detailed Description

Testing suite for [Renewable](#) class.

A suite of tests for the [Renewable](#) 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 <-- 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     // ===== 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() */

```

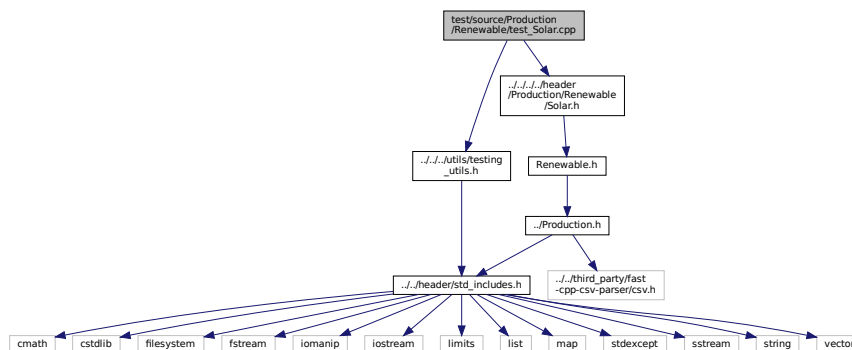
5.34 test/source/Production/Renewable/test_Solar.cpp File Reference

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)

5.34.1 Detailed Description

Testing suite for [Solar](#) class.

A suite of tests for the [Solar](#) 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 <-- 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() */

```

5.35 test/source/Production/Renewable/test_Tidal.cpp File Reference

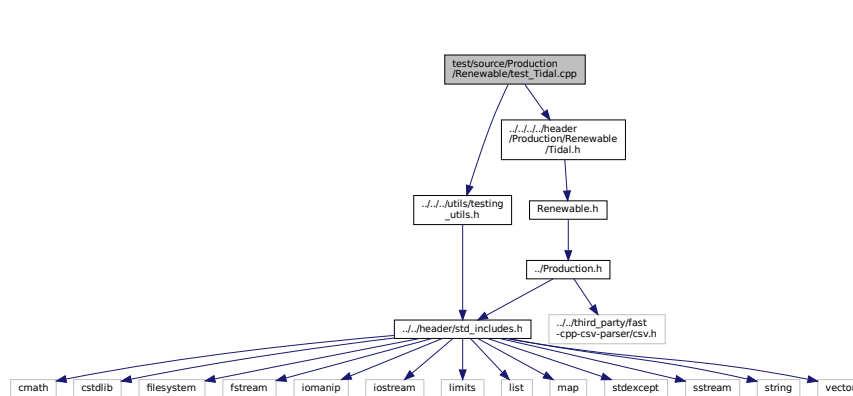
Testing suite for [Tidal](#) class.

```

#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)

5.35.1 Detailed Description

Testing suite for [Tidal](#) class.

A suite of tests for the [Tidal](#) 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 <-- 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 }

```

```

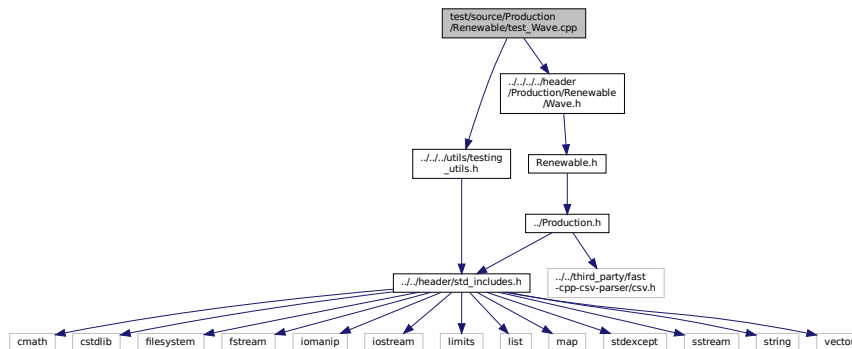
194     else {
195         testTruth(
196             not test_tidal_ptr->is_running,
197             __FILE__,
198             __LINE__
199         );
200     }
201
202     // load_kW <= load_vec_kW (i.e., after vs before)
203     testLessThanOrEqualTo(
204         load_kW,
205         load_vec_kW[i],
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() */

```

5.36 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)

5.36.1 Detailed Description

Testing suite for [Wave](#) class.

A suite of tests for the [Wave](#) 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 <-- 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 delete test_wave_ptr;
264
265 printGold(" ..... ");
266 printGreen("PASS");
267 std::cout << std::endl;
268 return 0;
269 } /* main() */

```

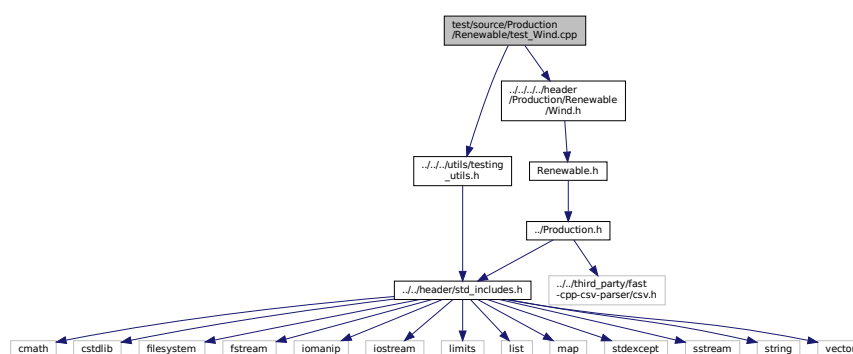
5.37 test/source/Production/Renewable/test_Wind.cpp File Reference

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)

5.37.1 Detailed Description

Testing suite for [Wind](#) class.

A suite of tests for the [Wind](#) 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 <-- 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() */

```

5.38 test/source/Production/test_Production.cpp File Reference

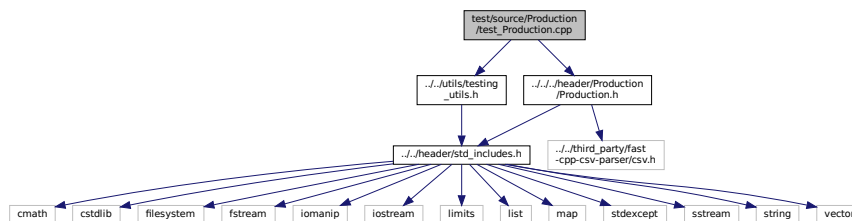
Testing suite for [Production](#) class.

```

#include "../utils/testing_utils.h"
#include "../../header/Production/Production.h"

```

Include dependency graph for test_Production.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.38.1 Detailed Description

Testing suite for [Production](#) class.

A suite of tests for the [Production](#) 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("\n\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 catch (...) {
154     //...
155
156     printGold(" ..... ");
157     printRed("FAIL");
158     std::cout << std::endl;
159     throw;
160 }
161
162
163
164 printGold(" ..... ");
165 printGreen("PASS");
166 std::cout << std::endl;
167 return 0;
168
169 } /* main() */

```

5.39 test/source/Storage/test_Lilon.cpp File Reference

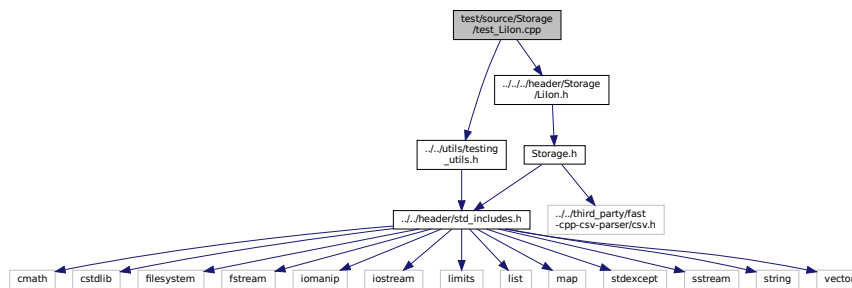
Testing suite for [Lilon](#) class.

```

#include "../utils/testing_utils.h"
#include "../header/Storage/LiIon.h"

```

Include dependency graph for test_Lilon.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.39.1 Detailed Description

Testing suite for [Lilon](#) class.

A suite of tests for the [Lilon](#) class.

5.39.2 Function Documentation

5.39.2.1 main()

```

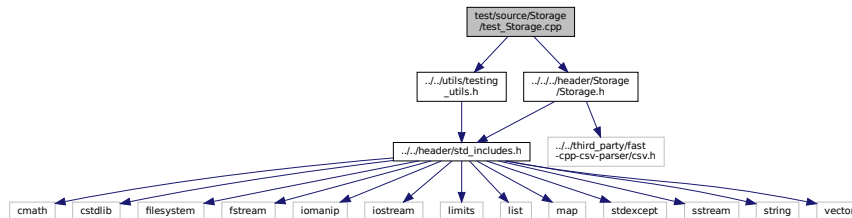
int main (
    int argc,
    char ** argv )
27 {
28     #ifdef _WIN32
29         activateVirtualTerminal();
30     #endif /* _WIN32 */
31
32     printGold("\tTesting Storage <-- LiIon");
33
34     srand(time(NULL));
35
36
37     try {
38         //...
39     }
40
41     catch (...) {
42         //...
43
44         printGold(" ..... ");
45         printRed("FAIL");
46         std::cout << std::endl;
47         throw;
48     }
49
50
51     printGold(" ..... ");
52     printGreen("PASS");
53     std::cout << std::endl;
54     return 0;
55 } /* main() */

```

5.40 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)

5.40.1 Detailed Description

Testing suite for [Storage](#) class.

A suite of tests for the [Storage](#) class.

5.40.2 Function Documentation

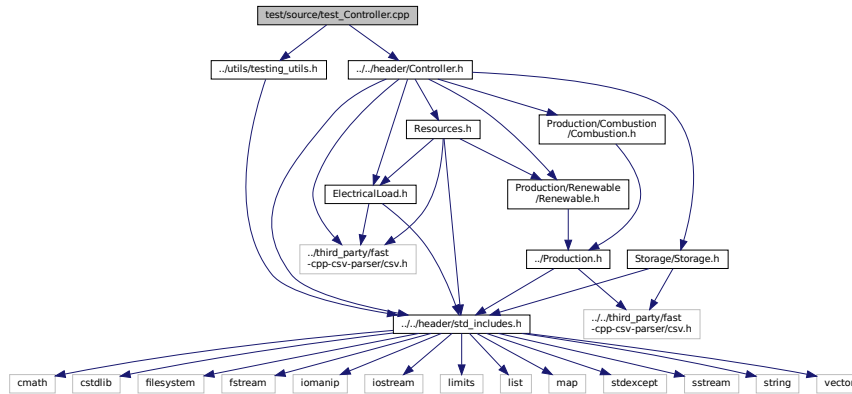
5.40.2.1 main()

```
int main (
    int argc,
    char ** argv )
{
    27 {
    28     #ifdef _WIN32
    29         activateVirtualTerminal();
    30     #endif /* _WIN32 */
    31
    32     printGold("\tTesting Storage");
    33
    34     srand(time(NULL));
    35
    36
    37     try {
    38         //...
    39     }
    40
    41     catch (...) {
    42         //...
    43
    44         printGold(" ..... ");
    45         printRed("FAIL");
    46         std::cout << std::endl;
    47         throw;
    48     }
    49
    50
    51     printGold(" ..... ");
    52     printGreen("PASS");
    53     std::cout << std::endl;
    54     return 0;
    55 } /* main() */
```

5.41 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)

5.41.1 Detailed Description

Testing suite for [Controller](#) class.

A suite of tests for the [Controller](#) 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 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() */

```

5.42 test/source/test_ElectricalLoad.cpp File Reference

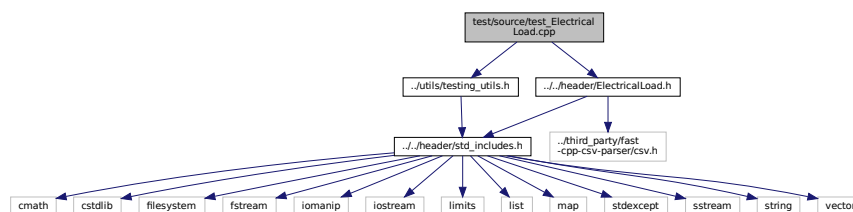
Testing suite for [ElectricalLoad](#) class.

```

#include "../utils/testing_utils.h"
#include "../..header/ElectricalLoad.h"

```

Include dependency graph for test_ElectricalLoad.cpp:



Functions

- int [main](#) (int argc, char **argv)

5.42.1 Detailed Description

Testing suite for [ElectricalLoad](#) class.

A suite of tests for the [ElectricalLoad](#) 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 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_generic_peak-500kW_1yr_dt-1hr.csv";
43
44         ElectricalLoad test_electrical_load(path_2_electrical_load_time_series);
45
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 (...) {

```



```

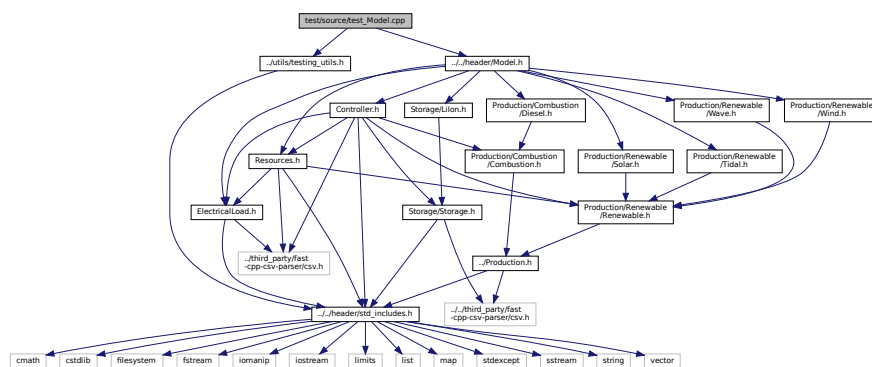
185 //...
186
187 printGold(" ..... ");
188 printRed("FAIL");
189 std::cout << std::endl;
190 throw;
191 }
192
193
194 printGold(" ..... ");
195 printGreen("PASS");
196 std::cout << std::endl;
197 return 0;
198 } /* main() */

```

5.43 test/source/test_Model.cpp File Reference

Testing suite for `Model` class.

```
#include "../utils/testing_utils.h"
#include "../..//header/Model.h"
Include dependency graph for test_Model.cpp:
```



Functions

- int **main** (int argc, char **argv)

5.43.1 Detailed Description

Testing suite for `Model` class.

A suite of tests for the [Model](#) 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 Model");
33
34     srand(time(NULL));
35
36
37     try {
38
39         // ===== CONSTRUCTION ===== //
40
41         bool error_flag = true;
42
43         try {
44             ModelInputs bad_model_inputs;
45             bad_model_inputs.path_2_electrical_load_time_series =
46                 "data/test/bad_path_240984069830.csv";
47
48             Model bad_model(bad_model_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         std::string path_2_electrical_load_time_series =
59             "data/test/electrical_load_generic_peak-500kW_1yr_dt-1hr.csv";
60
61         ModelInputs test_model_inputs;
62         test_model_inputs.path_2_electrical_load_time_series =
63             path_2_electrical_load_time_series;
64
65         Model test_model(test_model_inputs);
66
67         // ===== END CONSTRUCTION ===== //
68
69
70         // ===== ATTRIBUTES ===== //
71
72         testTruth(
73             test_model.electrical_load.path_2_electrical_load_time_series ==
74             path_2_electrical_load_time_series,
75             __FILE__,
76             __LINE__
77 );
78
79         testFloatEquals(
80             test_model.electrical_load.n_points,
81             8760,
82             __FILE__,
83             __LINE__
84 );
85
86         testFloatEquals(
87             test_model.electrical_load.n_years,
88             0.999886,
89             __FILE__,
90             __LINE__
91 );
92
93         testFloatEquals(
94             test_model.electrical_load.min_load_kW,
95             82.1211213927802,
96             __FILE__,
97             __LINE__
98 );
99
100        testFloatEquals(
101            test_model.electrical_load.mean_load_kW,
102            258.373472633202,
103            __FILE__,
104            __LINE__
105 );
106

```

```

107
108 testFloatEquals(
109     test_model.electrical_load.max_load_kW,
110     500,
111     __FILE__,
112     __LINE__
113 );
114
115
116 std::vector<double> expected_dt_vec_hrs (48, 1);
117
118 std::vector<double> expected_time_vec_hrs = {
119     0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11,
120     12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
121     24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35,
122     36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47
123 };
124
125 std::vector<double> expected_load_vec_kW = {
126     360.253836463674,
127     355.171277826775,
128     353.776453532298,
129     353.75405737934,
130     346.592867404975,
131     340.132411175118,
132     337.354867340578,
133     340.644115618736,
134     363.639028500678,
135     378.787797779238,
136     372.215798201712,
137     395.093925731298,
138     402.325427142659,
139     386.907725462306,
140     380.709170928091,
141     372.062070914977,
142     372.328646856954,
143     391.841444284136,
144     394.029351759596,
145     383.369407765254,
146     381.093099675206,
147     382.604158946193,
148     390.744843709034,
149     383.13949492437,
150     368.150393976985,
151     364.629744480226,
152     363.572736804082,
153     359.854924202248,
154     355.207590170267,
155     349.094656012401,
156     354.365935871597,
157     343.380608328546,
158     404.673065729266,
159     486.296896820126,
160     480.225974100847,
161     457.318764401085,
162     418.177339948609,
163     414.399018364126,
164     409.678420185754,
165     404.768766016563,
166     401.699589920585,
167     402.44339040654,
168     398.138372541906,
169     396.010498627646,
170     390.165117432277,
171     375.850429417013,
172     365.567100746484,
173     365.429624610923
174 };
175
176 for (int i = 0; i < 48; i++) {
177     testFloatEquals(
178         test_model.electrical_load.dt_vec_hrs[i],
179         expected_dt_vec_hrs[i],
180         __FILE__,
181         __LINE__
182     );
183
184     testFloatEquals(
185         test_model.electrical_load.time_vec_hrs[i],
186         expected_time_vec_hrs[i],
187         __FILE__,
188         __LINE__
189     );
190
191     testFloatEquals(
192         test_model.electrical_load.load_vec_kW[i],
193         expected_load_vec_kW[i],

```

```

194     __FILE__,
195     __LINE__
196 );
197 }
198
199 // ===== END ATTRIBUTES ===== //
200
201
202
203 // ===== METHODS ===== //
204
205 // add Solar resource
206 int solar_resource_key = 0;
207 std::string path_2_solar_resource_data =
208     "data/test/solar_GHI_peak-1kWm2_1yr_dt-1hr.csv";
209
210 test_model.addResource(
211     RenewableType :: SOLAR,
212     path_2_solar_resource_data,
213     solar_resource_key
214 );
215
216 std::vector<double> expected_solar_resource_vec_kWm2 = {
217     0,
218     0,
219     0,
220     0,
221     0,
222     0,
223     8.51702662684015E-05,
224     0.000348341567045,
225     0.00213793728593,
226     0.004099863613322,
227     0.000997135230553,
228     0.009534527624657,
229     0.022927996790616,
230     0.0136071715294,
231     0.002535134127751,
232     0.005206897515821,
233     0.005627658648597,
234     0.000701186722215,
235     0.00017119827089,
236     0,
237     0,
238     0,
239     0,
240     0,
241     0,
242     0,
243     0,
244     0,
245     0,
246     0,
247     0,
248     0.000141055102242,
249     0.00084525014743,
250     0.024893647822702,
251     0.091245556190749,
252     0.158722176731637,
253     0.152859680515876,
254     0.149922903895116,
255     0.13049996570866,
256     0.03081254222795,
257     0.001218928911125,
258     0.000206092647423,
259     0,
260     0,
261     0,
262     0,
263     0,
264     0
265 };
266
267 for (size_t i = 0; i < expected_solar_resource_vec_kWm2.size(); i++) {
268     testFloatEquals(
269         test_model.resources.resource_map_1D[solar_resource_key][i],
270         expected_solar_resource_vec_kWm2[i],
271         __FILE__,
272         __LINE__
273     );
274 }
275
276
277 // add Tidal resource
278 int tidal_resource_key = 1;
279 std::string path_2_tidal_resource_data =
280     "data/test/tidal_speed_peak-3ms_1yr_dt-1hr.csv";

```

```

281
282 test_model.addResource(
283     RenewableType :: TIDAL,
284     path_2_tidal_resource_data,
285     tidal_resource_key
286 );
287
288
289 // add Wave resource
290 int wave_resource_key = 2;
291 std::string path_2_wave_resource_data =
292     "data/test/waves_H_s_peak-8m_T_e_peak-15s_lyr_dt-1hr.csv";
293
294 test_model.addResource(
295     RenewableType :: WAVE,
296     path_2_wave_resource_data,
297     wave_resource_key
298 );
299
300
301 // add Wind resource
302 int wind_resource_key = 3;
303 std::string path_2_wind_resource_data =
304     "data/test/wind_speed_peak-25ms_lyr_dt-1hr.csv";
305
306 test_model.addResource(
307     RenewableType :: WIND,
308     path_2_wind_resource_data,
309     wind_resource_key
310 );
311
312
313 // add Diesel assets
314 DieselInputs diesel_inputs;
315 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 100;
316 diesel_inputs.combustion_inputs.production_inputs.is_sunk = true;
317
318 test_model.addDiesel(diesel_inputs);
319
320 testFloatEquals(
321     test_model.combustion_ptr_vec.size(),
322     1,
323     __FILE__,
324     __LINE__
325 );
326
327 testFloatEquals(
328     test_model.combustion_ptr_vec[0]->type,
329     CombustionType :: DIESEL,
330     __FILE__,
331     __LINE__
332 );
333
334 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 150;
335
336 test_model.addDiesel(diesel_inputs);
337
338 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 250;
339
340 test_model.addDiesel(diesel_inputs);
341
342 testFloatEquals(
343     test_model.combustion_ptr_vec.size(),
344     3,
345     __FILE__,
346     __LINE__
347 );
348
349 std::vector<int> expected_diesel_capacity_vec_kW = {100, 150, 250};
350
351 for (int i = 0; i < 3; i++) {
352     testFloatEquals(
353         test_model.combustion_ptr_vec[i]->capacity_kW,
354         expected_diesel_capacity_vec_kW[i],
355         __FILE__,
356         __LINE__
357     );
358 }
359
360 diesel_inputs.combustion_inputs.production_inputs.capacity_kW = 100;
361
362 for (int i = 0; i < 2 * ((double)rand() / RAND_MAX); i++) {
363     test_model.addDiesel(diesel_inputs);
364 }
365
366
367 // add Solar asset

```

```
368 SolarInputs solar_inputs;
369 solar_inputs.resource_key = solar_resource_key;
370
371 test_model.addSolar(solar_inputs);
372
373 testFloatEquals(
374     test_model.renewable_ptr_vec.size(),
375     1,
376     __FILE__,
377     __LINE__
378 );
379
380 testFloatEquals(
381     test_model.renewable_ptr_vec[0]->type,
382     RenewableType :: SOLAR,
383     __FILE__,
384     __LINE__
385 );
386
387
388 // add Tidal asset
389 TidalInputs tidal_inputs;
390 tidal_inputs.resource_key = tidal_resource_key;
391
392 test_model.addTidal(tidal_inputs);
393
394 testFloatEquals(
395     test_model.renewable_ptr_vec.size(),
396     2,
397     __FILE__,
398     __LINE__
399 );
400
401 testFloatEquals(
402     test_model.renewable_ptr_vec[1]->type,
403     RenewableType :: TIDAL,
404     __FILE__,
405     __LINE__
406 );
407
408
409 // add Wave asset
410 WaveInputs wave_inputs;
411 wave_inputs.resource_key = wave_resource_key;
412
413 test_model.addWave(wave_inputs);
414
415 testFloatEquals(
416     test_model.renewable_ptr_vec.size(),
417     3,
418     __FILE__,
419     __LINE__
420 );
421
422 testFloatEquals(
423     test_model.renewable_ptr_vec[2]->type,
424     RenewableType :: WAVE,
425     __FILE__,
426     __LINE__
427 );
428
429
430 // add Wind asset
431 WindInputs wind_inputs;
432 wind_inputs.resource_key = wind_resource_key;
433
434 test_model.addWind(wind_inputs);
435
436 testFloatEquals(
437     test_model.renewable_ptr_vec.size(),
438     4,
439     __FILE__,
440     __LINE__
441 );
442
443 testFloatEquals(
444     test_model.renewable_ptr_vec[3]->type,
445     RenewableType :: WIND,
446     __FILE__,
447     __LINE__
448 );
449
450
451 // run
452 test_model.run();
453
454
```

```

455 // write results
456 test_model.writeResults("test/test_results/");
457
458
459 // test post-run attributes
460 for (int i = 0; i < test_model.electrical_load.n_points; i++) {
461     testLessThanOrEqualTo(
462         test_model.controller.net_load_vec_kW[i],
463         test_model.electrical_load.max_load_kW,
464         __FILE__,
465         __LINE__
466     );
467 }
468
469 testGreaterThan(
470     test_model.net_present_cost,
471     0,
472     __FILE__,
473     __LINE__
474 );
475
476 testFloatEquals(
477     test_model.total_dispatch_discharge_kWh,
478     2263351.62026685,
479     __FILE__,
480     __LINE__
481 );
482
483 testGreaterThan(
484     test_model.levellized_cost_of_energy_kWh,
485     0,
486     __FILE__,
487     __LINE__
488 );
489
490 testGreaterThan(
491     test_model.total_fuel_consumed_L,
492     0,
493     __FILE__,
494     __LINE__
495 );
496
497 testGreaterThan(
498     test_model.total_emissions.CO2_kg,
499     0,
500     __FILE__,
501     __LINE__
502 );
503
504 testGreaterThan(
505     test_model.total_emissions.CO_kg,
506     0,
507     __FILE__,
508     __LINE__
509 );
510
511 testGreaterThan(
512     test_model.total_emissions.NOx_kg,
513     0,
514     __FILE__,
515     __LINE__
516 );
517
518 testGreaterThan(
519     test_model.total_emissions.SOx_kg,
520     0,
521     __FILE__,
522     __LINE__
523 );
524
525 testGreaterThan(
526     test_model.total_emissions.CH4_kg,
527     0,
528     __FILE__,
529     __LINE__
530 );
531
532 testGreaterThan(
533     test_model.total_emissions.PM_kg,
534     0,
535     __FILE__,
536     __LINE__
537 );
538
539 // ===== END METHODS ===== //
540
541 } /* try */

```

```

542
543
544 catch (...) {
545     //...
546
547     printGold(" ..... ");
548     printRed("FAIL");
549     std::cout << std::endl;
550     throw;
551 }
552
553
554 printGold(" ..... ");
555 printGreen("PASS");
556 std::cout << std::endl;
557 return 0;
558 } /* main() */

```

5.44 test/source/test_Resources.cpp File Reference

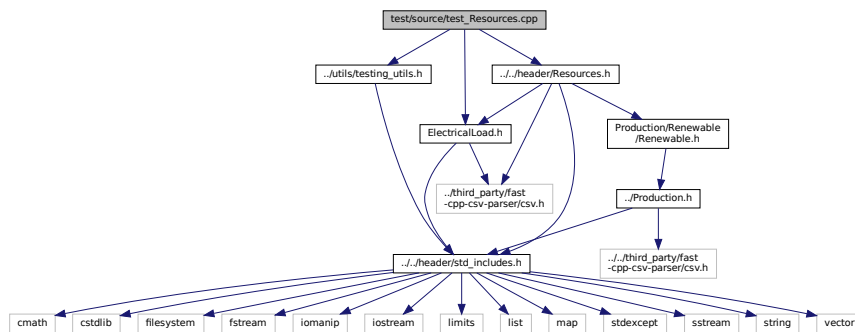
Testing suite for [Resources](#) class.

```

#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)

5.44.1 Detailed Description

Testing suite for [Resources](#) class.

A suite of tests for the [Resources](#) class.

5.44.2 Function Documentation

5.44.2.1 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_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/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/solar_GHI_peak-1kWm2_lyr_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/solar_GHI_peak-1kWm2_lyr_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/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/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/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() */

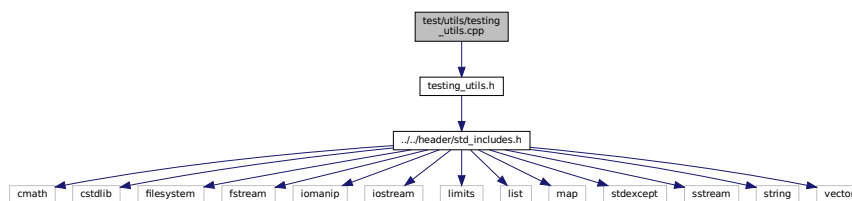
```

5.45 test/utis/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.

5.45.1 Detailed Description

Header file for various PGMcpp testing utilities.

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

5.45.2 Function Documentation

5.45.2.1 `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 " <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> ").

```
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() */
```

5.45.2.2 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() */
```

5.45.2.3 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() */
```

5.45.2.4 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() */

```

5.45.2.5 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() */

```

5.45.2.6 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() */

```

5.45.2.7 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() */

```

5.45.2.8 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() */

```

5.45.2.9 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() */

```

5.45.2.10 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() */

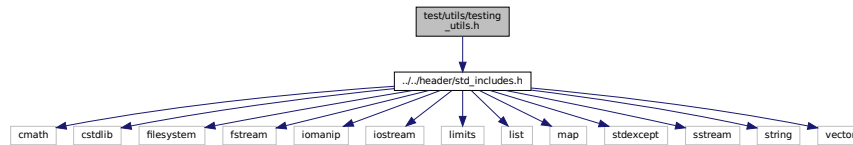
```

5.46 test/utils/testing_utils.h File Reference

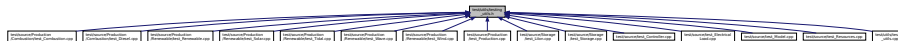
Header file for various PGMcpp testing utilities.

```
#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* >= *y*.
- void `testLessThan` (double, double, std::string, int)
Tests if *x* < *y*.
- void `testLessThanOrEqualTo` (double, double, std::string, int)
Tests if *x* <= *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.

5.46.1 Detailed Description

Header file for various PGMcpp testing utilities.

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

5.46.2 Macro Definition Documentation

5.46.2.1 FLOAT_TOLERANCE

```
#define FLOAT_TOLERANCE 1e-6
```

A tolerance for application to floating point equality tests.

5.46.3 Function Documentation

5.46.3.1 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() */
```

5.46.3.2 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() */

```

5.46.3.3 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() */

```

5.46.3.4 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() */

```

5.46.3.5 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() */

```

5.46.3.6 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() */

```

5.46.3.7 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() */

```

5.46.3.8 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() */

```

5.46.3.9 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() */

```

5.46.3.10 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() */
```


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