

## Road To Zero - The Microgrid Management Game

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# Chapter 1

## Hierarchical Index

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# Class Index

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<a href="#">EnergyStorageSystem</a>	A settlement class (child class of <a href="#">TileImprovement</a> ) . . . . .	52
<a href="#">Game</a>	A class which acts as the central class for the game, by containing all other classes and implementing the game loop . . . . .	60
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<a href="#">HexTile</a>	A class which defines a hex tile of the hex map . . . . .	123
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source/ <a href="#">SolarPV.cpp</a>	Implementation file for the <a href="#">SolarPV</a> class . . . . .	350
source/ <a href="#">TidalTurbine.cpp</a>	Implementation file for the <a href="#">TidalTurbine</a> class . . . . .	350
source/ <a href="#">TileImprovement.cpp</a>	Implementation file for the <a href="#">TileImprovement</a> class . . . . .	351
source/ <a href="#">WaveEnergyConverter.cpp</a>	Implementation file for the <a href="#">WaveEnergyConverter</a> class . . . . .	351
source/ <a href="#">WindTurbine.cpp</a>	Implementation file for the <a href="#">WindTurbine</a> class . . . . .	352
source/ESC_core/ <a href="#">AssetsManager.cpp</a>	Implementation file for the <a href="#">AssetsManager</a> class . . . . .	329
source/ESC_core/ <a href="#">MessageHub.cpp</a>	Implementation file for the <a href="#">MessageHub</a> class . . . . .	329
source/ESC_core/ <a href="#">testing_utils.cpp</a>	Implementation file for various testing utilities . . . . .	330

## Chapter 4

# Class Documentation

### 4.1 AssetsManager Class Reference

A class which manages visual and sound assets.

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

#### Public Member Functions

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

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

## Public Attributes

- std::map< std::string, sf::Font \* > [font\\_map](#)  
*A map of pointers to loaded fonts.*
- std::map< std::string, sf::Texture \* > [texture\\_map](#)  
*A map of pointers to loaded textures.*
- std::map< std::string, sf::SoundBuffer \* > [soundbuffer\\_map](#)  
*A map of pointers to sound buffers.*
- std::map< std::string, sf::Sound \* > [sound\\_map](#)  
*A map of pointers to loaded sounds.*
- std::map< std::string, sf::Music \* >::iterator [current\\_track](#)  
*A map iterator which corresponds to the current track (i.e., the track currently being played).*
- std::map< std::string, sf::Music \* > [track\\_map](#)  
*A map of pointers to opened tracks (i.e. sf::Music).*

## Private Member Functions

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

### 4.1.1 Detailed Description

A class which manages visual and sound assets.

### 4.1.2 Constructor & Destructor Documentation

#### 4.1.2.1 AssetsManager()

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

Constructor for the [AssetsManager](#) class.

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

### 4.1.2.2 ~AssetsManager()

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

Destructor for the [AssetsManager](#) class.

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

## 4.1.3 Member Function Documentation

### 4.1.3.1 \_\_loadSoundBuffer()

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

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

#### Parameters

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

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

```

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

```

#### 4.1.3.2 clear()

```

void AssetsManager::clear (
    void )

```

Method to clear all loaded assets.

```

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

```



```

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

```

#### 4.1.3.3 getCurrentTrackKey()

```

std::string AssetsManager::getCurrentTrackKey (
    void )

```

Method to get track key for current track.

##### Returns

The track key for the current track.

```

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

```

#### 4.1.3.4 getFont()

```

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

```

Method to get font associated with given font key.

##### Parameters

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

##### Returns

A pointer to the corresponding font.

```

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

```

```

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

```

#### 4.1.3.5 getSound()

```

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

```

Method to get sound associated with given sound key.

##### Parameters

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

##### Returns

A pointer to the corresponding sound.

```

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

```

#### 4.1.3.6 getSoundBuffer()

```

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

```

Method to get soundbuffer associated with given sound key.

##### Parameters

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

**Returns**

A pointer to the corresponding soundbuffer.

```

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

```

**4.1.3.7 getTexture()**

```

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

```

Method to get texture associated with given texture key.

**Parameters**

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

**Returns**

A pointer to the corresponding texture.

```

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

```

**4.1.3.8 getTrackStatus()**

```

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

```

Method to get the status of the current track.

## Returns

The status of the current track.

```

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

```

### 4.1.3.9 loadFont()

```

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

```

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

#### Parameters

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

```

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

```

### 4.1.3.10 loadSound()

```

void AssetsManager::loadSound (

```

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

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

#### Parameters

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

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

#### 4.1.3.11 loadTexture()

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

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

#### Parameters

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

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

```

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

```

#### 4.1.3.12 loadTrack()

```

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

```

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

##### Parameters

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

```

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

```

#### 4.1.3.13 nextTrack()

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

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

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

#### 4.1.3.14 pauseTrack()

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

Method to pause the current track.

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

#### 4.1.3.15 playTrack()

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

Method to play the current track.

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

#### 4.1.3.16 previousTrack()

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

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

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

#### 4.1.3.17 stopTrack()

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

Method to stop the current track.

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

### 4.1.4 Member Data Documentation

#### 4.1.4.1 current\_track

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

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

#### 4.1.4.2 font\_map

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

A map of pointers to loaded fonts.

#### 4.1.4.3 sound\_map

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

A map of pointers to loaded sounds.

#### 4.1.4.4 soundbuffer\_map

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

A map of pointers to sound buffers.



#### 4.1.4.5 texture\_map

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

A map of pointers to loaded textures.

#### 4.1.4.6 track\_map

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

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

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

- header/ESC\_core/[AssetsManager.h](#)
- source/ESC\_core/[AssetsManager.cpp](#)

## 4.2 ContextMenu Class Reference

A class which defines a context menu for the game.

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

Collaboration diagram for ContextMenu:



### Public Member Functions

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

## Public Attributes

- [ConsoleState console\\_state](#)  
*The current state of the console screen.*
- bool [console\\_string\\_changed](#)  
*Boolean which indicates if console string just changed.*
- bool [game\\_menu\\_up](#)  
*Indicates whether or not the game menu is up.*
- size\_t [console\\_substring\\_idx](#)  
*The current final index of the console string draw.*
- unsigned long long int [frame](#)  
*The current frame of this object.*
- double [position\\_x](#)  
*The position of the object.*
- double [position\\_y](#)  
*The position of the object.*
- std::string [console\\_string](#)  
*The string to be printed to the console screen.*
- sf::RectangleShape [menu\\_frame](#)  
*The frame of the context menu.*
- sf::RectangleShape [visual\\_screen](#)  
*The context menu screen for visuals.*
- sf::ConvexShape [visual\\_screen\\_frame\\_top](#)  
*The top framing of the visual screen.*
- sf::ConvexShape [visual\\_screen\\_frame\\_left](#)  
*The left framing of the visual screen.*
- sf::ConvexShape [visual\\_screen\\_frame\\_bottom](#)  
*The bottom framing of the visual screen.*
- sf::ConvexShape [visual\\_screen\\_frame\\_right](#)  
*The right framing of the visual screen.*
- sf::RectangleShape [console\\_screen](#)  
*The context menu console screen (for animated text output).*
- sf::ConvexShape [console\\_screen\\_frame\\_top](#)  
*The top framing of the console screen.*
- sf::ConvexShape [console\\_screen\\_frame\\_left](#)  
*The left framing of the console screen.*
- sf::ConvexShape [console\\_screen\\_frame\\_bottom](#)  
*The bottom framing of the console screen.*
- sf::ConvexShape [console\\_screen\\_frame\\_right](#)  
*The right framing of the console screen.*

## Private Member Functions

- void [\\_\\_setUpMenuFrame](#) (void)  
*Helper method to set up context menu frame (drawable).*
- void [\\_\\_setUpVisualScreen](#) (void)  
*Helper method to set up context menu visual screen (drawable).*
- void [\\_\\_setUpVisualScreenFrame](#) (void)  
*Helper method to set up framing for context menu visual screen (drawable).*
- void [\\_\\_drawVisualScreenFrame](#) (void)

- Helper method to draw visual screen frame.*
- void [\\_\\_setUpConsoleScreen](#) (void)
- Helper method to set up context menu console screen (drawable).*
- void [\\_\\_setUpConsoleScreenFrame](#) (void)
- Helper method to set up framing for context menu console screen (drawable).*
- void [\\_\\_drawConsoleScreenFrame](#) (void)
- Helper method to draw console screen frame.*
- void [\\_\\_setConsoleState](#) (ConsoleState)
- Helper method to set state of console screen and update string if necessary.*
- void [\\_\\_setConsoleString](#) (void)
- Helper method to set console string depending on console state.*
- void [\\_\\_drawConsoleText](#) (void)
- Helper method to draw animated text to context menu console screen.*
- void [\\_\\_handleKeyPressEvents](#) (void)
- Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)
- Helper method to handle mouse button events.*
- void [\\_\\_sendQuitGameMessage](#) (void)
- Helper method to format and send a quit game message.*
- void [\\_\\_sendRestartGameMessage](#) (void)
- Helper method to format and send a restart game message.*

## Private Attributes

- sf::Event \* [event\\_ptr](#)
- A pointer to the event class.*
- sf::RenderWindow \* [render\\_window\\_ptr](#)
- A pointer to the render window.*
- [AssetsManager](#) \* [assets\\_manager\\_ptr](#)
- A pointer to the assets manager.*
- [MessageHub](#) \* [message\\_hub\\_ptr](#)
- A pointer to the message hub.*

### 4.2.1 Detailed Description

A class which defines a context menu for the game.

### 4.2.2 Constructor & Destructor Documentation

#### 4.2.2.1 ContextMenu()

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

Constructor for the [ContextMenu](#) class.

## Parameters

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

```

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

```

## 4.2.2.2 ~ContextMenu()

```

ContextMenu::~ContextMenu (
    void )

```

Destructor for the [ContextMenu](#) class.

```

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

```

## 4.2.3 Member Function Documentation

## 4.2.3.1 \_\_drawConsoleScreenFrame()

```

void ContextMenu::__drawConsoleScreenFrame (
    void ) [private]

```

Helper method to draw console screen frame.

```

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

```

#### 4.2.3.2 \_\_drawConsoleText()

```

void ContextMenu::__drawConsoleText (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.2.3.3 \_\_drawVisualScreenFrame()

```

void ContextMenu::__drawVisualScreenFrame (
    void ) [private]

```

Helper method to draw visual screen frame.

```

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

```

#### 4.2.3.4 \_\_handleKeyPressEvents()

```

void ContextMenu::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

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

```

```

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

```

#### 4.2.3.5 \_\_handleMouseButtonEvents()

```

void ContextMenu::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

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

```

#### 4.2.3.6 \_\_sendQuitGameMessage()

```

void ContextMenu::__sendQuitGameMessage (
    void ) [private]

```

Helper method to format and send a quit game message.

```

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

```

#### 4.2.3.7 \_\_sendRestartGameMessage()

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

Helper method to format and send a restart game message.

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

#### 4.2.3.8 \_\_setConsoleState()

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

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

##### Parameters

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

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

#### 4.2.3.9 \_\_setConsoleString()

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

Helper method to set console string depending on console state.

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



```

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

```

#### 4.2.3.10 \_\_setUpConsoleScreen()

```

void ContextMenu::__setUpConsoleScreen (
    void ) [private]

```

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

```

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

```

#### 4.2.3.11 \_\_setUpConsoleScreenFrame()

```

void ContextMenu::__setUpConsoleScreenFrame (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.2.3.12 \_\_setUpMenuFrame()

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

```
void ) [private]
```

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

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

#### 4.2.3.13 \_\_setUpVisualScreen()

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

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

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

#### 4.2.3.14 \_\_setUpVisualScreenFrame()

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

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

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

```

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

```

#### 4.2.3.15 draw()

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

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

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

#### 4.2.3.16 processEvent()

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

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

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

#### 4.2.3.17 processMessage()

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

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

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

```

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

```

## 4.2.4 Member Data Documentation

### 4.2.4.1 assets\_manager\_ptr

`AssetsManager*` ContextMenu::assets\_manager\_ptr [private]

A pointer to the assets manager.

### 4.2.4.2 console\_screen

`sf::RectangleShape` ContextMenu::console\_screen

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

#### 4.2.4.3 console\_screen\_frame\_bottom

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

The bottom framing of the console screen.

#### 4.2.4.4 console\_screen\_frame\_left

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

The left framing of the console screen.

#### 4.2.4.5 console\_screen\_frame\_right

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

The right framing of the console screen.

#### 4.2.4.6 console\_screen\_frame\_top

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

The top framing of the console screen.

#### 4.2.4.7 console\_state

```
ConsoleState ContextMenu::console_state
```

The current state of the console screen.

#### 4.2.4.8 console\_string

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

The string to be printed to the console screen.



#### 4.2.4.9 console\_string\_changed

```
bool ContextMenu::console_string_changed
```

Boolean which indicates if console string just changed.

#### 4.2.4.10 console\_substring\_idx

```
size_t ContextMenu::console_substring_idx
```

The current final index of the console string draw.

#### 4.2.4.11 event\_ptr

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

A pointer to the event class.

#### 4.2.4.12 frame

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

The current frame of this object.

#### 4.2.4.13 game\_menu\_up

```
bool ContextMenu::game_menu_up
```

Indicates whether or not the game menu is up.

#### 4.2.4.14 menu\_frame

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

The frame of the context menu.

#### 4.2.4.15 message\_hub\_ptr

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

A pointer to the message hub.

#### 4.2.4.16 position\_x

```
double ContextMenu::position_x
```

The position of the object.

#### 4.2.4.17 position\_y

```
double ContextMenu::position_y
```

The position of the object.

#### 4.2.4.18 render\_window\_ptr

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

A pointer to the render window.

#### 4.2.4.19 visual\_screen

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

The context menu screen for visuals.

#### 4.2.4.20 visual\_screen\_frame\_bottom

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

The bottom framing of the visual screen.

#### 4.2.4.21 visual\_screen\_frame\_left

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

The left framing of the visual screen.

#### 4.2.4.22 visual\_screen\_frame\_right

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

The right framing of the visual screen.

#### 4.2.4.23 visual\_screen\_frame\_top

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

The top framing of the visual screen.

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

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

## 4.3 DieselGenerator Class Reference

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

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

Inheritance diagram for DieselGenerator:



Collaboration diagram for DieselGenerator:



## Public Member Functions

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

## Public Attributes

- int [capacity\\_kW](#)  
*The rated production capacity [kW] of the diesel generator.*
- int [production\\_MWh](#)  
*The current production [MWh] of the diesel generator.*
- int [max\\_production\\_MWh](#)  
*The maximum production [MWh] for this turn.*
- double [smoke\\_da](#)  
*The per frame delta in smoke particle alpha value.*

- double [smoke\\_dx](#)  
*The per frame delta in smoke particle x position.*
- double [smoke\\_dy](#)  
*The per frame delta in smoke particle y position.*
- double [smoke\\_prob](#)  
*The probability of spawning a new smoke prob in any given frame.*
- std::list< sf::Sprite > [smoke\\_sprite\\_list](#)  
*A list of smoke sprite (for exhaust animation).*
- int [fuel\\_cost](#)  
*The fuel costs for this turn.*
- int [emissions\\_tonnes\\_CO2e](#)  
*The emissions for this turn.*

## Private Member Functions

- void [\\_\\_setUpTileImprovementSpriteAnimated](#) (void)  
*Helper method to set up tile improvement sprite (static).*
- void [\\_\\_drawProductionMenu](#) (void)  
*Helper method to draw production menu assets.*
- void [\\_\\_upgrade](#) (void)  
*Helper method to upgrade the diesel generator.*
- void [\\_\\_computeProductionCosts](#) (void)  
*Helper method to compute production costs (fuel, O&M, emissions) based on current production level.*
- void [\\_\\_breakdown](#) (void)  
*Helper method to trigger an equipment breakdown.*
- void [\\_\\_repair](#) (void)  
*Helper method to repair the diesel generator.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_sendImprovementStateMessage](#) (void)  
*Helper method to format and sent improvement state message.*

## Additional Inherited Members

### 4.3.1 Detailed Description

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

### 4.3.2 Constructor & Destructor Documentation

### 4.3.2.1 DieselGenerator()

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

Constructor for the [DieselGenerator](#) class.

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

#### Parameters

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

```
508 :
509 TileImprovement (
510     position_x,
511     position_y,
512     tile_resource,
513     event_ptr,
514     render_window_ptr,
515     assets_manager_ptr,
516     message_hub_ptr
517 )
518 {
519     // 1. set attributes
520
521     // 1.1. private
522     //...
523
524     // 1.2. public
525     this->tile_improvement_type = TileImprovementType :: DIESEL_GENERATOR;
526
527     this->is_running = false;
528
529     this->health = 100;
530
531     this->capacity_kW = 200;
532     this->upgrade_level = 1;
533
534     this->production_MWh = 0;
535     this->max_production_MWh = 144;
536
537     this->smoke_da = 1e-8 * SECONDS_PER_FRAME;
538     this->smoke_dx = 5 * SECONDS_PER_FRAME;
539     this->smoke_dy = -10 * SECONDS_PER_FRAME;
540     this->smoke_prob = 16 * SECONDS_PER_FRAME;
541
542     this->smoke_sprite_list = {};
543
544     this->fuel_cost = 0;
545     this->emissions_tonnes_CO2e = 0;
546
547     this->tile_improvement_string = "DIESEL GEN";
548
549     this->__setUpTileImprovementSpriteAnimated();
550
551     std::cout << "DieselGenerator constructed at " << this << std::endl;
552
553     return;
```

```
554 }    /* DieselGenerator() */
```

#### 4.3.2.2 ~DieselGenerator()

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

Destructor for the [DieselGenerator](#) class.

```
935 {
936     std::cout << "DieselGenerator at " << this << " destroyed" << std::endl;
937
938     return;
939 }    /* ~DieselGenerator() */
```

### 4.3.3 Member Function Documentation

#### 4.3.3.1 \_\_breakdown()

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

Helper method to trigger an equipment breakdown.

```
270 {
271     TileImprovement :: __breakdown();
272
273     this->production_MWh = 0;
274     this->fuel_cost = 0;
275     this->operation_maintenance_cost = 0;
276     this->emissions_tonnes_CO2e = 0;
277
278     return;
279 }    /* __breakdown() */
```

#### 4.3.3.2 \_\_computeProductionCosts()

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

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

```
233 {
234     double litres_diesel = this->production_MWh * LITRES_DIESEL_PER_MWH_PRODUCTION;
235
236     double performance_factor = this->__getPerformanceFactor();
237
238     if (performance_factor > 0) {
239         litres_diesel /= performance_factor;
240     }
241
242     double fuel_cost = (litres_diesel * COST_PER_LITRE_DIESEL) / 1000;
243     this->fuel_cost = round(fuel_cost);
244
245     double emissions_tonnes_CO2e = (litres_diesel * KG_CO2E_PER_LITRE_DIESEL) / 1000;
246     this->emissions_tonnes_CO2e = round(emissions_tonnes_CO2e);
247
248     double operation_maintenance_cost =
249         (this->production_MWh * DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
250     this->operation_maintenance_cost = round(operation_maintenance_cost);
251
252     this->__sendTileStateRequest();
253
254     return;
255 }    /* __computeProductionCosts() */
```

#### 4.3.3.3 \_\_drawProductionMenu()

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

Helper method to draw production menu assets.

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

#### 4.3.3.4 \_\_handleKeyPressEvents()

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

Helper method to handle key press events.

```
327 {
328     if (this->just_built) {
329         return;
330     }
331 }
```



```

332
333     switch (this->event_ptr->key.code) {
334         case (sf::Keyboard::U): {
335             this->__upgrade();
336
337             break;
338         }
339
340
341         case (sf::Keyboard::W): {
342             if (this->production_menu_open) {
343                 this->production_MWh++;
344
345                 if (this->production_MWh > this->max_production_MWh) {
346                     this->production_MWh = 0;
347                 }
348
349                 this->__computeProductionCosts();
350                 this->assets_manager_ptr->getSound("interface click")->play();
351             }
352
353             break;
354         }
355
356
357         case (sf::Keyboard::S): {
358             if (this->production_menu_open) {
359                 this->production_MWh--;
360
361                 if (this->production_MWh < 0) {
362                     this->production_MWh = this->max_production_MWh;
363                 }
364
365                 this->__computeProductionCosts();
366                 this->assets_manager_ptr->getSound("interface click")->play();
367             }
368
369             break;
370         }
371
372
373         default: {
374             // do nothing!
375
376             break;
377         }
378     }
379
380
381     return;
382 } /* __handleKeyPressEvents() */

```

#### 4.3.3.5 \_\_handleMouseButtonEvents()

```

void DieselGenerator::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

397 {
398     if (this->just_built) {
399         return;
400     }
401
402     switch (this->event_ptr->mouseButton.button) {
403         case (sf::Mouse::Left): {
404             //...
405
406             break;
407         }
408
409
410         case (sf::Mouse::Right): {
411             //...
412
413             break;
414         }
415
416

```

```

417         default: {
418             // do nothing!
419
420             break;
421         }
422     }
423
424     return;
425 } /* __handleMouseButtonEvents() */

```

#### 4.3.3.6 \_\_repair()

```

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

```

Helper method to repair the diesel generator.

Reimplemented from [TileImprovement](#).

```

294 {
295     if (this->credits < DIESEL_GENERATOR_BUILD_COST) {
296         std::cout << "Cannot repair diesel generator: insufficient credits (need "
297             << DIESEL_GENERATOR_BUILD_COST << " K)" << std::endl;
298
299         this->__sendInsufficientCreditsMessage();
300         return;
301     }
302
303     TileImprovement :: __repair();
304
305     this->just_upgraded = true;
306
307     this->__sendCreditsSpentMessage(DIESEL_GENERATOR_BUILD_COST);
308     this->__sendTileStateRequest();
309     this->__sendGameStateRequest();
310
311     return;
312 } /* __repair() */

```

#### 4.3.3.7 \_\_sendImprovementStateMessage()

```

void DieselGenerator::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

440 {
441     Message improvement_state_message;
442
443     improvement_state_message.channel = GAME_CHANNEL;
444     improvement_state_message.subject = "improvement state";
445
446     improvement_state_message.int_payload["dispatch_MWh"] = this->production_MWh;
447     improvement_state_message.int_payload["fuel_cost"] = this->fuel_cost;
448     improvement_state_message.int_payload["operation_maintenance_cost"] =
449         this->operation_maintenance_cost;
450     improvement_state_message.int_payload["emissions_tonnes_CO2e"] =
451         this->emissions_tonnes_CO2e;
452
453     this->message_hub_ptr->sendMessage(improvement_state_message);
454
455     std::cout << "Improvement state message sent by " << this << std::endl;
456
457     return;
458 } /* __sendImprovementStateMessage() */

```

#### 4.3.3.8 \_\_setUpTileImprovementSpriteAnimated()

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

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

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

#### 4.3.3.9 \_\_upgrade()

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

Helper method to upgrade the diesel generator.

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

#### 4.3.3.10 advanceTurn()

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

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```
664 {
665     // 1. send improvement state message
666     this->__sendImprovementStateMessage();
667
668     // 2. handle start/stop
669     if ((not this->is_running) and (this->production_MWh > 0)) {
670         this->is_running = true;
671         this->assets_manager_ptr->getSound("diesel start")->play();
672     }
673
674     else if (this->is_running and (this->production_MWh <= 0)) {
675         this->is_running = false;
676         this->tile_improvement_sprite_animated[1].setScale(sf::Vector2f(1, 1));
677     }
678
679     // 3. handle equipment health and breakdowns
680     if (this->is_running) {
681         this->health--;
682
683         if (this->health <= 50) {
684             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
685
686             if ((double)rand() / RAND_MAX <= breakdown_prob) {
687                 this->health = 0;
688             }
689         }
690
691         if (this->health <= 0) {
692             this->__breakdown();
693         }
694     }
695
696     // 4. send tile state request (if selected)
697     if (this->is_selected) {
698         this->__sendTileStateRequest();
699     }
700
701     return;
702 } /* advanceTurn() */
```

#### 4.3.3.11 draw()

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

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

Reimplemented from [TileImprovement](#).

```
766 {
767     // 1. if just built, call base method and return
768     if (this->just_built) {
769         TileImprovement :: draw();
770
771         return;
772     }
773
774     // 2. handle upgrade effects
775     if (this->just_upgraded) {
776         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
777             this->tile_improvement_sprite_animated[i].setColor(
778                 sf::Color(
779                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
780                     255,
781                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
782                     255
```

```

783         )
784     );
785
786     this->tile_improvement_sprite_animated[i].setScale(
787         sf::Vector2f(
788             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
789             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
790         )
791     );
792 }
793
794 this->upgrade_frame++;
795 }
796
797 if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
798     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
799         this->tile_improvement_sprite_animated[i].setColor(
800             sf::Color(255,255,255,255)
801         );
802
803         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
804     }
805
806     this->just_upgraded = false;
807     this->upgrade_frame = 0;
808 }
809
810
811 // 3. draw first element of animated sprite
812 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
813
814
815 // 4. draw second element of animated sprite
816 double move_x = 0;
817 double move_y = 0;
818
819 if (this->is_running) {
820     this->tile_improvement_sprite_animated[1].setScale(
821         sf::Vector2f(
822             1 + 0.05 * pow(cos((6 * M_PI * this->frame) / FRAMES_PER_SECOND), 2),
823             1 + 0.05 * pow(cos((6 * M_PI * this->frame) / FRAMES_PER_SECOND), 2)
824         )
825     );
826
827     move_x = 1 * ((double)rand() / RAND_MAX) - 0.5;
828     move_y = 1 * ((double)rand() / RAND_MAX) - 0.5;
829
830     this->tile_improvement_sprite_animated[1].move(move_x, move_y);
831 }
832
833 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
834
835 if (this->is_running) {
836     this->tile_improvement_sprite_animated[1].move(-1 * move_x, -1 * move_y);
837 }
838
839
840 // 5. draw smoke effects
841 if (this->is_running) {
842     if ((double)rand() / RAND_MAX < smoke_prob) {
843         this->smoke_sprite_list.push_back(
844             sf::Sprite(*this->assets_manager_ptr->getTexture("emissions"))
845         );
846
847         this->smoke_sprite_list.back().setOrigin(
848             this->smoke_sprite_list.back().getLocalBounds().width / 2,
849             this->smoke_sprite_list.back().getLocalBounds().height / 2
850         );
851
852         this->smoke_sprite_list.back().setPosition(
853             this->position_x + 9 + 4 * ((double)rand() / RAND_MAX) - 2,
854             this->position_y - 33
855         );
856     }
857 }
858
859 std::list<sf::Sprite>::iterator iter = this->smoke_sprite_list.begin();
860
861 double alpha = 255;
862
863 while (iter != this->smoke_sprite_list.end()) {
864     this->render_window_ptr->draw(*iter);
865
866     alpha = (*iter).getColor().a;
867
868     alpha -= this->smoke_da;
869 }

```

```

870         if (alpha <= 0) {
871             iter = this->smoke_sprite_list.erase(iter);
872             continue;
873         }
874
875         (*iter).setColor(sf::Color(255, 255, 255, alpha));
876
877         (*iter).move(
878             this->smoke_dx + 2 * (((double)rand() / RAND_MAX) - 1) / FRAMES_PER_SECOND,
879             this->smoke_dy
880         );
881
882         (*iter).rotate((((double)rand() / RAND_MAX)));
883
884         iter++;
885     }
886
887
888     // 6. handle dispatch illustration
889     if (this->production_MWh > 0) {
890         this->dispatch_text.setString(std::to_string(this->production_MWh));
891         this->__drawDispatch();
892     }
893
894
895     // 7. draw production menu
896     if (this->production_menu_open) {
897         this->render_window_ptr->draw(this->production_menu_backing);
898         this->render_window_ptr->draw(this->production_menu_backing_text);
899
900         this->__drawProductionMenu();
901     }
902
903
904     // 8. handle broken effects
905     if (this->is_broken) {
906         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
907             this->tile_improvement_sprite_animated[i].setColor(
908                 sf::Color(
909                     255,
910                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
911                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
912                     255
913                 )
914             );
915         }
916     }
917
918     this->frame++;
919     return;
920 } /* draw() */

```

#### 4.3.3.12 getTileOptionsSubstring()

```

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

```

Helper method to assemble and return tile options substring.

#### Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

571 {
572     int upgrade_cost = DIESEL_GENERATOR_BUILD_COST;
573
574     // 32 char x 17 line console "-----\n";
575     std::string options_substring = "CAPACITY: ";
576     options_substring += std::to_string(this->capacity_kW);
577     options_substring += " kW (level ";
578     options_substring += std::to_string(this->upgrade_level);
579     options_substring += ")\n";
580 }

```

```

581     options_substring          += "PRODUCTION: ";
582     options_substring          += std::to_string(this->production_MWh);
583     options_substring          += " MWh (MAX ";
584     options_substring          += std::to_string(this->max_production_MWh);
585     options_substring          += ") \n";
586
587     options_substring          += "HEALTH: ";
588     options_substring          += std::to_string(this->health);
589     options_substring          += "/100";
590
591     if (this->health <= 0) {
592         options_substring      += " ** BROKEN! ** \n";
593     }
594
595     else {
596         options_substring      += " \n";
597     }
598
599     options_substring          += "
600     options_substring          += " **** DIESEL GEN OPTIONS ****
601     options_substring          += "
602
603     if (this->is_broken) {
604         options_substring      += " [R]: REPAIR (";
605         options_substring      += std::to_string(DIESEL_GENERATOR_BUILD_COST);
606         options_substring      += " K) \n";
607     }
608
609     else {
610         options_substring      += " [E]: OPEN PRODUCTION MENU \n";
611     }
612
613     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
614         options_substring      += " [U]: + 200 kW (";
615         options_substring      += std::to_string(upgrade_cost);
616         options_substring      += " K) \n";
617     }
618
619     options_substring          += "HOLD [P]: SCRAP (";
620     options_substring          += std::to_string(SCRAP_COST);
621     options_substring          += " K)";
622
623     return options_substring;
624 } /* getTileOptionsSubstring() */

```

#### 4.3.3.13 processEvent()

```

void DieselGenerator::processEvent (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

717 {
718     TileImprovement :: processEvent ();
719
720     if (this->event_ptr->type == sf::Event::KeyPressed) {
721         this->__handleKeyPressEvents ();
722     }
723
724     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
725         this->__handleMouseButtonEvents ();
726     }
727
728     return;
729 } /* processEvent() */

```

#### 4.3.3.14 processMessage()

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

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

Reimplemented from [TileImprovement](#).

```
744 {
745     TileImprovement :: processMessage ();
746
747     //...
748
749     return;
750 } /* processMessage() */
```

#### 4.3.3.15 setIsSelected()

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

Method to set the is selected attribute.

##### Parameters

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

Reimplemented from [TileImprovement](#).

```
641 {
642     TileImprovement :: setIsSelected(is_selected);
643
644     if (this->is_running and this->is_selected) {
645         this->assets_manager_ptr->getSound("diesel running")->play();
646     }
647
648     return;
649 } /* setIsSelected() */
```

### 4.3.4 Member Data Documentation

#### 4.3.4.1 capacity\_kW

```
int DieselGenerator::capacity_kW
```

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

#### 4.3.4.2 emissions\_tonnes\_CO2e

```
int DieselGenerator::emissions_tonnes_CO2e
```

The emissions for this turn.



#### 4.3.4.3 fuel\_cost

```
int DieselGenerator::fuel_cost
```

The fuel costs for this turn.

#### 4.3.4.4 max\_production\_MWh

```
int DieselGenerator::max_production_MWh
```

The maximum production [MWh] for this turn.

#### 4.3.4.5 production\_MWh

```
int DieselGenerator::production_MWh
```

The current production [MWh] of the diesel generator.

#### 4.3.4.6 smoke\_da

```
double DieselGenerator::smoke_da
```

The per frame delta in smoke particle alpha value.

#### 4.3.4.7 smoke\_dx

```
double DieselGenerator::smoke_dx
```

The per frame delta in smoke particle x position.

#### 4.3.4.8 smoke\_dy

```
double DieselGenerator::smoke_dy
```

The per frame delta in smoke particle y position.

#### 4.3.4.9 smoke\_prob

```
double DieselGenerator::smoke_prob
```

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

#### 4.3.4.10 smoke\_sprite\_list

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

A list of smoke sprite (for exhaust animation).

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

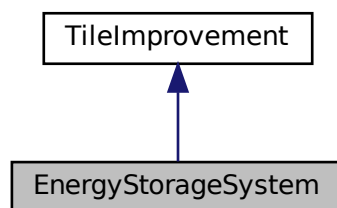
- header/[DieselGenerator.h](#)
- source/[DieselGenerator.cpp](#)

## 4.4 EnergyStorageSystem Class Reference

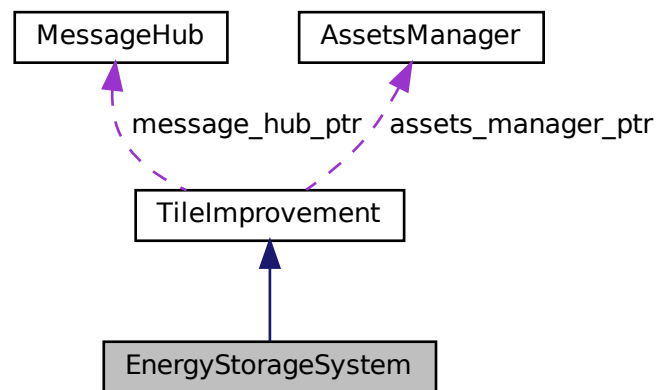
A settlement class (child class of [TileImprovement](#)).

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

Inheritance diagram for EnergyStorageSystem:



Collaboration diagram for EnergyStorageSystem:



## Public Member Functions

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

## Public Attributes

- int [capacity\\_MWh](#)  
*The rated energy capacity [MWh] of the energy storage system.*
- int [charge\\_MWh](#)  
*The charge [MWh] in the energy storage system.*

## Private Member Functions

- void [\\_\\_setUpTileImprovementSpriteStatic](#) (void)  
*Helper method to set up tile improvement sprite (static).*
- void [\\_\\_setUpProductionMenu](#) (void)  
*Helper method to set up and position production menu assets (drawable).*
- void [\\_\\_upgrade](#) (void)  
*Helper method to upgrade the diesel generator.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*

## Additional Inherited Members

### 4.4.1 Detailed Description

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

### 4.4.2 Constructor & Destructor Documentation

#### 4.4.2.1 EnergyStorageSystem()

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

Constructor for the [EnergyStorageSystem](#) class.

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

#### Parameters

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

```
291 :
292 TileImprovement (
```

```

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

```

#### 4.4.2.2 ~EnergyStorageSystem()

```

EnergyStorageSystem::~EnergyStorageSystem (
    void ) [virtual]

```

Destructor for the [EnergyStorageSystem](#) class.

```

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

```

### 4.4.3 Member Function Documentation

#### 4.4.3.1 \_\_handleKeyPressEvents()

```

void EnergyStorageSystem::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

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

```

```

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

```

#### 4.4.3.2 \_\_handleMouseButtonEvents()

```

void EnergyStorageSystem::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

217 {
218     if (this->just_built) {
219         return;
220     }
221
222     switch (this->event_ptr->mouseButton.button) {
223         case (sf::Mouse::Left): {
224             //...
225
226             break;
227         }
228
229         case (sf::Mouse::Right): {
230             //...
231
232             break;
233         }
234
235         default: {
236             // do nothing!
237
238             break;
239         }
240     }
241
242     return;
243 }
244
245 } /* __handleMouseButtonEvents() */

```

#### 4.4.3.3 \_\_setUpProductionMenu()

```

void EnergyStorageSystem::__setUpProductionMenu (
    void ) [private]

```

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

```

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

```

**4.4.3.4 \_\_setUpTileImprovementSpriteStatic()**

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

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

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

**4.4.3.5 \_\_upgrade()**

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

Helper method to upgrade the diesel generator.

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

#### 4.4.3.6 draw()

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

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

Reimplemented from [TileImprovement](#).

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

#### 4.4.3.7 getTileOptionsSubstring()

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

Helper method to assemble and return tile options substring.

#### Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

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



```

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

```

#### 4.4.3.8 processEvent()

```

void EnergyStorageSystem::processEvent (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

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

```

#### 4.4.3.9 processMessage()

```

void EnergyStorageSystem::processMessage (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

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

```

#### 4.4.3.10 setIsSelected()

```

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

```

Method to set the is selected attribute.

## Parameters

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

Reimplemented from [TileImprovement](#).

```

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

```

## 4.4.4 Member Data Documentation

### 4.4.4.1 capacity\_MWh

```
int EnergyStorageSystem::capacity_MWh
```

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

### 4.4.4.2 charge\_MWh

```
int EnergyStorageSystem::charge_MWh
```

The charge [MWh] in the energy storage system.

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

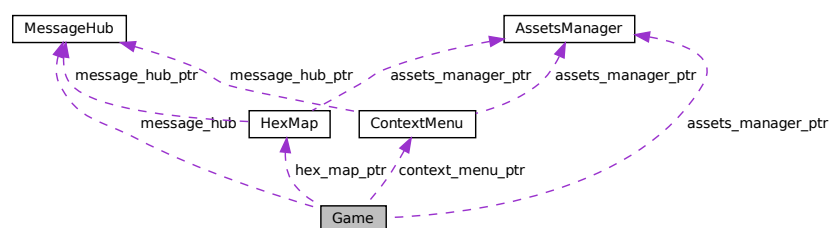
- header/[EnergyStorageSystem.h](#)
- source/[EnergyStorageSystem.cpp](#)

## 4.5 Game Class Reference

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

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

Collaboration diagram for Game:



## Public Member Functions

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

## Public Attributes

- [GamePhase](#) [game\\_phase](#)  
*The current phase of the game.*
- bool [quit\\_game](#)  
*Boolean indicating whether to quit (true) or create a new [Game](#) instance (false).*
- bool [game\\_loop\\_broken](#)  
*Boolean indicating whether or not the game loop is broken.*
- bool [show\\_frame\\_clock\\_overlay](#)  
*Boolean indicating whether or not to show frame and clock overlay.*
- bool [check\\_terminating\\_conditions](#)  
*Boolean indicating whether or not to check terminating conditions.*
- bool [message\\_deadlock](#)  
*A boolean indicating whether a message deadlock has been detected.*
- bool [show\\_tutorial](#)  
*A boolean indicating whether or not to show the tutorial.*
- bool [turn\\_end](#)  
*A boolean indicating a turn end.*
- bool [draw\\_turn\\_advance\\_banner](#)  
*A boolean indicating whether or not to draw the turn advance banner.*
- bool [increase\\_turn\\_advance\\_alpha](#)  
*A boolean which indicates whether the turn advance alpha is increasing or decreasing.*
- bool [transition\\_from\\_title](#)  
*A boolean which indicates if construction follows a title transition.*
- size\_t [tutorial\\_page](#)  
*Index for which page of the tutorial to show.*
- std::string [tutorial\\_string](#)  
*A string representation of the current tutorial page.*
- sf::Text [tutorial\\_text](#)  
*A text representation (drawable) of the tutorial page.*
- unsigned long long int [frame](#)  
*The current frame of the game.*
- double [time\\_since\\_start\\_s](#)  
*The time elapsed [s] since the start of the game.*
- int [year](#)  
*Current game year.*
- int [month](#)  
*Current game month.*
- int [population](#)  
*Current population.*
- int [credits](#)

- *Current balance of credits.*
- int [demand\\_MWh](#)
  - *Current energy demand [MWh].*
- int [cumulative\\_emissions\\_tonnes](#)
  - *Cumulative emissions [tonnes] (1 tonne = 1000 kg).*
- int [past\\_demand\\_MWh](#)
  - *The demand in the previous turn.*
- double [turn\\_advance\\_alpha](#)
  - *The alpha value for the turn advance banner.*
- int [demand\\_served\\_MWh](#)
  - *The demand served at the end of a turn.*
- int [demand\\_remaining\\_MWh](#)
  - *The demand remaining at the end of a turn.*
- int [overproduction\\_MWh](#)
  - *The amount of overproduction at the end of a turn.*
- int [turn\\_fuel\\_cost](#)
  - *The cost of fuel at the end of a turn.*
- int [turn\\_operation\\_maintenance\\_cost](#)
  - *The cost of operation and maintenance at the end of a turn.*
- int [turn\\_emissions\\_tonnes](#)
  - *The amount of emissions at the end of a turn.*
- int [dispatch\\_income](#)
  - *The amount earned from dispatch at the end of a turn.*
- int [overproduction\\_penalty](#)
  - *The penalty for overproduction.*
- int [net\\_credit\\_flow](#)
  - *The net credit flow at the end of a turn.*
- int [consecutive\\_zero\\_emissions\\_months](#)
  - *The number of recent, consecutive zero emission months.*
- size\_t [substring\\_idx](#)
  - *The index of the turn summary or tutorial substring.*
- std::string [turn\\_summary\\_string](#)
  - *A string representation of the end of turn summary.*
- sf::Text [turn\\_summary\\_text](#)
  - *A text representation (drawable) of the end of turn summary.*
- int [message\\_deadlock\\_frame](#)
  - *A frame counter for detecting message deadlock.*
- int [turn](#) = 0
  - *The current game turn.*
- std::vector< double > [demand\\_vec\\_MWh](#)
  - *A vector of daily demands [MWh] for the current month.*
- sf::Clock [clock](#)
  - *The game clock.*
- sf::Event [event](#)
  - *The game events class.*
- sf::RectangleShape [fade\\_rectangle](#)
  - *A fading rectangle (for smooth transition from title to game).*
- MessageHub [message\\_hub](#)
  - *The message hub (for inter-object message traffic).*
- HexMap \* [hex\\_map\\_ptr](#)
  - *Pointer to the hex map (defines game world).*
- ContextMenu \* [context\\_menu\\_ptr](#)
  - *Pointer to the context menu.*

## Private Member Functions

- void [\\_\\_toggleFrameClockOverlay](#) (void)  
*Helper method to toggle frame clock overlay.*
- void [\\_\\_checkTerminatingConditions](#) (void)  
*Helper method to check terminating conditions (i.e., loss or victory conditions).*
- void [\\_\\_updatePopulation](#) (void)  
*Helper method to update (i.e. grow) population.*
- void [\\_\\_advanceTurn](#) (void)  
*Helper method to advance turn.*
- void [\\_\\_computeCurrentDemand](#) (void)  
*Helper method to compute current energy demand.*
- void [\\_\\_toggleTutorial](#) (void)  
*Helper method to handle toggling the tutorial on and off.*
- void [\\_\\_incrementTutorial](#) (void)  
*Helper method to increment tutorial page (with wrap around).*
- void [\\_\\_decrementTutorial](#) (void)  
*Helper method to decrement tutorial page (with wrap around).*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_handleImprovementStateMessage](#) (Message)  
*Helper method to handle improvement state messages.*
- void [\\_\\_processEvent](#) (void)  
*Helper method to process [Game](#). To be called once per event.*
- void [\\_\\_processMessage](#) (void)  
*Helper method to process [Game](#). To be called once per message.*
- void [\\_\\_sendGameStateMessage](#) (void)  
*Helper method to format and send a game state message.*
- void [\\_\\_sendTurnAdvanceMessage](#) (void)  
*Helper method to format and send a turn advance message.*
- void [\\_\\_sendCreditsEarnedMessage](#) (void)  
*Helper method to format and send a credits earned message.*
- void [\\_\\_insufficientCreditsAlarm](#) (void)  
*Helper method to sound and display an insufficient credits alarm.*
- void [\\_\\_summarizeTurn](#) (void)  
*Helper method to generate end of turn summary.*
- void [\\_\\_drawLossDemand](#) (void)  
*Helper method to draw loss (demand) pop-up.*
- void [\\_\\_drawLossCredits](#) (void)  
*Helper method to draw loss (credits) pop-up.*
- void [\\_\\_drawLossEmissions](#) (void)  
*Helper method to draw loss (emissions) pop-up.*
- void [\\_\\_drawVictory](#) (void)  
*Helper method to draw victory pop-up.*
- void [\\_\\_drawTurnAdvanceBanner](#) (void)  
*Helper method to draw turn advance banner.*
- void [\\_\\_drawTutorial](#) (void)  
*Helper method to draw tutorial text.*
- void [\\_\\_drawTurnSummary](#) (void)

- *Helper method to draw turn summary.*  
void [\\_\\_drawFrameClockOverlay](#) (void)
- *Helper method to draw frame clock overlay.*  
void [\\_\\_drawHUD](#) (void)
- *Helper method to heads-up display (HUD).*  
void [\\_\\_draw](#) (void)
- *Helper method to draw game to the render window. To be called once per frame.*

## Private Attributes

- sf::RenderWindow \* [render\\_window\\_ptr](#)  
*A pointer to the render window.*
- [AssetsManager](#) \* [assets\\_manager\\_ptr](#)  
*A pointer to the assets manager.*

### 4.5.1 Detailed Description

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

### 4.5.2 Constructor & Destructor Documentation

#### 4.5.2.1 Game()

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

Constructor for the [Game](#) class.

#### Parameters

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

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

```

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

```

```

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

```

#### 4.5.2.2 ~Game()

```

Game::~~Game (
    void )

```

Destructor for the `Game` class.

```

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

```

### 4.5.3 Member Function Documentation

#### 4.5.3.1 \_\_advanceTurn()

```

void Game::__advanceTurn (
    void ) [private]

```

Helper method to advance turn.

```

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

```



### 4.5.3.2 \_\_checkTerminatingConditions()

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

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

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

### 4.5.3.3 \_\_computeCurrentDemand()

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

Helper method to compute current energy demand.

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

#### 4.5.3.4 \_\_decrementTutorial()

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

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

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

#### 4.5.3.5 \_\_draw()

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

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

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

```

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

```

#### 4.5.3.6 \_\_drawFrameClockOverlay()

```

void Game::__drawFrameClockOverlay (
    void ) [private]

```

Helper method to draw frame clock overlay.

```

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

```

#### 4.5.3.7 \_\_drawHUD()

```

void Game::__drawHUD (
    void ) [private]

```

Helper method to heads-up display (HUD).

```

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

```

```

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

```

#### 4.5.3.8 \_\_drawLossCredits()

```

void Game::__drawLossCredits (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.5.3.9 \_\_drawLossDemand()

```

void Game::__drawLossDemand (
    void ) [private]

```

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

```

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

```

## 4.5.3.10 \_\_drawLossEmissions()

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

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

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

## 4.5.3.11 \_\_drawTurnAdvanceBanner()

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

Helper method to draw turn advance banner.

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

```

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

```

#### 4.5.3.12 \_\_drawTurnSummary()

```

void Game::__drawTurnSummary (
    void ) [private]

```

Helper method to draw turn summary.

```

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

```



```

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

```

#### 4.5.3.13 \_\_drawTutorial()

```

void Game::__drawTutorial (
    void ) [private]

```

Helper method to draw tutorial text.

```

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

```

#### 4.5.3.14 \_\_drawVictory()

```

void Game::__drawVictory (
    void ) [private]

```

Helper method to draw victory pop-up.

```

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

```

```

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

```

#### 4.5.3.15 \_\_handleImprovementStateMessage()

```

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

```

Helper method to handle improvement state messages.

```

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

```

**4.5.3.16 \_\_handleKeyPressEvents()**

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

Helper method to handle key press events.

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

**4.5.3.17 \_\_handleMouseButtonEvents()**

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

Helper method to handle mouse button events.

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

```

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

```

#### 4.5.3.18 \_\_incrementTutorial()

```

void Game::__incrementTutorial (
    void ) [private]

```

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

```

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

```

#### 4.5.3.19 \_\_insufficientCreditsAlarm()

```

void Game::__insufficientCreditsAlarm (
    void ) [private]

```

Helper method to sound and display and insufficient credits alarm.

```

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

```

```

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

```

#### 4.5.3.20 \_\_processEvent()

```

void Game::__processEvent (
    void ) [private]

```

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

```

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

```

#### 4.5.3.21 \_\_processMessage()

```

void Game::__processMessage (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.5.3.22 \_\_sendCreditsEarnedMessage()

```

void Game::__sendCreditsEarnedMessage (
    void ) [private]

```

Helper method to format and send a credits earned message.

```

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

```

#### 4.5.3.23 \_\_sendGameStateMessage()

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

Helper method to format and send a game state message.

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



## 4.5.3.24 \_\_sendTurnAdvanceMessage()

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

Helper method to format and send a turn advance message.

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

## 4.5.3.25 \_\_summarizeTurn()

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

Helper method to generate end of turn summary.

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

```

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

```

#### 4.5.3.26 \_\_toggleFrameClockOverlay()

```

void Game::__toggleFrameClockOverlay (
    void ) [private]

```

Helper method to toggle frame clock overlay.

```

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

```

```

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

```

#### 4.5.3.27 \_\_toggleTutorial()

```

void Game::__toggleTutorial (
    void ) [private]

```

Helper method to handle toggling the tutorial on and off.

```

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

```

#### 4.5.3.28 \_\_updatePopulation()

```

void Game::__updatePopulation (
    void ) [private]

```

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

```

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

```

#### 4.5.3.29 run()

```

bool Game::run (
    void )

```

Method to run game (defines game loop).

## Returns

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

```

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

```

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

## 4.5.4 Member Data Documentation

### 4.5.4.1 assets\_manager\_ptr

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

A pointer to the assets manager.

### 4.5.4.2 check\_terminating\_conditions

```
bool Game::check_terminating_conditions
```

Boolean indicating whether or not to check terminating conditions.

### 4.5.4.3 clock

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

The game clock.

### 4.5.4.4 consecutive\_zero\_emissions\_months

```
int Game::consecutive_zero_emissions_months
```

The number of recent, consecutive zero emission months.

#### 4.5.4.5 context\_menu\_ptr

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

Pointer to the context menu.

#### 4.5.4.6 credits

```
int Game::credits
```

Current balance of credits.

#### 4.5.4.7 cumulative\_emissions\_tonnes

```
int Game::cumulative_emissions_tonnes
```

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

#### 4.5.4.8 demand\_MWh

```
int Game::demand_MWh
```

Current energy demand [MWh].

#### 4.5.4.9 demand\_remaining\_MWh

```
int Game::demand_remaining_MWh
```

The demand remaining at the end of a turn.

#### 4.5.4.10 demand\_served\_MWh

```
int Game::demand_served_MWh
```

The demand served at the end of a turn.

#### 4.5.4.11 demand\_vec\_MWh

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

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

#### 4.5.4.12 dispatch\_income

```
int Game::dispatch_income
```

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

#### 4.5.4.13 draw\_turn\_advance\_banner

```
bool Game::draw_turn_advance_banner
```

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

#### 4.5.4.14 event

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

The game events class.

#### 4.5.4.15 fade\_rectangle

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

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

#### 4.5.4.16 frame

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

The current frame of the game.

#### 4.5.4.17 game\_loop\_broken

```
bool Game::game_loop_broken
```

Boolean indicating whether or not the game loop is broken.

#### 4.5.4.18 game\_phase

```
GamePhase Game::game_phase
```

The current phase of the game.

#### 4.5.4.19 hex\_map\_ptr

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

Pointer to the hex map (defines game world).

#### 4.5.4.20 increase\_turn\_advance\_alpha

```
bool Game::increase_turn_advance_alpha
```

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

#### 4.5.4.21 message\_deadlock

```
bool Game::message_deadlock
```

A boolean indicating whether a message deadlock has been detected.

#### 4.5.4.22 message\_deadlock\_frame

```
int Game::message_deadlock_frame
```

A frame counter for detecting message deadlock.



#### 4.5.4.23 message\_hub

`MessageHub` `Game::message_hub`

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

#### 4.5.4.24 month

`int` `Game::month`

Current game month.

#### 4.5.4.25 net\_credit\_flow

`int` `Game::net_credit_flow`

The net credit flow at the end of a turn.

#### 4.5.4.26 overproduction\_MWh

`int` `Game::overproduction_MWh`

The amount of overproduction at the end of a turn.

#### 4.5.4.27 overproduction\_penalty

`int` `Game::overproduction_penalty`

The penalty for overproduction.

#### 4.5.4.28 past\_demand\_MWh

`int` `Game::past_demand_MWh`

The demand in the previous turn.

#### 4.5.4.29 population

```
int Game::population
```

Current population.

#### 4.5.4.30 quit\_game

```
bool Game::quit_game
```

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

#### 4.5.4.31 render\_window\_ptr

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

A pointer to the render window.

#### 4.5.4.32 show\_frame\_clock\_overlay

```
bool Game::show_frame_clock_overlay
```

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

#### 4.5.4.33 show\_tutorial

```
bool Game::show_tutorial
```

A boolean indicating whether or not to show the tutorial.

#### 4.5.4.34 substring\_idx

```
size_t Game::substring_idx
```

The index of the turn summary or tutorial substring.

**4.5.4.35 time\_since\_start\_s**

```
double Game::time_since_start_s
```

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

**4.5.4.36 transition\_from\_title**

```
bool Game::transition_from_title
```

A boolean which indicates if construction follows a title transition.

**4.5.4.37 turn**

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

The current game turn.

**4.5.4.38 turn\_advance\_alpha**

```
double Game::turn_advance_alpha
```

The alpha value for the turn advance banner.

**4.5.4.39 turn\_emissions\_tonnes**

```
int Game::turn_emissions_tonnes
```

The amount of emissions at the end of a turn.

**4.5.4.40 turn\_end**

```
bool Game::turn_end
```

A boolean indicating a turn end.

#### 4.5.4.41 turn\_fuel\_cost

```
int Game::turn_fuel_cost
```

The cost of fuel at the end of a turn.

#### 4.5.4.42 turn\_operation\_maintenance\_cost

```
int Game::turn_operation_maintenance_cost
```

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

#### 4.5.4.43 turn\_summary\_string

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

A string representation of the end of turn summary.

#### 4.5.4.44 turn\_summary\_text

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

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

#### 4.5.4.45 tutorial\_page

```
size_t Game::tutorial_page
```

Index for which page of the tutorial to show.

#### 4.5.4.46 tutorial\_string

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

A string representation of the current tutorial page.

#### 4.5.4.47 tutorial\_text

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

A text representation (drawable) of the tutorial page.

#### 4.5.4.48 year

```
int Game::year
```

Current game year.

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

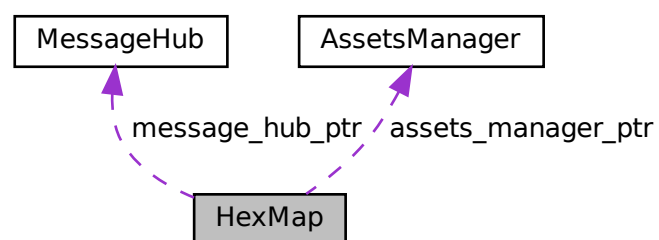
- header/[Game.h](#)
- source/[Game.cpp](#)

## 4.6 HexMap Class Reference

A class which defines a hex map of hex tiles.

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

Collaboration diagram for HexMap:



## Public Member Functions

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

## Public Attributes

- bool [show\\_resource](#)  
*A boolean which indicates whether or not to show resource value.*
- bool [tile\\_selected](#)  
*A boolean which indicates if a tile is currently selected.*
- bool [settlement\\_position\\_logged](#)  
*A boolean which indicates if the settlement position has been logged.*
- bool [just\\_constructed](#)  
*A boolean which indicates if the [HexMap](#) has just been constructed.*
- int [n\\_layers](#)  
*The number of layers in the hex map.*
- int [n\\_tiles](#)  
*The number of tiles in the hex map.*
- unsigned long long int [frame](#)  
*The current frame of this object.*
- size\_t [initial\\_draw\\_tile\\_idx](#)  
*The current tile idx (for the initial draw tile wave animation).*
- int [demand\\_MWh](#)  
*Current energy demand [MWh].*
- double [dalpha](#)  
*The change in tile alpha (for the tile wave animation).*
- double [position\\_x](#)  
*The x position of the hex map's origin (i.e. central) tile.*
- double [position\\_y](#)  
*The y position of the hex map's origin (i.e. central) tile.*
- double [settlement\\_position\\_x](#)  
*The x position of the settlement.*
- double [settlement\\_position\\_y](#)

- *The y position of the settlement.*  
• `sf::RectangleShape` [glass\\_screen](#)  
*To give the effect of an old glass screen over the hex map.*
- `std::vector< double >` [tile\\_position\\_x\\_vec](#)  
*A vector of tile x positions.*
- `std::vector< double >` [tile\\_position\\_y\\_vec](#)  
*A vector of tile y position.*
- `std::vector< HexTile * >` [border\\_tiles\\_vec](#)  
*A vector of pointers to the border tiles.*
- `std::map< double, std::map< double, HexTile * > >` [hex\\_map](#)  
*A position-indexed, nested map of hex tiles.*
- `std::vector< HexTile * >` [hex\\_draw\\_order\\_vec](#)  
*A vector of hex tiles, in drawing order.*

## Private Member Functions

- `void` [\\_\\_setUpGlassScreen](#) (`void`)  
*Helper method to set up glass screen effect (drawable).*
- `void` [\\_\\_layTiles](#) (`void`)  
*Helper method to lay the hex tiles down to generate the game world.*
- `void` [\\_\\_buildDrawOrderVector](#) (`void`)  
*Helper method to build tile drawing order vector.*
- `void` [\\_\\_setUpInitialDraw](#) (`void`)  
*Helper method to set up initial map draw (scale all tiles to zero, to support tile wave animation).*
- `void` [\\_\\_handleInitialDraw](#) (`void`)  
*Helper method to handle initial map draw (tile wave animation).*
- `std::vector< double >` [\\_\\_getNoise](#) (`int`, `int=128`)  
*Helper method to generate a vector of noise, with values mapped to the closed interval [0, 1]. Applies a random cosine series approach.*
- `void` [\\_\\_procedurallyGenerateTileTypes](#) (`void`)  
*Helper method to procedurally generate tile types and set tiles accordingly.*
- `std::vector< double >` [\\_\\_getValidMapIndexPositions](#) (`double`, `double`)  
*Helper method to translate given position into valid index position for a.*
- `std::vector< HexTile * >` [\\_\\_getNeighboursVector](#) (`HexTile *`)  
*Helper method to assemble a vector pointers to all neighbours of the given tile.*
- `TileType` [\\_\\_getMajorityTileType](#) (`HexTile *`)  
*Function to return majority tile type of a tile and its neighbours. If no clear majority, simply returns the type of the given tile.*
- `void` [\\_\\_smoothTileTypes](#) (`void`)  
*Helper method to smooth tile types using a majority rules approach.*
- `bool` [\\_\\_isLakeTouchingOcean](#) (`HexTile *`)
- `void` [\\_\\_enforceOceanContinuity](#) (`void`)  
*Helper method to scan tiles and enforce ocean continuity. That is to say, if a lake tile is found to be in contact with an ocean tile, then it becomes ocean.*
- `void` [\\_\\_procedurallyGenerateTileResources](#) (`void`)  
*Helper method to procedurally generate tile resources and set tiles accordingly.*
- `void` [\\_\\_assembleHexMap](#) (`void`)  
*Helper method to assemble the hex map.*
- `HexTile *` [\\_\\_getSelectedTile](#) (`void`)  
*Helper method to get pointer to selected tile.*
- `void` [\\_\\_logSettlementPosition](#) (`void`)

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

## Private Attributes

- sf::Event \* [event\\_ptr](#)  
*A pointer to the event class.*
- sf::RenderWindow \* [render\\_window\\_ptr](#)  
*A pointer to the render window.*
- [AssetsManager](#) \* [assets\\_manager\\_ptr](#)  
*A pointer to the assets manager.*
- [MessageHub](#) \* [message\\_hub\\_ptr](#)  
*A pointer to the message hub.*

## 4.6.1 Detailed Description

A class which defines a hex map of hex tiles.

## 4.6.2 Constructor & Destructor Documentation

### 4.6.2.1 HexMap()

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

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

#### Parameters

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



```

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

```

#### 4.6.2.2 ~HexMap()

```

HexMap::~HexMap (
    void )

```

Destructor for the [HexMap](#) class.

```

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

```

### 4.6.3 Member Function Documentation

#### 4.6.3.1 \_\_assembleHexMap()

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

Helper method to assemble the hex map.

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

#### 4.6.3.2 \_\_assessNeighbours()

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

Helper method to assess all neighbours of the given tile.

##### Parameters

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

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

#### 4.6.3.3 \_\_buildDrawOrderVector()

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

Helper method to build tile drawing order vector.

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

```

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

```

#### 4.6.3.4 \_\_drawTotalDispatch()

```

void HexMap::__drawTotalDispatch (
    void ) [private]

```

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

```

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

```

```

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

```

```

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

```

#### 4.6.3.5 \_\_enforceOceanContinuity()

```

void HexMap::__enforceOceanContinuity (
    void ) [private]

```

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

```

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

```

#### 4.6.3.6 \_\_getMajorityTileType()

```

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

```

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

## Parameters

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

## Returns

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

```

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

```

## 4.6.3.7 \_\_getNeighboursVector()

```

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

```

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

## Parameters

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

**Returns**

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

```

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

```

**4.6.3.8 \_\_getNoise()**

```

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

```

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

**Parameters**

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

**Returns**

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

```

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

```

```

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

```

#### 4.6.3.9 \_\_getSelectedTile()

```

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

```

Helper method to get pointer to selected tile.



**Returns**

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

```

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

```

**4.6.3.10 \_\_getValidMapIndexPositions()**

```

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

```

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

**Parameters**

<i>potential</i> ↔ _x	The potential x position of the tile.
<i>potential</i> ↔ _y	The potential y position of the tile.

**Returns**

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

```

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

```

```

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

```

#### 4.6.3.11 \_\_handleInitialDraw()

```

void HexMap::__handleInitialDraw (
    void ) [private]

```

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

```

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

```

#### 4.6.3.12 \_\_handleKeyPressEvents()

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

Helper method to handle key press events.

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

#### 4.6.3.13 \_\_handleMouseButtonEvents()

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

Helper method to handle mouse button events.

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

#### 4.6.3.14 \_\_isLakeTouchingOcean()

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

#### 4.6.3.15 \_\_layTiles()

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

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

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

```

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

```

```

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

```

#### 4.6.3.16 \_\_logSettlementPosition()

```

void HexMap::__logSettlementPosition (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.6.3.17 \_\_procedurallyGenerateTileResources()

```

void HexMap::__procedurallyGenerateTileResources (
    void ) [private]

```

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

```

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

```

#### 4.6.3.18 \_\_procedurallyGenerateTileTypes()

```

void HexMap::__procedurallyGenerateTileTypes (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.6.3.19 \_\_sendNoTileSelectedMessage()

```

void HexMap::__sendNoTileSelectedMessage (
    void ) [private]

```

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

```

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

```

#### 4.6.3.20 \_\_setUpGlassScreen()

```

void HexMap::__setUpGlassScreen (
    void ) [private]

```

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

```

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

```



**4.6.3.21 \_\_setUpInitialDraw()**

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

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

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

**4.6.3.22 \_\_smoothTileTypes()**

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

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

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

**4.6.3.23 assess()**

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

Method to assess the resource of the selected tile.

```

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

```

#### 4.6.3.24 clear()

```

void HexMap::clear (
    void )

```

Method to clear the hex map.

```

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

```

#### 4.6.3.25 draw()

```

void HexMap::draw (
    void )

```

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

```

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

```

```

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

```

#### 4.6.3.26 processEvent()

```

void HexMap::processEvent (
    void )

```

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

```

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

```

#### 4.6.3.27 processMessage()

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

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

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

#### 4.6.3.28 reroll()

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

Method to re-roll the hex map.

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

#### 4.6.3.29 toggleResourceOverlay()

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

Method to toggle the hex map resource overlay.

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

### 4.6.4 Member Data Documentation

#### 4.6.4.1 assets\_manager\_ptr

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

A pointer to the assets manager.

#### 4.6.4.2 border\_tiles\_vec

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

A vector of pointers to the border tiles.

#### 4.6.4.3 dalpha

```
double HexMap::dalpha
```

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

#### 4.6.4.4 demand\_MWh

```
int HexMap::demand_MWh
```

Current energy demand [MWh].

#### 4.6.4.5 event\_ptr

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

A pointer to the event class.

#### 4.6.4.6 frame

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

The current frame of this object.

#### 4.6.4.7 glass\_screen

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

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

#### 4.6.4.8 hex\_draw\_order\_vec

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

A vector of hex tiles, in drawing order.

#### 4.6.4.9 hex\_map

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

A position-indexed, nested map of hex tiles.

#### 4.6.4.10 initial\_draw\_tile\_idx

```
size_t HexMap::initial_draw_tile_idx
```

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

#### 4.6.4.11 just\_constructed

```
bool HexMap::just_constructed
```

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

#### 4.6.4.12 message\_hub\_ptr

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

A pointer to the message hub.

#### 4.6.4.13 n\_layers

```
int HexMap::n_layers
```

The number of layers in the hex map.

#### 4.6.4.14 n\_tiles

```
int HexMap::n_tiles
```

The number of tiles in the hex map.

#### 4.6.4.15 position\_x

```
double HexMap::position_x
```

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

#### 4.6.4.16 position\_y

```
double HexMap::position_y
```

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

#### 4.6.4.17 render\_window\_ptr

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

A pointer to the render window.

#### 4.6.4.18 settlement\_position\_logged

```
bool HexMap::settlement_position_logged
```

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

#### 4.6.4.19 settlement\_position\_x

```
double HexMap::settlement_position_x
```

The x position of the settlement.

#### 4.6.4.20 settlement\_position\_y

```
double HexMap::settlement_position_y
```

The y position of the settlement.

#### 4.6.4.21 show\_resource

```
bool HexMap::show_resource
```

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



#### 4.6.4.22 tile\_position\_x\_vec

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

A vector of tile x positions.

#### 4.6.4.23 tile\_position\_y\_vec

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

A vector of tile y position.

#### 4.6.4.24 tile\_selected

```
bool HexMap::tile_selected
```

A boolean which indicates if a tile is currently selected.

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

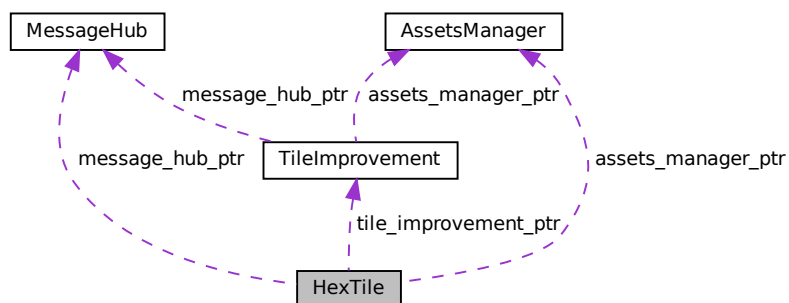
- header/[HexMap.h](#)
- source/[HexMap.cpp](#)

## 4.7 HexTile Class Reference

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

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

Collaboration diagram for HexTile:



## Public Member Functions

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

## Public Attributes

- [TileType](#) [tile\\_type](#)  
*The terrain type of the tile.*
- [TileResource](#) [tile\\_resource](#)  
*The renewable resource quality of the tile.*
- bool [show\\_node](#)  
*A boolean which indicates whether or not to show the tile node.*
- bool [show\\_resource](#)  
*A boolean which indicates whether or not to show resource value.*
- bool [resource\\_assessed](#)  
*A boolean which indicates whether or not the resource has been assessed.*
- bool [resource\\_assessment](#)  
*A boolean which triggers a resource assessment notification.*
- bool [is\\_selected](#)  
*A boolean which indicates whether or not the tile is selected.*
- bool [draw\\_explosion](#)  
*A boolean which indicates whether or not to draw a tile explosion.*
- bool [decoration\\_cleared](#)  
*A boolean which indicates if the tile decoration has been cleared.*
- bool [has\\_improvement](#)  
*A boolean which indicates if tile has improvement or not.*
- [TileImprovement](#) \* [tile\\_improvement\\_ptr](#)

- A pointer to the improvement for this tile.*

  - bool [build\\_menu\\_open](#)

*A boolean which indicates if the tile build menu is open.*
  - size\_t [explosion\\_frame](#)

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

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

*The current balance of credits.*
  - int [scrap\\_improvement\\_frame](#)

*A frame for key-hold to confirm scrapping.*
  - double [position\\_x](#)

*The x position of the tile.*
  - double [position\\_y](#)

*The y position of the tile.*
  - double [major\\_radius](#)

*The radius of the smallest bounding circle.*
  - double [minor\\_radius](#)

*The radius of the largest inscribed circle.*
  - std::string [game\\_phase](#)

*The current phase of the game.*
  - sf::CircleShape [node\\_sprite](#)

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

*A convex shape which represents the tile.*
  - sf::ConvexShape [select\\_outline\\_sprite](#)

*A convex shape which outlines the tile when selected.*
  - sf::CircleShape [resource\\_chip\\_sprite](#)

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

*A text representation of the resource.*
  - sf::Sprite [tile\\_decoration\\_sprite](#)

*A tile decoration sprite.*
  - sf::Sprite [magnifying\\_glass\\_sprite](#)

*A magnifying glass sprite.*
  - std::vector< sf::Sprite > [explosion\\_sprite\\_reel](#)

*A reel of sprites for a tile explosion animation.*
  - sf::RectangleShape [build\\_menu\\_backing](#)

*A backing for the tile build menu.*
  - sf::Text [build\\_menu\\_backing\\_text](#)

*A text label for the build menu.*
  - std::vector< std::vector< sf::Sprite > > [build\\_menu\\_options\\_vec](#)

*A vector of sprites for illustrating the tile build options.*
  - std::vector< sf::Text > [build\\_menu\\_options\\_text\\_vec](#)

*A vector of text for the tile build options.*

## Private Member Functions

- void [\\_\\_setUpNodeSprite](#) (void)  
*Helper method to set up node sprite.*
- void [\\_\\_setUpTileSprite](#) (void)  
*Helper method to set up tile sprite.*
- void [\\_\\_setUpSelectOutlineSprite](#) (void)  
*Helper method to set up select outline sprite.*
- void [\\_\\_setUpResourceChipSprite](#) (void)  
*Helper method to set up resource chip sprite.*
- void [\\_\\_setResourceText](#) (void)  
*Helper method to set up resource text.*
- void [\\_\\_setUpMagnifyingGlassSprite](#) (void)  
*Helper method to set up and position magnifying glass sprite.*
- void [\\_\\_setUpTileExplosionReel](#) (void)  
*Helper method to set up tile explosion sprite reel.*
- void [\\_\\_setUpBuildOption](#) (std::string, std::string)  
*Helper method to set up and position the sprite and text for a build option.*
- void [\\_\\_setUpDieselGeneratorBuildOption](#) (void)  
*Helper method to set up and position the diesel generator build option.*
- void [\\_\\_setUpWindTurbineBuildOption](#) (bool=false, bool=false)  
*Helper method to set up and position the wind turbine build option.*
- void [\\_\\_setUpSolarPVBuildOption](#) (bool=false)  
*Helper method to set up and position the solar PV array build option.*
- void [\\_\\_setUpTidalTurbineBuildOption](#) (void)  
*Helper method to set up and position the tidal turbine build option.*
- void [\\_\\_setUpWaveEnergyConverterBuildOption](#) (void)  
*Helper method to set up and position the wave energy converter build option.*
- void [\\_\\_setUpEnergyStorageSystemBuildOption](#) (void)  
*Helper method to set up and position the wave energy converter build option.*
- void [\\_\\_setUpBuildMenu](#) (void)  
*Helper method to set up and place build menu assets (drawable).*
- void [\\_\\_setIsSelected](#) (bool)  
*Helper method to set the is selected attribute (of tile and improvement).*
- void [\\_\\_clearDecoration](#) (void)  
*Helper method to clear tile decoration.*
- bool [\\_\\_isClicked](#) (void)  
*Helper method to determine if tile was clicked on.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleKeyReleaseEvents](#) (void)
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_openBuildMenu](#) (void)  
*Helper method to open the tile improvement build menu.*
- void [\\_\\_closeBuildMenu](#) (void)  
*Helper method to close the tile improvement build menu.*
- void [\\_\\_buildSettlement](#) (void)  
*Helper method to build a settlement on this tile.*
- void [\\_\\_buildDieselGenerator](#) (void)  
*Helper method to build a diesel generator on this tile.*

- void [\\_\\_buildSolarPV](#) (void)  
*Helper method to build a solar PV array on this tile.*
- void [\\_\\_buildWindTurbine](#) (void)  
*Helper method to build a wind turbine on this tile.*
- void [\\_\\_buildTidalTurbine](#) (void)  
*Helper method to build a tidal turbine on this tile.*
- void [\\_\\_buildWaveEnergyConverter](#) (void)  
*Helper method to build a wave energy converter on this tile.*
- void [\\_\\_buildEnergyStorage](#) (void)  
*Helper method to build an energy storage system on this tile. DEPRECATED.*
- void [\\_\\_scrapImprovement](#) (void)  
*Helper method to scrap the tile improvement ([Settlement](#) cannot be scrapped). Requires the mapped key to be held continuously to confirm.*
- void [\\_\\_sendTileSelectedMessage](#) (void)  
*Helper method to format and send message on tile selection.*
- std::string [\\_\\_getTileCoordsSubstring](#) (void)  
*Helper method to assemble and return tile coordinates substring.*
- std::string [\\_\\_getTileTypeSubstring](#) (void)  
*Helper method to assemble and return tile type substring.*
- std::string [\\_\\_getTileResourceSubstring](#) (void)  
*Helper method to assemble and return tile resource substring.*
- std::string [\\_\\_getTileImprovementSubstring](#) (void)  
*Helper method to assemble and return the tile improvement substring.*
- std::string [\\_\\_getTileOptionsSubstring](#) (void)  
*Helper method to assemble and return tile options substring.*
- void [\\_\\_sendTileStateMessage](#) (void)  
*Helper method to format and send tile state message.*
- void [\\_\\_sendAssessNeighboursMessage](#) (void)  
*Helper method to format and send assess neighbours message.*
- void [\\_\\_sendGameStateRequest](#) (void)  
*Helper method to format and send a game state request (message).*
- void [\\_\\_sendUpdateGamePhaseMessage](#) (std::string)  
*Helper method to format and send update game phase message.*
- void [\\_\\_sendCreditsSpentMessage](#) (int)  
*Helper method to format and send a credits spent message.*
- void [\\_\\_sendInsufficientCreditsMessage](#) (void)  
*Helper method to format and send an insufficient credits message.*

## Private Attributes

- sf::Event \* [event\\_ptr](#)  
*A pointer to the event class.*
- sf::RenderWindow \* [render\\_window\\_ptr](#)  
*A pointer to the render window.*
- [AssetsManager](#) \* [assets\\_manager\\_ptr](#)  
*A pointer to the assets manager.*
- [MessageHub](#) \* [message\\_hub\\_ptr](#)  
*A pointer to the message hub.*

### 4.7.1 Detailed Description

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

### 4.7.2 Constructor & Destructor Documentation

#### 4.7.2.1 HexTile()

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

Constructor for the [HexTile](#) class.

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

#### Parameters

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

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

```

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

```

#### 4.7.2.2 ~HexTile()

```

HexTile::~HexTile (
    void )

```

Destructor for the [HexTile](#) class.

```

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

```

### 4.7.3 Member Function Documentation

#### 4.7.3.1 \_\_buildDieselGenerator()

```

void HexTile::__buildDieselGenerator (
    void ) [private]

```

Helper method to build a diesel generator on this tile.

```

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

```

```

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

```

#### 4.7.3.2 \_\_buildEnergyStorage()

```

void HexTile::__buildEnergyStorage (
    void ) [private]

```

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

```

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

```

#### 4.7.3.3 \_\_buildSettlement()

```

void HexTile::__buildSettlement (
    void ) [private]

```

Helper method to build a settlement on this tile.

```

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

```



```

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

```

#### 4.7.3.4 \_\_buildSolarPV()

```

void HexTile::__buildSolarPV (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.7.3.5 \_\_buildTidalTurbine()

```

void HexTile::__buildTidalTurbine (
    void ) [private]

```

Helper method to build a tidal turbine on this tile.

```

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

```

#### 4.7.3.6 \_\_buildWaveEnergyConverter()

```

void HexTile::__buildWaveEnergyConverter (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.7.3.7 \_\_buildWindTurbine()

```

void HexTile::__buildWindTurbine (
    void ) [private]

```

Helper method to build a wind turbine on this tile.

```

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

```

#### 4.7.3.8 \_\_clearDecoration()

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

Helper method to clear tile decoration.

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

#### 4.7.3.9 \_\_closeBuildMenu()

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

Helper method to close the tile improvement build menu.

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

#### 4.7.3.10 \_\_getTileCoordsSubstring()

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

Helper method to assemble and return tile coordinates substring.

**Returns**

Tile coordinates substring.

```

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

```

**4.7.3.11 \_\_getTileImprovementSubstring()**

```

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

```

Helper method to assemble and return the tile improvement substring.

**Returns**

Tile improvement substring.

```

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

```

**4.7.3.12 \_\_getTileOptionsSubstring()**

```

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

```

Helper method to assemble and return tile options substring.

**Returns**

Tile options substring.

```

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

```

```

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

```

#### 4.7.3.13 \_\_getTileResourceSubstring()

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

```
void ) [private]
```

Helper method to assemble and return tile resource substring.

#### Returns

Tile resource substring.

```

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

```

#### 4.7.3.14 \_\_getTileTypeSubstring()

```

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

```

Helper method to assemble and return tile type substring.

**Returns**

Tile type substring.

```

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

```

**4.7.3.15 \_\_handleKeyPressEvents()**

```

void HexTile::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

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

```



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

```
982
983         break;
984     }
985
986     default: {
987         // do nothing!
988
989         break;
990     }
991 }
992
993 break;
994 }
995
996
997 case (TileType :: OCEAN): {
998     switch (this->event_ptr->key.code) {
999         case (sf::Keyboard::W): {
1000             this->__buildWindTurbine();
1001
1002             break;
1003         }
1004
1005         case (sf::Keyboard::T): {
1006             this->__buildTidalTurbine();
1007
1008             break;
1009         }
1010
1011         case (sf::Keyboard::A): {
1012             this->__buildWaveEnergyConverter();
1013
1014             break;
1015         }
1016
1017         default: {
1018             // do nothing!
1019
1020             break;
1021         }
1022     }
1023
1024     break;
1025 }
1026
1027
1028 case (TileType :: PLAINS): {
1029     switch (this->event_ptr->key.code) {
1030         case (sf::Keyboard::D): {
1031             this->__buildDieselGenerator();
1032
1033             break;
1034         }
1035
1036         case (sf::Keyboard::S): {
1037             this->__buildSolarPV();
1038
1039             break;
1040         }
1041
1042         case (sf::Keyboard::W): {
1043             this->__buildWindTurbine();
1044
1045             break;
1046         }
1047
1048         case (sf::Keyboard::E): {
1049             this->__buildEnergyStorage();
1050
1051             break;
1052         }
1053
1054         default: {
1055             // do nothing!
1056
1057             break;
1058         }
1059     }
1060
1061     break;
1062 }
1063
1064 }
```

```

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

```

```

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

```

#### 4.7.3.16 \_\_handleKeyReleaseEvents()

```

void HexTile::__handleKeyReleaseEvents (
    void ) [private]

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

```

```

1234     }
1235
1236
1237     default: {
1238         // do nothing!
1239
1240         break;
1241     }
1242 }
1243
1244 /*
1245 if (this->event_ptr->key.code == sf::Keyboard::P) {
1246
1247 }
1248 */
1249
1250 return;
1251 } /* __handleKeyReleaseEvents() */

```

#### 4.7.3.17 \_\_handleMouseButtonEvents()

```

void HexTile::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

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

```

#### 4.7.3.18 \_\_isClicked()

```

bool HexTile::__isClicked (
    void ) [private]

```

Helper method to determine if tile was clicked on.

**Returns**

Boolean indicating whether or not tile was clicked on.

```

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

```

**4.7.3.19 \_\_openBuildMenu()**

```

void HexTile::__openBuildMenu (
    void ) [private]

```

Helper method to open the tile improvement build menu.

```

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

```

**4.7.3.20 \_\_scrapImprovement()**

```

void HexTile::__scrapImprovement (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.7.3.21 \_\_sendAssessNeighboursMessage()

```

void HexTile::__sendAssessNeighboursMessage (
    void ) [private]

```

Helper method to format and send assess neighbours message.

```

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

```

#### 4.7.3.22 \_\_sendCreditsSpentMessage()

```

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

```

Helper method to format and send a credits spent message.

## Parameters

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

```

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

```

## 4.7.3.23 \_\_sendGameStateRequest()

```

void HexTile::__sendGameStateRequest (
    void ) [private]

```

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

```

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

```

## 4.7.3.24 \_\_sendInsufficientCreditsMessage()

```

void HexTile::__sendInsufficientCreditsMessage (
    void ) [private]

```

Helper method to format and send an insufficient credits message.

```

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

```



**4.7.3.25 \_\_sendTileSelectedMessage()**

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

Helper method to format and send message on tile selection.

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

**4.7.3.26 \_\_sendTileStateMessage()**

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

Helper method to format and send tile state message.

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

**4.7.3.27 \_\_sendUpdateGamePhaseMessage()**

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

Helper method to format and send update game phase message.

**Parameters**

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

```

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

```

#### 4.7.3.28 \_\_setIsSelected()

```

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

```

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

##### Parameters

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

```

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

```

#### 4.7.3.29 \_\_setResourceText()

```

void HexTile::__setResourceText (
    void ) [private]

```

Helper method to set up resource text.

```

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

```

```

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

```

#### 4.7.3.30 \_\_setUpBuildMenu()

```

void HexTile::__setUpBuildMenu (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.7.3.31 \_\_setUpBuildOption()

```

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

```

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

##### Parameters

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

```

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

```

#### 4.7.3.32 \_\_setUpDieselGeneratorBuildOption()

```

void HexTile::__setUpDieselGeneratorBuildOption (
    void ) [private]

```

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

```

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

```

```

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

```

#### 4.7.3.33 \_\_setUpEnergyStorageSystemBuildOption()

```

void HexTile::__setUpEnergyStorageSystemBuildOption (
    void ) [private]

```

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

```

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

```

#### 4.7.3.34 \_\_setUpMagnifyingGlassSprite()

```

void HexTile::__setUpMagnifyingGlassSprite (
    void ) [private]

```

Helper method to set up and position magnifying glass sprite.

```

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

```

**4.7.3.35 \_\_setUpNodeSprite()**

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

Helper method to set up node sprite.

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

**4.7.3.36 \_\_setUpResourceChipSprite()**

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

Helper method to set up resource chip sprite.

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

**4.7.3.37 \_\_setUpSelectOutlineSprite()**

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

Helper method to set up select outline sprite.

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

#### 4.7.3.38 \_\_setUpSolarPVBuildOption()

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

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

##### Parameters

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

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

#### 4.7.3.39 \_\_setUpTidalTurbineBuildOption()

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

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

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



**4.7.3.40 \_\_setUpTileExplosionReel()**

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

Helper method to set up tile explosion sprite reel.

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

**4.7.3.41 \_\_setUpTileSprite()**

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

Helper method to set up tile sprite.

```
96 {
97     int n_points = 6;
98
99     this->tile_sprite.setPointCount(n_points);
100
101     for (int i = 0; i < n_points; i++) {
102         this->tile_sprite.setPoint(
103             i,
104             sf::Vector2f(
105                 this->position_x + this->major_radius * cos((30 + 60 * i) * (M_PI / 180)),
106                 this->position_y + this->major_radius * sin((30 + 60 * i) * (M_PI / 180))
107             )
108         );
109     }
110
111     this->tile_sprite.setOutlineThickness(1);
112     this->tile_sprite.setOutlineColor(sf::Color(175, 175, 175, 255));
113
114     return;
115 } /* __setUpTileSprite() */
```

**4.7.3.42 \_\_setUpWaveEnergyConverterBuildOption()**

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

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

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

```

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

```

#### 4.7.3.43 \_\_setUpWindTurbineBuildOption()

```

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

```

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

##### Parameters

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

```

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

```

**4.7.3.44 assess()**

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

Method to assess the tile's resource.

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

**4.7.3.45 decorateTile()**

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

Method to decorate tile.

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

```

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

```

#### 4.7.3.46 draw()

```

void HexTile::draw (
    void )

```

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

```

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

```

```

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

```

#### 4.7.3.47 processEvent()

```

void HexTile::processEvent (
    void )

```

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

```

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

```

```

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

```

#### 4.7.3.48 processMessage()

```

void HexTile::processMessage (
    void )

```

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

```

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

```

**4.7.3.49 setTitleResource() [1/2]**

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

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

**Parameters**

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

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

**4.7.3.50 setTitleResource() [2/2]**

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

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

**Parameters**

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

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

**4.7.3.51 setTileType() [1/2]**

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

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

**Parameters**

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

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

**4.7.3.52 setTileType() [2/2]**

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

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

**Parameters**

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

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



```

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

```

#### 4.7.3.53 toggleResourceOverlay()

```

void HexTile::toggleResourceOverlay (
    void )

```

Method to toggle the tile resource overlay.

```

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

```

## 4.7.4 Member Data Documentation

### 4.7.4.1 assets\_manager\_ptr

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

A pointer to the assets manager.

#### 4.7.4.2 build\_menu\_backing

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

A backing for the tile build menu.

#### 4.7.4.3 build\_menu\_backing\_text

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

A text label for the build menu.

#### 4.7.4.4 build\_menu\_open

```
bool HexTile::build_menu_open
```

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

#### 4.7.4.5 build\_menu\_options\_text\_vec

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

A vector of text for the tile build options.

#### 4.7.4.6 build\_menu\_options\_vec

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

A vector of sprites for illustrating the tile build options.

#### 4.7.4.7 credits

```
int HexTile::credits
```

The current balance of credits.

#### 4.7.4.8 decoration\_cleared

```
bool HexTile::decoration_cleared
```

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

#### 4.7.4.9 draw\_explosion

```
bool HexTile::draw_explosion
```

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

#### 4.7.4.10 event\_ptr

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

A pointer to the event class.

#### 4.7.4.11 explosion\_frame

```
size_t HexTile::explosion_frame
```

The current frame of the explosion animation.

#### 4.7.4.12 explosion\_sprite\_reel

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

A reel of sprites for a tile explosion animation.

#### 4.7.4.13 frame

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

The current frame of this object.

#### 4.7.4.14 game\_phase

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

The current phase of the game.

#### 4.7.4.15 has\_improvement

```
bool HexTile::has_improvement
```

A boolean which indicates if tile has improvement or not.

#### 4.7.4.16 is\_selected

```
bool HexTile::is_selected
```

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

#### 4.7.4.17 magnifying\_glass\_sprite

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

A magnifying glass sprite.

#### 4.7.4.18 major\_radius

```
double HexTile::major_radius
```

The radius of the smallest bounding circle.

#### 4.7.4.19 message\_hub\_ptr

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

A pointer to the message hub.

#### 4.7.4.20 minor\_radius

```
double HexTile::minor_radius
```

The radius of the largest inscribed circle.

#### 4.7.4.21 node\_sprite

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

A circle shape to mark the tile node.

#### 4.7.4.22 position\_x

```
double HexTile::position_x
```

The x position of the tile.

#### 4.7.4.23 position\_y

```
double HexTile::position_y
```

The y position of the tile.

#### 4.7.4.24 render\_window\_ptr

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

A pointer to the render window.

#### 4.7.4.25 resource\_assessed

```
bool HexTile::resource_assessed
```

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

#### 4.7.4.26 resource\_assessment

```
bool HexTile::resource_assessment
```

A boolean which triggers a resource assessment notification.

#### 4.7.4.27 resource\_chip\_sprite

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

A circle shape which represents a resource chip.

#### 4.7.4.28 resource\_text

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

A text representation of the resource.

#### 4.7.4.29 scrap\_improvement\_frame

```
int HexTile::scrap_improvement_frame
```

A frame for key-hold to confirm scrapping.

#### 4.7.4.30 select\_outline\_sprite

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

A convex shape which outlines the tile when selected.

#### 4.7.4.31 show\_node

```
bool HexTile::show_node
```

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

#### 4.7.4.32 show\_resource

```
bool HexTile::show_resource
```

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

#### 4.7.4.33 tile\_decoration\_sprite

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

A tile decoration sprite.

#### 4.7.4.34 tile\_improvement\_ptr

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

A pointer to the improvement for this tile.

#### 4.7.4.35 tile\_resource

```
TileResource HexTile::tile_resource
```

The renewable resource quality of the tile.

#### 4.7.4.36 tile\_sprite

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

A convex shape which represents the tile.

#### 4.7.4.37 tile\_type

```
TileType HexTile::tile_type
```

The terrain type of the tile.

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

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

## 4.8 Message Struct Reference

A structure which defines a standard message format.

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

### Public Attributes

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

### 4.8.1 Detailed Description

A structure which defines a standard message format.

### 4.8.2 Member Data Documentation

#### 4.8.2.1 bool\_payload

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

A boolean payload.

#### 4.8.2.2 channel

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

A string identifying the appropriate channel for this message.



#### 4.8.2.3 double\_payload

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

A double payload.

#### 4.8.2.4 int\_payload

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

An int payload.

#### 4.8.2.5 number\_of\_reads

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

The number of times the message has been read.

#### 4.8.2.6 string\_payload

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

A string payload.

#### 4.8.2.7 subject

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

A string describing the message subject.

#### 4.8.2.8 vector\_payload

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

A vector (double) payload.

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

- header/ESC\_core/[MessageHub.h](#)

## 4.9 MessageHub Class Reference

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

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

### Public Member Functions

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

### Private Attributes

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

#### 4.9.1 Detailed Description

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

## 4.9.2 Constructor & Destructor Documentation

### 4.9.2.1 MessageHub()

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

Constructor for the [MessageHub](#) class.

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

### 4.9.2.2 ~MessageHub()

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

Destructor for the [MessageHub](#) class.

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

## 4.9.3 Member Function Documentation

### 4.9.3.1 addChannel()

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

Method to add channel to message map.

#### Parameters

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

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

```

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

```

#### 4.9.3.2 clear()

```

void MessageHub::clear (
    void )

```

Method to clear the [MessageHub](#).

```

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

```

#### 4.9.3.3 clearMessages()

```

void MessageHub::clearMessages (
    void )

```

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

```

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

```

#### 4.9.3.4 hasTraffic()

```

bool MessageHub::hasTraffic (
    void )

```

Method to determine if there remains any message traffic.

```

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

```

#### 4.9.3.5 incrementMessageRead()

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

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

##### Parameters

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

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

#### 4.9.3.6 isEmpty()

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

Method to check if channel is empty.

##### Parameters

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

##### Returns

A boolean indicating whether the channel is empty or not.

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

```

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

```

#### 4.9.3.7 popMessage()

```

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

```

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

##### Parameters

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

```

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

```

#### 4.9.3.8 printState()

```

void MessageHub::printState (
    void )

```

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

```

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

```

#### 4.9.3.9 receiveMessage()

```

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

```

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

##### Parameters

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

##### Returns

The first message in the given channel.

```

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

```

```

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

```

#### 4.9.3.10 removeChannel()

```

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

```

Method to remove channel from message map.

##### Parameters

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

```

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

```

#### 4.9.3.11 sendMessage()

```

void MessageHub::sendMessage (
    Message message )

```

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

##### Parameters

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



```

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

```

## 4.9.4 Member Data Documentation

### 4.9.4.1 message\_map

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

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

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

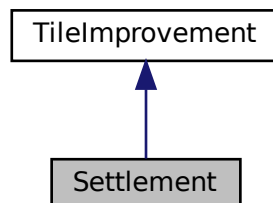
- header/ESC\_core/[MessageHub.h](#)
- source/ESC\_core/[MessageHub.cpp](#)

## 4.10 Settlement Class Reference

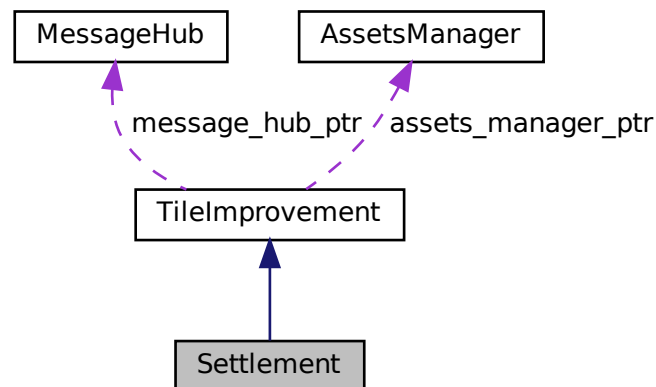
A settlement class (child class of [TileImprovement](#)).

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

Inheritance diagram for Settlement:



Collaboration diagram for Settlement:



## Public Member Functions

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

## Public Attributes

- bool [draw\\_coin](#)  
*Boolean indicating whether or not to draw credits earned coin.*
- double [smoke\\_da](#)  
*The per frame delta in smoke particle alpha value.*
- double [smoke\\_dx](#)  
*The per frame delta in smoke particle x position.*
- double [smoke\\_dy](#)  
*The per frame delta in smoke particle y position.*
- double [smoke\\_prob](#)  
*The probability of spawning a new smoke prob in any given frame.*
- std::list< sf::Sprite > [smoke\\_sprite\\_list](#)  
*A list of smoke sprite (for chimney animation).*
- sf::Sprite [coin\\_sprite](#)  
*A coin sprite (for credits earned animation).*

## Private Member Functions

- void [\\_\\_setUpTileImprovementSpriteStatic](#) (void)  
*Helper method to set up tile improvement sprite (static).*
- void [\\_\\_setUpCoinSprite](#) (void)  
*Helper method to set up and place coin sprite.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*

## Additional Inherited Members

### 4.10.1 Detailed Description

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

### 4.10.2 Constructor & Destructor Documentation

#### 4.10.2.1 Settlement()

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

Constructor for the [Settlement](#) class.

Ref: [Wikipedia](#) [2023]

#### Parameters

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

```
241 :
242 TileImprovement (
```

```

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

```

#### 4.10.2.2 ~Settlement()

```

Settlement::~Settlement (
    void ) [virtual]

```

Destructor for the [Settlement](#) class.

```

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

```

### 4.10.3 Member Function Documentation

#### 4.10.3.1 \_\_handleKeyPressEvents()

```

void Settlement::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

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

```

```

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

```

#### 4.10.3.2 \_\_handleMouseButtonEvents()

```

void Settlement::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

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

```

#### 4.10.3.3 \_\_setUpCoinSprite()

```

void Settlement::__setUpCoinSprite (
    void ) [private]

```

Helper method to set up and place coin sprite.

```

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

```

#### 4.10.3.4 \_\_setUpTileImprovementSpriteStatic()

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

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

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

#### 4.10.3.5 draw()

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

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

Reimplemented from [TileImprovement](#).

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

```

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

```

#### 4.10.3.6 getTileOptionsSubstring()

```

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

```

Helper method to assemble and return tile options substring.

##### Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

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

```

#### 4.10.3.7 processEvent()

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

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

Reimplemented from [TileImprovement](#).

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

#### 4.10.3.8 processMessage()

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

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

Reimplemented from [TileImprovement](#).

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

#### 4.10.3.9 setIsSelected()

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

Method to set the is selected attribute.

##### Parameters

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



Reimplemented from [TileImprovement](#).

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

## 4.10.4 Member Data Documentation

### 4.10.4.1 coin\_sprite

`sf::Sprite Settlement::coin_sprite`

A coin sprite (for credits earned animation).

### 4.10.4.2 draw\_coin

`bool Settlement::draw_coin`

Boolean indicating whether or not to draw credits earned coin.

### 4.10.4.3 smoke\_da

`double Settlement::smoke_da`

The per frame delta in smoke particle alpha value.

### 4.10.4.4 smoke\_dx

`double Settlement::smoke_dx`

The per frame delta in smoke particle x position.

### 4.10.4.5 smoke\_dy

`double Settlement::smoke_dy`

The per frame delta in smoke particle y position.

#### 4.10.4.6 smoke\_prob

```
double Settlement::smoke_prob
```

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

#### 4.10.4.7 smoke\_sprite\_list

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

A list of smoke sprite (for chimney animation).

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

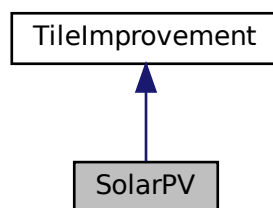
- header/[Settlement.h](#)
- source/[Settlement.cpp](#)

## 4.11 SolarPV Class Reference

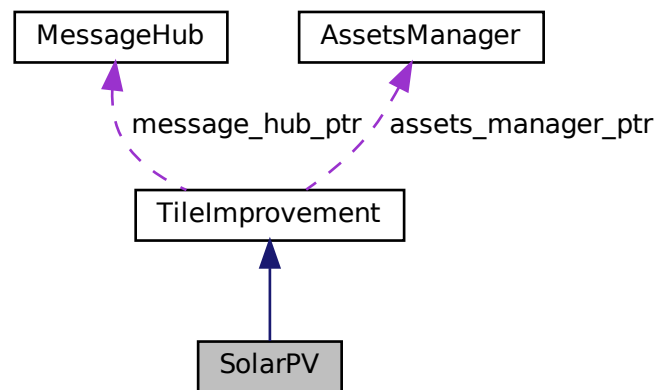
A settlement class (child class of [TileImprovement](#)).

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

Inheritance diagram for SolarPV:



Collaboration diagram for SolarPV:



## Public Member Functions

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

## Public Attributes

- int [capacity\\_kW](#)  
*The rated production capacity [kW] of the solar PV array.*
- int [production\\_MWh](#)  
*The current production [MWh] of the solar PV array.*
- int [dispatch\\_MWh](#)  
*The current dispatch [MWh] of the solar PV array.*

- int [dispatchable\\_MWh](#)  
*The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).*
- double [max\\_daily\\_production\\_MWh](#)  
*The maximum daily production [MWh] of the solar PV array.*
- std::vector< double > [capacity\\_factor\\_vec](#)  
*A vector of daily capacity factors for the current month.*
- std::vector< double > [production\\_vec\\_MWh](#)  
*A vector of daily production [MWh] for the current month.*
- std::vector< double > [dispatch\\_vec\\_MWh](#)  
*A vector of daily dispatch [MWh] for the current month.*

## Private Member Functions

- void [\\_\\_setUpTileImprovementSpriteStatic](#) (void)  
*Helper method to set up tile improvement sprite (static).*
- void [\\_\\_drawProductionMenu](#) (void)  
*Helper method to draw production menu assets.*
- void [\\_\\_upgradePowerCapacity](#) (void)  
*Helper method to upgrade power capacity.*
- void [\\_\\_computeProductionCosts](#) (void)  
*Helper method to compute production costs (O&M) based on current production level.*
- void [\\_\\_breakdown](#) (void)  
*Helper method to trigger an equipment breakdown.*
- void [\\_\\_repair](#) (void)  
*Helper method to repair the solar PV array.*
- void [\\_\\_computeCapacityFactors](#) (void)  
*Helper method to compute capacity factors (by definition in the closed interval [0, 1]).*
- void [\\_\\_computeProduction](#) (void)  
*Helper method to compute production values.*
- void [\\_\\_computeDispatch](#) (void)  
*Helper method to compute dispatch values.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_drawUpgradeOptions](#) (void)  
*Helper method to set up and draw upgrade options.*
- void [\\_\\_sendImprovementStateMessage](#) (void)  
*Helper method to format and sent improvement state message.*

## Additional Inherited Members

### 4.11.1 Detailed Description

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

## 4.11.2 Constructor & Destructor Documentation

### 4.11.2.1 SolarPV()

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

Constructor for the [SolarPV](#) class.

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

#### Parameters

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

```
777 :
778 TileImprovement (
779     position_x,
780     position_y,
781     tile_resource,
782     event_ptr,
783     render_window_ptr,
784     assets_manager_ptr,
785     message_hub_ptr
786 )
787 {
788     // 1. set attributes
789
790     // 1.1. private
791     //...
792
793     // 1.2. public
794     this->tile_improvement_type = TileImprovementType :: SOLAR_PV;
795
796     this->is_running = false;
797
798     this->health = 100;
799
800     this->capacity_kW = 100;
801     this->upgrade_level = 1;
802
803     this->storage_kWh = 0;
804     this->storage_level = 0;
805
806     this->production_MWh = 0;
807     this->dispatch_MWh = 0;
808     this->dispatchable_MWh = 0;
809
810     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
811
812     this->capacity_factor_vec.resize(30, 0);
813     this->production_vec_MWh.resize(30, 0);
```

```

814     this->dispatch_vec_MWh.resize(30, 0);
815
816     this->tile_improvement_string = "SOLAR PV ARRAY";
817
818     this->__setUpTileImprovementSpriteStatic();
819     this->__computeCapacityFactors();
820     this->update();
821
822     std::cout << "SolarPV constructed at " << this << std::endl;
823
824     return;
825 } /* SolarPV() */

```

#### 4.11.2.2 ~SolarPV()

```

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

```

Destructor for the [SolarPV](#) class.

```

1165 {
1166     std::cout << "SolarPV at " << this << " destroyed" << std::endl;
1167
1168     return;
1169 } /* ~SolarPV() */

```

### 4.11.3 Member Function Documentation

#### 4.11.3.1 \_\_breakdown()

```

void SolarPV::__breakdown (
    void ) [private]

```

Helper method to trigger an equipment breakdown.

```

240 {
241     TileImprovement :: __breakdown();
242
243     this->production_MWh = 0;
244     this->dispatch_MWh = 0;
245     this->dispatchable_MWh = 0;
246     this->operation_maintenance_cost = 0;
247
248     return;
249 } /* __breakdown() */

```

## 4.11.3.2 \_\_computeCapacityFactors()

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

Helper method to compute capacity factors (by definition in the closed interval [0, 1]).

```
298 {
299     if (this->is_broken) {
300         return;
301     }
302
303     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
304     std::default_random_engine generator(seed);
305
306     double mean =
307         this->tile_resource_scalar * MEAN_DAILY_SOLAR_CAPACITY_FACTORS[this->month - 1];
308
309     double stdev = STDEV_DAILY_SOLAR_CAPACITY_FACTORS[this->month - 1];
310
311     if (this->tile_resource_scalar > 1) {
312         stdev /= this->tile_resource_scalar;
313     }
314
315     double performance_factor = this->__getPerformanceFactor();
316
317     std::normal_distribution<double> normal_dist(mean, stdev);
318
319     double capacity_factor = 0;
320
321     for (int i = 0; i < 30; i++) {
322         capacity_factor = performance_factor * normal_dist(generator);
323
324         if (capacity_factor < 0) {
325             capacity_factor = 0;
326         }
327
328         else if (capacity_factor > 1) {
329             capacity_factor = 1;
330         }
331
332         this->capacity_factor_vec[i] = capacity_factor;
333     }
334
335     return;
336 } /* __computeCapacityFactors() */
```

## 4.11.3.3 \_\_computeDispatch()

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

Helper method to compute dispatch values.

```
384 {
385     if (this->is_broken) {
386         this->dispatchable_MWh = 0;
387         return;
388     }
389
390     double stored_energy_MWh = 0;
391     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
392
393     double demand_MWh = 0;
394     double production_MWh = 0;
395     double dispatchable_MWh = 0;
396     double difference_MWh = 0;
397
398     double room_MWh = 0;
399
400     for (int i = 0; i < 30; i++) {
401         demand_MWh = this->demand_vec_MWh[i];
402         production_MWh = this->production_vec_MWh[i];
403
404         if (production_MWh <= demand_MWh) {
405             this->dispatch_vec_MWh[i] = production_MWh;
406             dispatchable_MWh += this->dispatch_vec_MWh[i];
407         }
408         else {
409             this->dispatch_vec_MWh[i] = demand_MWh - production_MWh;
410             difference_MWh += this->dispatch_vec_MWh[i];
411         }
412     }
413
414     this->dispatchable_MWh = dispatchable_MWh;
415     this->difference_MWh = difference_MWh;
416 }
```

```

407         difference_MWh = demand_MWh - production_MWh;
408
409
410         if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
411             if (difference_MWh > stored_energy_MWh) {
412                 this->dispatch_vec_MWh[i] += stored_energy_MWh;
413                 dispatchable_MWh += stored_energy_MWh;
414                 stored_energy_MWh = 0;
415             }
416
417             else {
418                 this->dispatch_vec_MWh[i] += difference_MWh;
419                 dispatchable_MWh += difference_MWh;
420                 stored_energy_MWh -= difference_MWh;
421             }
422         }
423     }
424
425     else {
426         this->dispatch_vec_MWh[i] = demand_MWh;
427         dispatchable_MWh += this->dispatch_vec_MWh[i];
428
429         difference_MWh = production_MWh - demand_MWh;
430
431         if (
432             (storage_capacity_MWh > 0) and
433             (stored_energy_MWh < storage_capacity_MWh)
434         ) {
435             room_MWh = storage_capacity_MWh - stored_energy_MWh;
436
437             if (difference_MWh > room_MWh) {
438                 stored_energy_MWh += room_MWh;
439             }
440
441             else {
442                 stored_energy_MWh += difference_MWh;
443             }
444         }
445     }
446 }
447
448 this->dispatchable_MWh = round(dispatchable_MWh);
449
450 if (this->dispatch_MWh <= 0) {
451     this->dispatch_MWh = 0;
452 }
453
454 else if (this->dispatch_MWh != this->dispatchable_MWh) {
455     this->dispatch_MWh = this->dispatchable_MWh;
456 }
457
458 return;
459 } /* __computeDispatch() */

```

#### 4.11.3.4 \_\_computeProduction()

```

void SolarPV::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

351 {
352     if (this->is_broken) {
353         this->production_MWh = 0;
354         return;
355     }
356
357     double production_MWh = 0;
358
359     for (int i = 0; i < 30; i++) {
360         this->production_vec_MWh[i] =
361             this->max_daily_production_MWh * this->capacity_factor_vec[i];
362
363         production_MWh += this->production_vec_MWh[i];
364     }
365
366     this->production_MWh = round(production_MWh);
367
368     return;
369 } /* __computeProduction() */

```



## 4.11.3.5 \_\_computeProductionCosts()

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

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

```
212 {
213     if (this->is_running) {
214         double operation_maintenance_cost =
215             (this->production_MWh * SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
216         this->operation_maintenance_cost = round(operation_maintenance_cost);
217     }
218 }
219
220 else {
221     this->operation_maintenance_cost = 0;
222 }
223
224 return;
225 } /* __computeProductionCosts() */
```

## 4.11.3.6 \_\_drawProductionMenu()

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

Helper method to draw production menu assets.

```
103 {
104     // 1. draw static sprite
105     sf::Vector2f initial_position = this->tile_improvement_sprite_static.getPosition();
106     this->tile_improvement_sprite_static.setPosition(400 - 138, 400 + 16);
107
108     sf::Color initial_colour = this->tile_improvement_sprite_static.getColor();
109     this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
110
111     sf::Vector2f initial_scale = this->tile_improvement_sprite_static.getScale();
112     this->tile_improvement_sprite_static.setScale(sf::Vector2f(1, 1));
113
114     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
115
116     this->tile_improvement_sprite_static.setPosition(initial_position);
117     this->tile_improvement_sprite_static.setColor(initial_colour);
118     this->tile_improvement_sprite_static.setScale(initial_scale);
119
120     // 2. draw production text
121     std::string production_string = "[W]: INCREASE DISPATCH\n";
122     production_string += "[S]: DECREASE DISPATCH\n";
123     production_string += "\n";
124
125     production_string += "DISPATCH: ";
126     production_string += std::to_string(this->dispatch_MWh);
127     production_string += " MWh (MAX ";
128     production_string += std::to_string(this->dispatchable_MWh);
129     production_string += ")\n";
130
131     production_string += "O&M COST: ";
132     production_string += std::to_string(this->operation_maintenance_cost);
133     production_string += " K\n";
134
135     sf::Text production_text(
136         production_string,
137         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
138         16
139     );
140
141     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
142     production_text.setFillColor(MONOCROME_TEXT_GREEN);
143
144     production_text.setPosition(400 + 30, 400 - 45);
145
146     this->render_window_ptr->draw(production_text);
147
148     return;
149 } /* __drawProductionMenu() */
```

### 4.11.3.7 \_\_drawUpgradeOptions()

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

Helper method to set up and draw upgrade options.

```
600 {
601     // 1. draw power capacity upgrade sprite
602     sf::Vector2f initial_position = this->tile_improvement_sprite_static.getPosition();
603     this->tile_improvement_sprite_static.setPosition(400 - 100, 400 - 32);
604
605     sf::Color initial_colour = this->tile_improvement_sprite_static.getColor();
606     this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
607
608     sf::Vector2f initial_scale = this->tile_improvement_sprite_static.getScale();
609     this->tile_improvement_sprite_static.setScale(sf::Vector2f(1, 1));
610
611     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
612
613     this->tile_improvement_sprite_static.setPosition(initial_position);
614     this->tile_improvement_sprite_static.setColor(initial_colour);
615     this->tile_improvement_sprite_static.setScale(initial_scale);
616
617     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
618
619
620     // 2. draw power capacity upgrade text
621     // 16 char line = "                                \n"
622     std::string power_upgrade_string = "POWER CAPACITY \n";
623     power_upgrade_string += "                                \n";
624
625     power_upgrade_string += "CAPACITY: ";
626     power_upgrade_string += std::to_string(this->capacity_kW);
627     power_upgrade_string += " kW\n";
628
629     power_upgrade_string += "LEVEL: ";
630     power_upgrade_string += std::to_string(this->upgrade_level);
631     power_upgrade_string += "\n\n";
632
633     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
634         power_upgrade_string += "[W]: + 100 kW (";
635         power_upgrade_string += std::to_string(SOLAR_PV_BUILD_COST);
636         power_upgrade_string += " K)\n";
637     }
638
639     else {
640         power_upgrade_string += " * MAX LEVEL * \n";
641     }
642
643     sf::Text power_upgrade_text = sf::Text(
644         power_upgrade_string,
645         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
646         16
647     );
648
649     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
650     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
651     power_upgrade_text.setFillColors(MONOCROME_TEXT_GREEN);
652
653     this->render_window_ptr->draw(power_upgrade_text);
654
655
656     // 3. draw energy capacity (storage) upgrade sprite
657     this->render_window_ptr->draw(this->storage_upgrade_sprite);
658     this->render_window_ptr->draw(this->upgrade_plus_sprite);
659
660
661     // 4. draw energy capacity (storage) upgrade text
662     // 16 char line = "                                \n"
663     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
664     energy_upgrade_string += "                                \n";
665
666     energy_upgrade_string += "CAPACITY: ";
667     energy_upgrade_string += std::to_string(this->storage_level * 200);
668     energy_upgrade_string += " kWh\n";
669
670     energy_upgrade_string += "LEVEL: ";
671     energy_upgrade_string += std::to_string(this->storage_level);
672     energy_upgrade_string += "\n\n";
673
674     if (this->storage_level < MAX_STORAGE_LEVELS) {
675         energy_upgrade_string += "[D]: + 200 kWh (";
676         energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
677         energy_upgrade_string += " K)\n";
678     }
```

```

678     }
679
680     else {
681         energy_upgrade_string += " * MAX LEVEL * \n";
682     }
683
684     sf::Text energy_upgrade_text = sf::Text(
685         energy_upgrade_string,
686         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
687         16
688     );
689
690     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
691     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
692     energy_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
693
694     this->render_window_ptr->draw(energy_upgrade_text);
695
696     return;
697 } /* __drawUpgradeOptions() */

```

#### 4.11.3.8 \_\_handleKeyPressEvents()

```

void SolarPV::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

474 {
475     if (this->just_built) {
476         return;
477     }
478
479     switch (this->event_ptr->key.code) {
480         case (sf::Keyboard::U): {
481             this->__openUpgradeMenu();
482             break;
483         }
484
485         case (sf::Keyboard::W): {
486             if (this->production_menu_open) {
487                 this->dispatch_MWh++;
488
489                 if (this->dispatch_MWh > this->dispatchable_MWh) {
490                     this->dispatch_MWh = 0;
491                 }
492
493                 this->__computeProductionCosts();
494                 this->assets_manager_ptr->getSound("interface click")->play();
495             }
496
497             else if (this->upgrade_menu_open) {
498                 this->__upgradePowerCapacity();
499             }
500
501             break;
502         }
503
504         case (sf::Keyboard::S): {
505             if (this->production_menu_open) {
506                 this->dispatch_MWh--;
507
508                 if (this->dispatch_MWh < 0) {
509                     this->dispatch_MWh = this->dispatchable_MWh;
510                 }
511
512                 this->__computeProductionCosts();
513                 this->assets_manager_ptr->getSound("interface click")->play();
514             }
515
516             break;
517         }
518
519         case (sf::Keyboard::D): {
520             if (this->upgrade_menu_open) {

```

```

525         this->__upgradeStorageCapacity();
526         this->__computeProduction();
527         this->__computeDispatch();
528     }
529
530     break;
531 }
532
533
534     default: {
535         // do nothing!
536
537         break;
538     }
539 }
540
541 return;
542 } /* __handleKeyPressEvents() */

```

#### 4.11.3.9 \_\_handleMouseButtonEvents()

```

void SolarPV::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

557 {
558     if (this->just_built) {
559         return;
560     }
561
562     switch (this->event_ptr->mouseButton.button) {
563         case (sf::Mouse::Left): {
564             //...
565
566             break;
567         }
568
569         case (sf::Mouse::Right): {
570             //...
571
572             break;
573         }
574
575         default: {
576             // do nothing!
577
578             break;
579         }
580     }
581
582     return;
583 }
584
585 } /* __handleMouseButtonEvents() */

```

#### 4.11.3.10 \_\_repair()

```

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

```

Helper method to repair the solar PV array.

Reimplemented from [TileImprovement](#).

```

264 {
265     if (this->credits < SOLAR_PV_BUILD_COST) {
266         std::cout << "Cannot repair solar PV: insufficient credits (need "
267             << SOLAR_PV_BUILD_COST << " K)" << std::endl;
268     }

```

```

269         this->__sendInsufficientCreditsMessage();
270         return;
271     }
272
273     TileImprovement::__repair();
274
275     this->just_upgraded = true;
276
277     this->__sendCreditsSpentMessage(SOLAR_PV_BUILD_COST);
278     this->__sendTileStateRequest();
279     this->__sendGameStateRequest();
280
281     return;
282 } /* __repair() */

```

#### 4.11.3.11 \_\_sendImprovementStateMessage()

```

void SolarPV::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

712 {
713     Message improvement_state_message;
714
715     improvement_state_message.channel = GAME_CHANNEL;
716     improvement_state_message.subject = "improvement state";
717
718     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
719     improvement_state_message.int_payload["operation_maintenance_cost"] =
720         this->operation_maintenance_cost;
721
722     this->message_hub_ptr->sendMessage(improvement_state_message);
723
724     std::cout << "Improvement state message sent by " << this << std::endl;
725
726     return;
727 } /* __sendImprovementStateMessage() */

```

#### 4.11.3.12 \_\_setUpTileImprovementSpriteStatic()

```

void SolarPV::__setUpTileImprovementSpriteStatic (
    void ) [private]

```

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

```

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

```

#### 4.11.3.13 \_\_upgradePowerCapacity()

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

Helper method to upgrade power capacity.

```
164 {
165     if (this->credits < SOLAR_PV_BUILD_COST) {
166         std::cout << "Cannot upgrade solar PV: insufficient credits (need "
167             << SOLAR_PV_BUILD_COST << " K)" << std::endl;
168
169         this->__sendInsufficientCreditsMessage();
170         return;
171     }
172
173     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
174         return;
175     }
176
177     TileImprovement :: __repair();
178
179     this->capacity_kW += 100;
180     this->upgrade_level++;
181
182     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
183
184     this->__computeProduction();
185     this->__computeDispatch();
186
187     this->just_upgraded = true;
188
189     this->assets_manager_ptr->getSound("upgrade")->play();
190
191     this->__sendCreditsSpentMessage(SOLAR_PV_BUILD_COST);
192     this->__sendTileStateRequest();
193     this->__sendGameStateRequest();
194
195     return;
196 } /* __upgradePowerCapacity() */
```

#### 4.11.3.14 advanceTurn()

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

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```
930 {
931     // 1. send improvement state message
932     this->__sendImprovementStateMessage();
933
934     // 2. update
935     this->__computeCapacityFactors();
936     this->update();
937
938     // 3. handle start/stop
939     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
940         this->is_running = true;
941     }
942
943     else if (this->is_running and (this->dispatch_MWh <= 0)) {
944         this->is_running = false;
945     }
946
947     // 4. handle equipment health and breakdowns
948     if (this->is_running) {
949         this->health--;
950
951         if (this->health <= 50) {
952             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
953
954             if ((double)rand() / RAND_MAX <= breakdown_prob) {
955                 this->health = 0;
```

```

956         }
957     }
958
959     if (this->health <= 0) {
960         this->__breakdown();
961     }
962 }
963
964 // 5. send tile state request (if selected)
965 if (this->is_selected) {
966     this->__sendTileStateRequest();
967 }
968
969 return;
970 } /* advanceTurn() */

```

#### 4.11.3.15 draw()

```

void SolarPV::draw (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

1059 {
1060     // 1. if just built, call base method and return
1061     if (this->just_built) {
1062         TileImprovement :: draw();
1063
1064         return;
1065     }
1066
1067
1068     // 2. handle upgrade effects
1069     if (this->just_upgraded) {
1070         this->tile_improvement_sprite_static.setColor(
1071             sf::Color(
1072                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1073                 255,
1074                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1075                 255
1076             )
1077         );
1078
1079         this->tile_improvement_sprite_static.setScale(
1080             sf::Vector2f(
1081                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1082                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1083             )
1084         );
1085
1086         this->upgrade_frame++;
1087     }
1088
1089     if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1090         this->tile_improvement_sprite_static.setColor(
1091             sf::Color(255,255,255,255)
1092         );
1093
1094         this->tile_improvement_sprite_static.setScale(sf::Vector2f(1,1));
1095
1096         this->just_upgraded = false;
1097         this->upgrade_frame = 0;
1098     }
1099
1100
1101     // 3. draw static sprite
1102     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
1103
1104
1105     // 4. draw storage upgrades
1106     for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1107         this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1108     }
1109
1110
1111     // 5. handle dispatch illustration

```

```

1112     if (this->dispatch_MWh > 0) {
1113         this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1114         this->__drawDispatch();
1115     }
1116
1117
1118     // 6. draw production menu
1119     if (this->production_menu_open) {
1120         this->render_window_ptr->draw(this->production_menu_backing);
1121         this->render_window_ptr->draw(this->production_menu_backing_text);
1122
1123         this->__drawProductionMenu();
1124     }
1125
1126
1127     // 7. draw upgrade menu
1128     if (this->upgrade_menu_open) {
1129         this->render_window_ptr->draw(this->upgrade_menu_backing);
1130         this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1131
1132         this->__drawUpgradeOptions();
1133     }
1134
1135
1136     // 10. handle broken effects
1137     if (this->is_broken) {
1138         this->tile_improvement_sprite_static.setColor(
1139             sf::Color(
1140                 255,
1141                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1142                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1143                 255
1144             )
1145         );
1146     }
1147
1148     this->frame++;
1149     return;
1150 } /* draw() */

```

#### 4.11.3.16 getTileOptionsSubstring()

```

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

```

Helper method to assemble and return tile options substring.

#### Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

842 {
843     // 32 char x 17 line console "-----\n";
844     std::string options_substring = "CAPACITY: ";
845     options_substring += std::to_string(this->capacity_kW);
846     options_substring += " kW (level ";
847     options_substring += std::to_string(this->upgrade_level);
848     options_substring += ")\n";
849
850     options_substring += "PRODUCTION: ";
851     options_substring += std::to_string(this->production_MWh);
852     options_substring += " MWh\n";
853
854     options_substring += "DISPATCHABLE: ";
855     options_substring += std::to_string(this->dispatchable_MWh);
856     options_substring += " MWh\n";
857
858     options_substring += "HEALTH: ";
859     options_substring += std::to_string(this->health);
860     options_substring += "/100";
861
862     if (this->health <= 0) {
863         options_substring += " ** BROKEN! **\n";

```



```

864     }
865
866     else {
867         options_substring += "\n";
868     }
869
870     options_substring += "
871     options_substring += "      **** SOLAR PV OPTIONS ****
872     options_substring += "
873
874     if (this->is_broken) {
875         options_substring += "      [R]: REPAIR (";
876         options_substring += std::to_string(SOLAR_PV_BUILD_COST);
877         options_substring += " K)\n";
878     }
879
880     else {
881         options_substring += "      [E]: OPEN PRODUCTION MENU \n";
882     }
883
884     options_substring += "      [U]: OPEN UPGRADE MENU \n";
885     options_substring += "HOLD [P]: SCRAP (";
886     options_substring += std::to_string(SCRAP_COST);
887     options_substring += " K)";
888
889     return options_substring;
890 } /* getTileOptionsSubstring() */

```

#### 4.11.3.17 processEvent()

```

void SolarPV::processEvent (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

1010 {
1011     TileImprovement :: processEvent();
1012
1013     if (this->event_ptr->type == sf::Event::KeyPressed) {
1014         this->__handleKeyPressEvents();
1015     }
1016
1017     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1018         this->__handleMouseButtonEvents();
1019     }
1020
1021     return;
1022 } /* processEvent() */

```

#### 4.11.3.18 processMessage()

```

void SolarPV::processMessage (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

1037 {
1038     TileImprovement :: processMessage();
1039
1040     //...
1041
1042     return;
1043 } /* processMessage() */

```

#### 4.11.3.19 setIsSelected()

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

Method to set the is selected attribute.

##### Parameters

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

Reimplemented from [TileImprovement](#).

```
907 {
908     TileImprovement :: setIsSelected(is_selected);
909
910     if (this->is_running and this->is_selected) {
911         this->assets_manager_ptr->getSound("solar hum")->play();
912     }
913
914     return;
915 } /* setIsSelected() */
```

#### 4.11.3.20 update()

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

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
985 {
986     this->__computeProduction();
987     this->__computeProductionCosts();
988     this->__computeDispatch();
989
990     if (this->is_selected) {
991         this->__sendTileStateRequest();
992     }
993
994     return;
995 } /* update() */
```

### 4.11.4 Member Data Documentation

#### 4.11.4.1 capacity\_factor\_vec

```
std::vector<double> SolarPV::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

#### 4.11.4.2 capacity\_kW

```
int SolarPV::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

#### 4.11.4.3 dispatch\_MWh

```
int SolarPV::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

#### 4.11.4.4 dispatch\_vec\_MWh

```
std::vector<double> SolarPV::dispatch_vec_MWh
```

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

#### 4.11.4.5 dispatchable\_MWh

```
int SolarPV::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

#### 4.11.4.6 max\_daily\_production\_MWh

```
double SolarPV::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

#### 4.11.4.7 production\_MWh

```
int SolarPV::production_MWh
```

The current production [MWh] of the solar PV array.

#### 4.11.4.8 production\_vec\_MWh

```
std::vector<double> SolarPV::production_vec_MWh
```

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

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

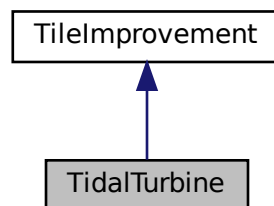
- header/[SolarPV.h](#)
- source/[SolarPV.cpp](#)

## 4.12 TidalTurbine Class Reference

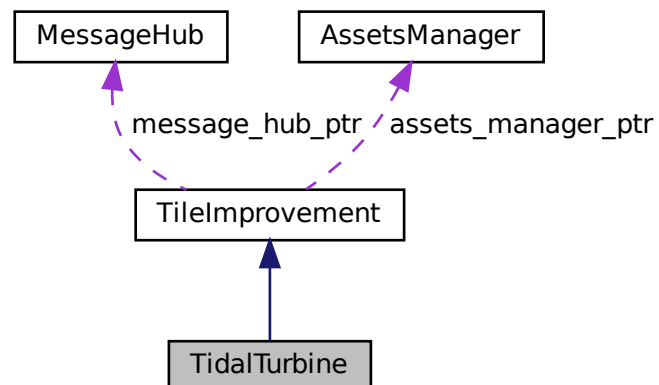
A settlement class (child class of [TileImprovement](#)).

```
#include <TidalTurbine.h>
```

Inheritance diagram for TidalTurbine:



Collaboration diagram for TidalTurbine:



## Public Member Functions

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

## Public Attributes

- int [capacity\\_kW](#)  
*The rated production capacity [kW] of the solar PV array.*
- int [production\\_MWh](#)  
*The current production [MWh] of the solar PV array.*
- int [dispatch\\_MWh](#)  
*The current dispatch [MWh] of the solar PV array.*
- int [dispatchable\\_MWh](#)  
*The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).*
- double [max\\_daily\\_production\\_MWh](#)  
*The maximum daily production [MWh] of the solar PV array.*
- double [rotor\\_drotation](#)  
*The rotation rate of the rotor.*
- double [bobbing\\_y](#)  
*The bobbing extent of the tidal turbine.*
- std::vector< double > [capacity\\_factor\\_vec](#)  
*A vector of daily capacity factors for the current month.*
- std::vector< double > [production\\_vec\\_MWh](#)  
*A vector of daily production [MWh] for the current month.*
- std::vector< double > [dispatch\\_vec\\_MWh](#)  
*A vector of daily dispatch [MWh] for the current month.*

## Private Member Functions

- void [\\_\\_setUpTileImprovementSpriteAnimated](#) (void)  
*Helper method to set up tile improvement sprite (static).*
- void [\\_\\_drawProductionMenu](#) (void)  
*Helper method to draw production menu assets.*
- void [\\_\\_upgradePowerCapacity](#) (void)  
*Helper method to upgrade power capacity.*
- void [\\_\\_computeProductionCosts](#) (void)  
*Helper method to compute production costs (O&M) based on current production level.*
- void [\\_\\_breakdown](#) (void)  
*Helper method to trigger an equipment breakdown.*
- void [\\_\\_repair](#) (void)  
*Helper method to repair the tidal turbine.*
- void [\\_\\_computeCapacityFactors](#) (void)  
*Helper method to compute capacity factors (by definition in the closed interval [0, 1]).*
- void [\\_\\_computeProduction](#) (void)  
*Helper method to compute production values.*
- void [\\_\\_computeDispatch](#) (void)  
*Helper method to compute dispatch values.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_drawUpgradeOptions](#) (void)  
*Helper method to set up and draw upgrade options.*
- void [\\_\\_sendImprovementStateMessage](#) (void)  
*Helper method to format and sent improvement state message.*

## Additional Inherited Members

### 4.12.1 Detailed Description

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

### 4.12.2 Constructor & Destructor Documentation

#### 4.12.2.1 TidalTurbine()

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

Constructor for the [TidalTurbine](#) class.

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

## Parameters

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

```

775 :
776 TileImprovement (
777     position_x,
778     position_y,
779     tile_resource,
780     event_ptr,
781     render_window_ptr,
782     assets_manager_ptr,
783     message_hub_ptr
784 )
785 {
786     // 1. set attributes
787
788     // 1.1. private
789     //...
790
791     // 1.2. public
792     this->tile_improvement_type = TileImprovementType :: TIDAL_TURBINE;
793
794     this->is_running = false;
795
796     this->health = 100;
797
798     this->capacity_kW = 100;
799     this->upgrade_level = 1;
800
801     this->storage_kWh = 0;
802     this->storage_level = 0;
803
804     this->production_MWh = 0;
805     this->dispatch_MWh = 0;
806     this->dispatchable_MWh = 0;
807
808     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
809
810     this->rotor_drotation = 64 * SECONDS_PER_FRAME;
811     this->bobbing_y = 4;
812
813     this->capacity_factor_vec.resize(30, 0);
814     this->production_vec_MWh.resize(30, 0);
815     this->dispatch_vec_MWh.resize(30, 0);
816
817     this->tile_improvement_string = "TIDAL TURBINE";
818
819     this->__setUpTileImprovementSpriteAnimated();
820     this->__computeCapacityFactors();
821     this->update();
822
823     std::cout << "TidalTurbine constructed at " << this << std::endl;
824
825     return;
826 } /* TidalTurbine() */

```

## 4.12.2.2 ~TidalTurbine()

```

TidalTurbine::~TidalTurbine (
    void ) [virtual]

```

Destructor for the [TidalTurbine](#) class.

```

1192 {
1193     std::cout << "TidalTurbine at " << this << " destroyed" << std::endl;
1194
1195     return;
1196 } /* ~TidalTurbine() */

```

## 4.12.3 Member Function Documentation

### 4.12.3.1 \_\_breakdown()

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

Helper method to trigger an equipment breakdown.

```
257 {
258     TileImprovement :: __breakdown();
259
260     this->production_MWh = 0;
261     this->dispatch_MWh = 0;
262     this->dispatchable_MWh = 0;
263     this->operation_maintenance_cost = 0;
264
265     return;
266 } /* __breakdown() */
```

### 4.12.3.2 \_\_computeCapacityFactors()

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

Helper method to compute capacity factors (by definition in the closed interval [0, 1]).

```
315 {
316     if (this->is_broken) {
317         return;
318     }
319
320     double performance_factor = this->__getPerformanceFactor();
321
322     for (int i = 0; i < 30; i++) {
323         this->capacity_factor_vec[i] =
324             performance_factor * this->tile_resource_scalar * DAILY_TIDAL_CAPACITY_FACTOR;
325     }
326
327     return;
328 } /* __computeCapacityFactors() */
```

### 4.12.3.3 \_\_computeDispatch()

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

Helper method to compute dispatch values.

```
376 {
377     if (this->is_broken) {
378         this->dispatchable_MWh = 0;
379         return;
380     }
381
382     double stored_energy_MWh = 0;
383     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
384
385     double demand_MWh = 0;
386     double production_MWh = 0;
387     double dispatchable_MWh = 0;
388     double difference_MWh = 0;
```



```

389
390     double room_MWh = 0;
391
392     for (int i = 0; i < 30; i++) {
393         demand_MWh = this->demand_vec_MWh[i];
394         production_MWh = this->production_vec_MWh[i];
395
396         if (production_MWh <= demand_MWh) {
397             this->dispatch_vec_MWh[i] = production_MWh;
398             dispatchable_MWh += this->dispatch_vec_MWh[i];
399
400             difference_MWh = demand_MWh - production_MWh;
401
402             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
403                 if (difference_MWh > stored_energy_MWh) {
404                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
405                     dispatchable_MWh += stored_energy_MWh;
406                     stored_energy_MWh = 0;
407                 }
408
409                 else {
410                     this->dispatch_vec_MWh[i] += difference_MWh;
411                     dispatchable_MWh += difference_MWh;
412                     stored_energy_MWh -= difference_MWh;
413                 }
414             }
415         }
416
417         else {
418             this->dispatch_vec_MWh[i] = demand_MWh;
419             dispatchable_MWh += this->dispatch_vec_MWh[i];
420
421             difference_MWh = production_MWh - demand_MWh;
422
423             if (
424                 (storage_capacity_MWh > 0) and
425                 (stored_energy_MWh < storage_capacity_MWh)
426             ) {
427                 room_MWh = storage_capacity_MWh - stored_energy_MWh;
428
429                 if (difference_MWh > room_MWh) {
430                     stored_energy_MWh += room_MWh;
431                 }
432
433                 else {
434                     stored_energy_MWh += difference_MWh;
435                 }
436             }
437         }
438     }
439
440     this->dispatchable_MWh = round(dispatchable_MWh);
441
442     if (this->dispatch_MWh <= 0) {
443         this->dispatch_MWh = 0;
444     }
445
446     else if (this->dispatch_MWh != this->dispatchable_MWh) {
447         this->dispatch_MWh = this->dispatchable_MWh;
448     }
449
450     return;
451 } /* __computeDispatch() */

```

#### 4.12.3.4 \_\_computeProduction()

```

void TidalTurbine::__computeProduction (
    void ) [private]

```

Helper method to compute production values.

```

343 {
344     if (this->is_broken) {
345         this->production_MWh = 0;
346         return;
347     }
348
349     double production_MWh = 0;
350

```

```

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

```

#### 4.12.3.5 \_\_computeProductionCosts()

```

void TidalTurbine::__computeProductionCosts (
    void ) [private]

```

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

```

229 {
230     if (this->is_running) {
231         double operation_maintenance_cost =
232             (this->production_MWh * TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
233
234         this->operation_maintenance_cost = round(operation_maintenance_cost);
235     }
236
237     else {
238         this->operation_maintenance_cost = 0;
239     }
240
241     return;
242 } /* __computeProductionCosts() */

```

#### 4.12.3.6 \_\_drawProductionMenu()

```

void TidalTurbine::__drawProductionMenu (
    void ) [private]

```

Helper method to draw production menu assets.

```

114 {
115     // 1. draw static sprite
116     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
117         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
118         this->tile_improvement_sprite_animated[i].setPosition(400 - 138, 400 + 16);
119
120         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
121         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
122
123         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
124         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
125
126         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
127         this->tile_improvement_sprite_animated[i].setRotation(0);
128
129         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
130
131         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
132         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
133         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
134         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
135     }
136
137     // 2. draw production text
138     std::string production_string = "[W]:  INCREASE DISPATCH\n";
139     production_string             += "[S]:  DECREASE DISPATCH\n";
140     production_string             += "      \n";
141
142     production_string             += "DISPATCH:  ";
143     production_string             += std::to_string(this->dispatch_MWh);

```

```

144     production_string      += " MWh (MAX ";
145     production_string      += std::to_string(this->dispatchable_MWh);
146     production_string      += ")\n";
147
148     production_string      += "O&M COST: ";
149     production_string      += std::to_string(this->operation_maintenance_cost);
150     production_string      += " K\n";
151
152     sf::Text production_text(
153         production_string,
154         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
155         16
156     );
157
158     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
159     production_text.setFillColor(MONOCROME_TEXT_GREEN);
160
161     production_text.setPosition(400 + 30, 400 - 45);
162
163     this->render_window_ptr->draw(production_text);
164
165     return;
166 } /* __drawProductionMenu() */

```

#### 4.12.3.7 \_\_drawUpgradeOptions()

```

void TidalTurbine::__drawUpgradeOptions (
    void ) [private]

```

Helper method to set up and draw upgrade options.

```

592 {
593     // 1. draw power capacity upgrade sprite
594     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
595         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
596         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 32 - 8);
597
598         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
599         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
600
601         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
602         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
603
604         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
605         this->tile_improvement_sprite_animated[i].setRotation(0);
606
607         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
608
609         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
610         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
611         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
612         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
613     }
614
615     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
616
617     // 2. draw power capacity upgrade text
618     // 16 char line = "                                \n"
619     std::string power_upgrade_string = "POWER CAPACITY \n";
620     power_upgrade_string      += "                                \n";
621
622     power_upgrade_string      += "CAPACITY: ";
623     power_upgrade_string      += std::to_string(this->capacity_kW);
624     power_upgrade_string      += " kW\n";
625
626     power_upgrade_string      += "LEVEL: ";
627     power_upgrade_string      += std::to_string(this->upgrade_level);
628     power_upgrade_string      += "\n\n";
629
630     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
631         power_upgrade_string      += "[W]: + 100 kW (";
632         power_upgrade_string      += std::to_string(TIDAL_TURBINE_BUILD_COST);
633         power_upgrade_string      += " K)\n";
634     }
635
636     else {
637         power_upgrade_string      += " * MAX LEVEL * \n";
638     }
639 }

```

```

640
641     sf::Text power_upgrade_text = sf::Text(
642         power_upgrade_string,
643         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
644         16
645     );
646
647     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
648     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
649     power_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
650
651     this->render_window_ptr->draw(power_upgrade_text);
652
653
654     // 3. draw energy capacity (storage) upgrade sprite
655     this->render_window_ptr->draw(this->storage_upgrade_sprite);
656     this->render_window_ptr->draw(this->upgrade_plus_sprite);
657
658
659     // 4. draw energy capacity (storage) upgrade text
660     // 16 char line = " \n"
661     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
662     energy_upgrade_string += " \n";
663
664     energy_upgrade_string += "CAPACITY: ";
665     energy_upgrade_string += std::to_string(this->storage_level * 200);
666     energy_upgrade_string += " kWh\n";
667
668     energy_upgrade_string += "LEVEL: ";
669     energy_upgrade_string += std::to_string(this->storage_level);
670     energy_upgrade_string += "\n\n";
671
672     if (this->storage_level < MAX_STORAGE_LEVELS) {
673         energy_upgrade_string += "[D]: + 200 kWh ";
674         energy_upgrade_string += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
675         energy_upgrade_string += " K\n";
676     }
677
678     else {
679         energy_upgrade_string += " * MAX LEVEL * \n";
680     }
681
682     sf::Text energy_upgrade_text = sf::Text(
683         energy_upgrade_string,
684         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
685         16
686     );
687
688     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
689     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
690     energy_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
691
692     this->render_window_ptr->draw(energy_upgrade_text);
693
694     return;
695 } /* __drawUpgradeOptions() */

```

#### 4.12.3.8 \_\_handleKeyPressEvents()

```

void TidalTurbine::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

466 {
467     if (this->just_built) {
468         return;
469     }
470
471     switch (this->event_ptr->key.code) {
472         case (sf::Keyboard::U): {
473             this->__openUpgradeMenu();
474
475             break;
476         }
477
478         case (sf::Keyboard::W): {
479             if (this->production_menu_open) {
480

```

```

481         this->dispatch_MWh++;
482
483         if (this->dispatch_MWh > this->dispatchable_MWh) {
484             this->dispatch_MWh = 0;
485         }
486
487         this->__computeProductionCosts();
488         this->assets_manager_ptr->getSound("interface click")->play();
489     }
490
491     else if (this->upgrade_menu_open) {
492         this->__upgradePowerCapacity();
493     }
494
495     break;
496 }
497
498
499 case (sf::Keyboard::S): {
500     if (this->production_menu_open) {
501         this->dispatch_MWh--;
502
503         if (this->dispatch_MWh < 0) {
504             this->dispatch_MWh = this->dispatchable_MWh;
505         }
506
507         this->__computeProductionCosts();
508         this->assets_manager_ptr->getSound("interface click")->play();
509     }
510
511     break;
512 }
513
514
515 case (sf::Keyboard::D): {
516     if (this->upgrade_menu_open) {
517         this->__upgradeStorageCapacity();
518         this->__computeProduction();
519         this->__computeDispatch();
520     }
521
522     break;
523 }
524
525
526 default: {
527     // do nothing!
528
529     break;
530 }
531 }
532
533 return;
534 } /* __handleKeyPressEvents() */

```

#### 4.12.3.9 \_\_handleMouseButtonEvents()

```

void TidalTurbine::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

549 {
550     if (this->just_built) {
551         return;
552     }
553
554     switch (this->event_ptr->mouseButton.button) {
555         case (sf::Mouse::Left): {
556             //...
557
558             break;
559         }
560
561         case (sf::Mouse::Right): {
562             //...
563
564             break;
565         }
566     }
567 }

```

```

566         }
567
568
569         default: {
570             // do nothing!
571
572             break;
573         }
574     }
575
576     return;
577 } /* __handleMouseButtonEvents() */

```

#### 4.12.3.10 \_\_repair()

```

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

```

Helper method to repair the tidal turbine.

Reimplemented from [TileImprovement](#).

```

281 {
282     if (this->credits < TIDAL_TURBINE_BUILD_COST) {
283         std::cout << "Cannot repair tidal turbine: insufficient credits (need "
284             << TIDAL_TURBINE_BUILD_COST << " K)" << std::endl;
285
286         this->__sendInsufficientCreditsMessage();
287         return;
288     }
289
290     TileImprovement :: __repair();
291
292     this->just_upgraded = true;
293
294     this->__sendCreditsSpentMessage(TIDAL_TURBINE_BUILD_COST);
295     this->__sendTileStateRequest();
296     this->__sendGameStateRequest();
297
298     return;
299 } /* __repair() */

```

#### 4.12.3.11 \_\_sendImprovementStateMessage()

```

void TidalTurbine::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

710 {
711     Message improvement_state_message;
712
713     improvement_state_message.channel = GAME_CHANNEL;
714     improvement_state_message.subject = "improvement state";
715
716     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
717     improvement_state_message.int_payload["operation_maintenance_cost"] =
718         this->operation_maintenance_cost;
719
720     this->message_hub_ptr->sendMessage(improvement_state_message);
721
722     std::cout << "Improvement state message sent by " << this << std::endl;
723
724     return;
725 } /* __sendImprovementStateMessage() */

```

**4.12.3.12 \_\_setUpTileImprovementSpriteAnimated()**

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

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

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

**4.12.3.13 \_\_upgradePowerCapacity()**

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

Helper method to upgrade power capacity.

```
181 {
182     if (this->credits < TIDAL_TURBINE_BUILD_COST) {
183         std::cout << "Cannot upgrade tidal turbine: insufficient credits (need "
184             << TIDAL_TURBINE_BUILD_COST << " K)" << std::endl;
185
186         this->__sendInsufficientCreditsMessage();
187         return;
188     }
189
190     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
191         return;
192     }
193
194     TileImprovement :: __repair();
195
196     this->capacity_kW += 100;
197     this->upgrade_level++;
198
199     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
200
201     this->__computeProduction();
202     this->__computeDispatch();
203
204     this->just_upgraded = true;
205
206     this->assets_manager_ptr->getSound("upgrade")->play();
207
208     this->__sendCreditsSpentMessage(TIDAL_TURBINE_BUILD_COST);
209     this->__sendTileStateRequest();
210     this->__sendGameStateRequest();
211
212     return;
213 } /* __upgradePowerCapacity() */
```

#### 4.12.3.14 advanceTurn()

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

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```
932 {
933     // 1. send improvement state message
934     this->__sendImprovementStateMessage();
935
936     // 2. update
937     this->__computeCapacityFactors();
938     this->update();
939
940     // 3. handle start/stop
941     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
942         this->is_running = true;
943     }
944
945     else if (this->is_running and (this->dispatch_MWh <= 0)) {
946         this->is_running = false;
947     }
948
949     // 4. handle equipment health and breakdowns
950     if (this->is_running) {
951         this->health--;
952
953         if (this->health <= 50) {
954             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
955
956             if ((double)rand() / RAND_MAX <= breakdown_prob) {
957                 this->health = 0;
958             }
959         }
960
961         if (this->health <= 0) {
962             this->__breakdown();
963         }
964     }
965
966     // 5. send tile state request (if selected)
967     if (this->is_selected) {
968         this->__sendTileStateRequest();
969     }
970
971     return;
972 } /* advanceTurn() */
```

#### 4.12.3.15 draw()

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

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

Reimplemented from [TileImprovement](#).

```
1061 {
1062     // 1. if just built, call base method and return
1063     if (this->just_built) {
1064         TileImprovement :: draw();
1065
1066         return;
1067     }
1068
1069     // 2. handle upgrade effects
1070     if (this->just_upgraded) {
1071         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1072             this->tile_improvement_sprite_animated[i].setColor(
1073                 sf::Color(
1074                     255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
```



```

1076         255,
1077         255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1078         255
1079     )
1080 };
1081
1082     this->tile_improvement_sprite_animated[i].setScale(
1083         sf::Vector2f(
1084             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1085             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1086         )
1087     );
1088 }
1089
1090     this->upgrade_frame++;
1091 }
1092
1093     if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1094         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1095             this->tile_improvement_sprite_animated[i].setColor(
1096                 sf::Color(255,255,255,255)
1097             );
1098
1099             this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1100         }
1101
1102         this->just_upgraded = false;
1103         this->upgrade_frame = 0;
1104     }
1105
1106
1107     // 3. handle bobbing
1108     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1109         this->tile_improvement_sprite_animated[i].setPosition(
1110             this->position_x,
1111             this->position_y + this->bobbing_y * cos(
1112                 (double) (0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1113             )
1114         );
1115     }
1116
1117
1118     // 4. draw first element of animated sprite
1119     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1120
1121
1122     // 5. draw second element of animated sprite
1123     if (this->is_running) {
1124         this->tile_improvement_sprite_animated[1].rotate(this->rotor_drotation);
1125     }
1126
1127     this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1128
1129
1130     // 6. draw storage upgrades
1131     for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1132         this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1133     }
1134
1135
1136     // 7. handle dispatch illustration
1137     if (this->dispatch_MWh > 0) {
1138         this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1139         this->__drawDispatch();
1140     }
1141
1142
1143     // 8. draw production menu
1144     if (this->production_menu_open) {
1145         this->render_window_ptr->draw(this->production_menu_backing);
1146         this->render_window_ptr->draw(this->production_menu_backing_text);
1147
1148         this->__drawProductionMenu();
1149     }
1150
1151
1152     // 9. draw upgrade menu
1153     if (this->upgrade_menu_open) {
1154         this->render_window_ptr->draw(this->upgrade_menu_backing);
1155         this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1156
1157         this->__drawUpgradeOptions();
1158     }
1159
1160
1161     // 10. handle broken effects
1162     if (this->is_broken) {

```

```

1163         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1164             this->tile_improvement_sprite_animated[i].setColor(
1165                 sf::Color(
1166                     255,
1167                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1168                     255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1169                     255
1170                 )
1171             );
1172         }
1173     }
1174
1175     this->frame++;
1176     return;
1177 } /* draw() */

```

#### 4.12.3.16 getTileOptionsSubstring()

```

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

```

Helper method to assemble and return tile options substring.

##### Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

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

```

**4.12.3.17 processEvent()**

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

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

Reimplemented from [TileImprovement](#).

```
1012 {
1013     TileImprovement :: processEvent();
1014
1015     if (this->event_ptr->type == sf::Event::KeyPressed) {
1016         this->__handleKeyPressEvents();
1017     }
1018
1019     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1020         this->__handleMouseButtonEvents();
1021     }
1022
1023     return;
1024 } /* processEvent() */
```

**4.12.3.18 processMessage()**

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

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

Reimplemented from [TileImprovement](#).

```
1039 {
1040     TileImprovement :: processMessage();
1041
1042     //...
1043
1044     return;
1045 } /* processMessage() */
```

**4.12.3.19 setIsSelected()**

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

Method to set the is selected attribute.

**Parameters**

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

Reimplemented from [TileImprovement](#).

```
908 {
909     TileImprovement :: setIsSelected(is_selected);
910
911     if (this->is_running and this->is_selected) {
912         this->assets_manager_ptr->getSound("water flow")->play();
913     }
914 }
```

```
915     return;  
916 } /* setIsSelected() */
```

#### 4.12.3.20 update()

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

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
987 {  
988     this->__computeProduction();  
989     this->__computeProductionCosts();  
990     this->__computeDispatch();  
991  
992     if (this->is_selected) {  
993         this->__sendTileStateRequest();  
994     }  
995  
996     return;  
997 } /* update() */
```

### 4.12.4 Member Data Documentation

#### 4.12.4.1 bobbing\_y

```
double TidalTurbine::bobbing_y
```

The bobbing extent of the tidal turbine.

#### 4.12.4.2 capacity\_factor\_vec

```
std::vector<double> TidalTurbine::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

#### 4.12.4.3 capacity\_kW

```
int TidalTurbine::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

#### 4.12.4.4 dispatch\_MWh

```
int TidalTurbine::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

#### 4.12.4.5 dispatch\_vec\_MWh

```
std::vector<double> TidalTurbine::dispatch_vec_MWh
```

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

#### 4.12.4.6 dispatchable\_MWh

```
int TidalTurbine::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

#### 4.12.4.7 max\_daily\_production\_MWh

```
double TidalTurbine::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

#### 4.12.4.8 production\_MWh

```
int TidalTurbine::production_MWh
```

The current production [MWh] of the solar PV array.

#### 4.12.4.9 production\_vec\_MWh

```
std::vector<double> TidalTurbine::production_vec_MWh
```

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

#### 4.12.4.10 rotor\_drotation

```
double TidalTurbine::rotor_drotation
```

The rotation rate of the rotor.

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

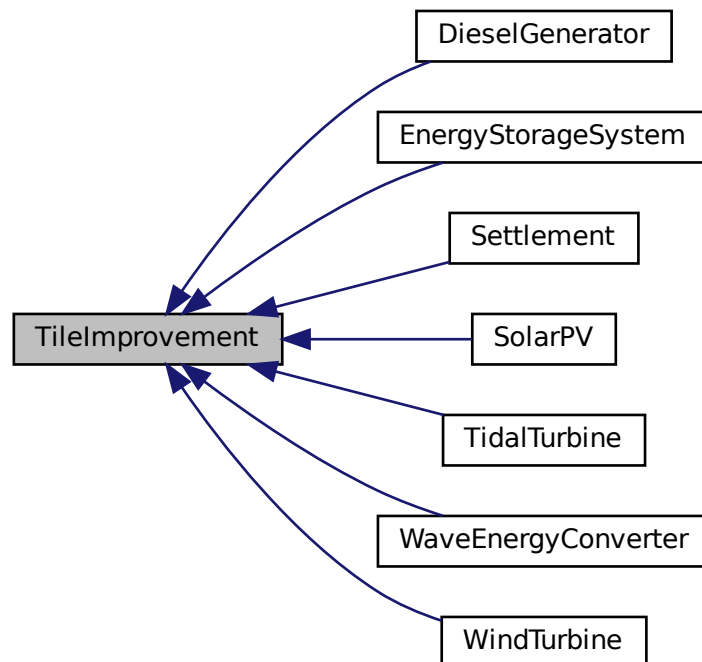
- header/[TidalTurbine.h](#)
- source/[TidalTurbine.cpp](#)

### 4.13 TileImprovement Class Reference

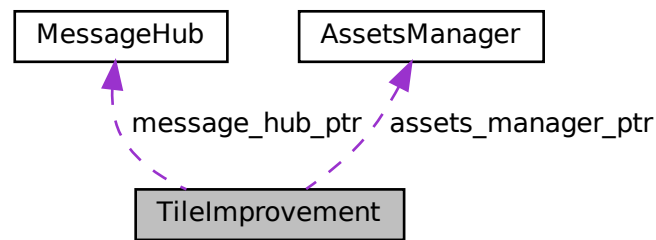
A base class for the tile improvement hierarchy.

```
#include <TileImprovement.h>
```

Inheritance diagram for TileImprovement:



Collaboration diagram for TileImprovement:



## Public Member Functions

- [TileImprovement](#) (double, double, int, sf::Event \*, sf::RenderWindow \*, [AssetsManager](#) \*, [MessageHub](#) \*)  
*Constructor for the [TileImprovement](#) class.*
- virtual void [setIsSelected](#) (bool)  
*Method to set the is selected attribute.*
- virtual void [advanceTurn](#) (void)
- virtual void [update](#) (void)
- virtual std::string [getTileOptionsSubstring](#) (void)
- virtual void [processEvent](#) (void)  
*Method to process [TileImprovement](#). To be called once per event.*
- virtual void [processMessage](#) (void)  
*Method to process [TileImprovement](#). To be called once per message.*
- virtual void [draw](#) (void)  
*Method to draw the hex tile to the render window. To be called once per frame.*
- virtual [~TileImprovement](#) (void)  
*Destructor for the [TileImprovement](#) class.*

## Public Attributes

- [TileImprovementType](#) [tile\\_improvement\\_type](#)  
*The type of the tile improvement.*
- bool [is\\_running](#)  
*A boolean which indicates whether or not the improvement is running.*
- bool [is\\_selected](#)  
*A boolean which indicates whether or not the tile is selected.*
- bool [just\\_built](#)  
*A boolean which indicates that the improvement was just built.*
- bool [just\\_upgraded](#)  
*A boolean which indicates that the improvement was just upgraded.*
- bool [production\\_menu\\_open](#)  
*A boolean which indicates whether or not the production menu is open.*
- bool [upgrade\\_menu\\_open](#)  
*A boolean which indicates whether or not the build menu is open.*

- bool `is_broken`  
*A boolean which indicated whether or not improvement is broken.*
- unsigned long long int `frame`  
*The current frame of this object.*
- int `credits`  
*The current balance of credits.*
- int `month`  
*The current month of play.*
- int `demand_MWh`  
*The current demand [MWh].*
- int `health`  
*The health of the improvement.*
- int `upgrade_level`  
*The upgrade level of the improvement.*
- int `upgrade_frame`  
*The frame of the upgrade animation.*
- int `storage_kWh`  
*The rated energy capacity [kWh] of the storage.*
- int `storage_level`  
*The level of storage installed alongside the tile improvement.*
- int `operation_maintenance_cost`  
*The operation and maintenance costs for this turn.*
- int `tile_resource`  
*The renewable resource quality of the tile.*
- double `tile_resource_scalar`  
*A scalar associated with the renewable resource quality.*
- double `position_x`  
*The x position of the tile improvement.*
- double `position_y`  
*The y position of the tile improvement.*
- std::vector< double > `demand_vec_MWh`  
*A vector of daily demands [MWh] for the current month.*
- std::string `game_phase`  
*The current phase of the game.*
- std::string `tile_improvement_string`  
*A string representation of the tile improvement type.*
- sf::Sprite `tile_improvement_sprite_static`  
*A static sprite, for decorating the tile.*
- std::vector< sf::Sprite > `tile_improvement_sprite_animated`  
*An animated sprite, for the `ContextMenu` visual screen.*
- sf::RectangleShape `production_menu_backing`  
*A backing for the production menu.*
- sf::Text `production_menu_backing_text`  
*Text for the production menu backing.*
- sf::RectangleShape `upgrade_menu_backing`  
*A backing for the upgrade menu.*
- sf::Text `upgrade_menu_backing_text`  
*Text for the upgrade menu backing.*
- sf::Sprite `storage_upgrade_sprite`  
*A sprite for illustrating storage (in upgrade menu).*
- std::vector< sf::Sprite > `storage_upgrade_sprite_vec`



- *A vector of sprites for illustrating the storage upgrade level (on tile).*
- sf::Sprite [upgrade\\_arrow\\_sprite](#)  
*An upgrade arrow sprite.*
- sf::Sprite [upgrade\\_plus\\_sprite](#)  
*An upgrade plus sprite.*
- sf::CircleShape [dispatch\\_backing](#)  
*A backing circle for dispatch text illustration.*
- sf::Text [dispatch\\_text](#)  
*Text for illustrating dispatch.*

## Protected Member Functions

- void [\\_\\_setUpProductionMenu](#) (void)  
*Helper method to set up and position production menu assets (drawable).*
- void [\\_\\_setUpUpgradeMenu](#) (void)  
*Helper method to set up and position upgrade menu assets (drawable).*
- void [\\_\\_setUpDispatchIllustration](#) (void)  
*Helper method to set up and position dispatch assets (drawable).*
- void [\\_\\_upgradeStorageCapacity](#) (void)  
*Helper method to upgrade storage capacity.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_openProductionMenu](#) (void)  
*Helper method to open the production menu.*
- void [\\_\\_closeProductionMenu](#) (void)  
*Helper method to close the production menu.*
- double [\\_\\_getPerformanceFactor](#) (void)  
*Helper method to compute and return performance factor as a function of state of health. For renewable assets, it affects production, whereas for diesel it effects fuel consumption.*
- void [\\_\\_breakdown](#) (void)  
*Helper method to trigger an equipment breakdown.*
- virtual void [\\_\\_repair](#) (void)  
*Helper method to repair a tile improvement.*
- void [\\_\\_openUpgradeMenu](#) (void)  
*Helper method to open the upgrade menu.*
- void [\\_\\_closeUpgradeMenu](#) (void)  
*Helper method to close the build menu.*
- void [\\_\\_sendTileStateRequest](#) (void)  
*Helper method to format and send a request for the parent [HexTile](#) to send a tile state message.*
- void [\\_\\_sendGameStateRequest](#) (void)  
*Helper method to format and send a game state request (message).*
- void [\\_\\_sendCreditsSpentMessage](#) (int)  
*Helper method to format and send a credits spent message.*
- void [\\_\\_sendInsufficientCreditsMessage](#) (void)  
*Helper method to format and send an insufficient credits message.*
- void [\\_\\_drawDispatch](#) (void)  
*Helper method to draw dispatch illustration.*

## Protected Attributes

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

### 4.13.1 Detailed Description

A base class for the tile improvement hierarchy.

### 4.13.2 Constructor & Destructor Documentation

#### 4.13.2.1 TileImprovement()

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

Constructor for the [TileImprovement](#) class.

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

#### Parameters

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

```
759 {
760     // 1. set attributes
761
762     // 1.1. protected
763     this->event_ptr = event_ptr;
764     this->render_window_ptr = render_window_ptr;
765 }
```

```

766     this->assets_manager_ptr = assets_manager_ptr;
767     this->message_hub_ptr = message_hub_ptr;
768
769     // 1.2. public
770     this->is_selected = true;
771     this->just_built = true;
772     this->production_menu_open = false;
773     this->upgrade_menu_open = false;
774     this->is_broken = false;
775
776     this->just_upgraded = false;
777     this->upgrade_frame = 0;
778
779     this->frame = 0;
780     this->credits = 0;
781     this->month = 1;
782     this->demand_MWh = 0;
783
784     this->demand_vec_MWh.resize(30, 0);
785
786     this->operation_maintenance_cost = 0;
787
788     this->tile_resource = tile_resource;
789
790     switch (this->tile_resource) {
791     case (0): {
792         this->tile_resource_scalar = 0.85;
793
794         break;
795     }
796
797     case (1): {
798         this->tile_resource_scalar = 0.925;
799
800         break;
801     }
802
803
804     case (2): {
805         this->tile_resource_scalar = 1;
806
807         break;
808     }
809
810
811     case (3): {
812         this->tile_resource_scalar = 1.075;
813
814         break;
815     }
816
817
818     case (4): {
819         this->tile_resource_scalar = 1.15;
820
821         break;
822     }
823
824
825     default: {
826         this->tile_resource_scalar = 1;
827     }
828 }
829
830
831     this->position_x = position_x;
832     this->position_y = position_y;
833
834     this->game_phase = "build settlement";
835
836     this->__setUpProductionMenu();
837     this->__setUpUpgradeMenu();
838     this->__setUpDispatchIllustration();
839
840     std::cout << "TileImprovement constructed at " << this << std::endl;
841
842     return;
843 } /* TileImprovement() */

```

#### 4.13.2.2 ~TileImprovement()

```
TileImprovement::~TileImprovement (
```

```
void ) [virtual]
```

Destructor for the [TileImprovement](#) class.

```
1076 {
1077     std::cout << "TileImprovement at " << this << " destroyed" << std::endl;
1078
1079     return;
1080 } /* ~TileImprovement() */
```

### 4.13.3 Member Function Documentation

#### 4.13.3.1 \_\_breakdown()

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

Helper method to trigger an equipment breakdown.

```
463 {
464     this->is_broken = true;
465     this->is_running = false;
466     this->update();
467     this->assets_manager_ptr->getSound("breakdown")->play();
468
469     return;
470 } /* __breakdown() */
```

#### 4.13.3.2 \_\_closeProductionMenu()

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

Helper method to close the production menu.

```
407 {
408     if (not this->production_menu_open) {
409         return;
410     }
411
412     this->production_menu_open = false;
413     this->assets_manager_ptr->getSound("build menu close")->play();
414
415     return;
416 } /* __closeProductionMenu() */
```

#### 4.13.3.3 \_\_closeUpgradeMenu()

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

Helper method to close the build menu.

```
549 {
550     if (not this->upgrade_menu_open) {
551         return;
552     }
553
554     this->upgrade_menu_open = false;
555     this->assets_manager_ptr->getSound("build menu close")->play();
556
557     return;
558 } /* __closeUpgradeMenu() */
```

## 4.13.3.4 \_\_drawDispatch()

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

Helper method to draw dispatch illustration.

```
680 {
681     double alpha = 255 * pow(cos((0.5 * M_PI * this->frame) / FRAMES_PER_SECOND), 2);
682
683
684     // 1. dispatch backing
685     sf::Color backing_colour = this->dispatch_backing.getFillColor();
686     backing_colour.a = alpha;
687
688     this->dispatch_backing.setFillColor(backing_colour);
689     this->dispatch_backing.setOutlineColor(sf::Color(0, 0, 0, alpha));
690
691     this->render_window_ptr->draw(this->dispatch_backing);
692
693
694     // 2. dispatch text
695     this->dispatch_text.setOrigin(
696         this->dispatch_text.getLocalBounds().width / 2,
697         this->dispatch_text.getLocalBounds().height / 2
698     );
699
700     sf::Color text_colour = this->dispatch_text.getFillColor();
701     text_colour.a = alpha;
702
703     this->dispatch_text.setFillColor(text_colour);
704
705     this->render_window_ptr->draw(this->dispatch_text);
706
707     return;
708 } /* __drawDispatch() */
```

## 4.13.3.5 \_\_getPerformanceFactor()

```
double TileImprovement::__getPerformanceFactor (
    void ) [protected]
```

Helper method to compute and return performance factor as a function of state of health. For renewable assets, it affects production, whereas for diesel it effects fuel consumption.

## Returns

A performance factor (in the close interval[0, 1]).

```
435 {
436     double performance_factor =
437         PERFORMANCE_FACTOR_COEFFICIENT * pow(this->health, PERFORMANCE_FACTOR_EXPONENT);
438
439     if (performance_factor < 0) {
440         performance_factor = 0;
441     }
442
443     else if (performance_factor > 1) {
444         performance_factor = 1;
445     }
446
447     return performance_factor;
448 } /* __getPerformanceFactor(void) */
```

#### 4.13.3.6 \_\_handleKeyPressEvents()

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

Helper method to handle key press events.

```
277 {
278     if (this->tile_improvement_type == TileImprovementType :: SETTLEMENT) {
279         return;
280     }
281
282     if (this->just_built) {
283         return;
284     }
285
286     switch (this->event_ptr->key.code) {
287         case (sf::Keyboard::E): {
288             if (this->is_broken) {
289                 this->assets_manager_ptr->getSound("breakdown")->play();
290             }
291
292             else {
293                 this->__openProductionMenu();
294             }
295
296             break;
297         }
298
299
300         case (sf::Keyboard::R): {
301             if (this->is_broken) {
302                 this->__repair();
303             }
304
305             break;
306         }
307
308
309         default: {
310             // do nothing!
311
312             break;
313         }
314     }
315
316     return;
317 } /* __handleKeyPressEvents() */
```

#### 4.13.3.7 \_\_handleMouseButtonEvents()

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

Helper method to handle mouse button events.

```
332 {
333     if (this->tile_improvement_type == TileImprovementType :: SETTLEMENT) {
334         return;
335     }
336
337     if (this->just_built) {
338         return;
339     }
340
341     switch (this->event_ptr->mouseButton.button) {
342         case (sf::Mouse::Left): {
343             //...
344
345             break;
346         }
347
348
349         case (sf::Mouse::Right): {
350             //...
351
352             break;
353         }
354     }
```

```

353         }
354
355         default: {
356             // do nothing!
357
358             break;
359         }
360     }
361 }
362
363 return;
364 } /* __handleMouseButtonEvents() */

```

#### 4.13.3.8 \_\_openProductionMenu()

```

void TileImprovement::__openProductionMenu (
    void ) [protected]

```

Helper method to open the production menu.

```

379 {
380     if (this->production_menu_open) {
381         return;
382     }
383
384     if (this->upgrade_menu_open) {
385         this->__closeUpgradeMenu();
386     }
387
388     this->production_menu_open = true;
389     this->assets_manager_ptr->getSound("build menu open")->play();
390
391     return;
392 } /* __openProductionMenu() */

```

#### 4.13.3.9 \_\_openUpgradeMenu()

```

void TileImprovement::__openUpgradeMenu (
    void ) [protected]

```

Helper method to open the upgrade menu.

```

521 {
522     if (this->upgrade_menu_open) {
523         return;
524     }
525
526     if (this->production_menu_open) {
527         this->__closeProductionMenu();
528     }
529
530     this->upgrade_menu_open = true;
531     this->assets_manager_ptr->getSound("build menu open")->play();
532
533     return;
534 } /* __openUpgradeMenu() */

```

#### 4.13.3.10 \_\_repair()

```
void TileImprovement::__repair (
    void ) [protected], [virtual]
```

Helper method to repair a tile improvement.

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), and [DieselGenerator](#).

```
485 {
486     this->health = 100;
487     if (this->is_broken) {
488         this->is_broken = false;
489         this->assets_manager_ptr->getSound("positive notification")->play();
490     }
491
492
493     if (this->tile_improvement_sprite_static.getTexture() != NULL) {
494         this->tile_improvement_sprite_static.setColor(sf::Color(255, 255, 255, 255));
495     }
496
497     else {
498         for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
499             this->tile_improvement_sprite_animated[i].setColor(
500                 sf::Color(255, 255, 255, 255)
501             );
502         }
503     }
504
505     return;
506 } /* __repair() */
```

#### 4.13.3.11 \_\_sendCreditsSpentMessage()

```
void TileImprovement::__sendCreditsSpentMessage (
    int credits_spent ) [protected]
```

Helper method to format and send a credits spent message.

##### Parameters

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

```
626 {
627     Message credits_spent_message;
628
629     credits_spent_message.channel = GAME_CHANNEL;
630     credits_spent_message.subject = "credits spent";
631
632     credits_spent_message.int_payload["credits spent"] = credits_spent;
633
634     this->message_hub_ptr->sendMessage(credits_spent_message);
635
636     std::cout << "Credits spent (" << credits_spent << ") message sent by " << this
637         << std::endl;
638     return;
639 } /* __sendCreditsSpentMessage() */
```

#### 4.13.3.12 \_\_sendGameStateRequest()

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



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

```

599 {
600     Message game_state_request;
601
602     game_state_request.channel = GAME_CHANNEL;
603     game_state_request.subject = "state request";
604
605     this->message_hub_ptr->sendMessage(game_state_request);
606
607     std::cout << "Game state request message sent by " << this << std::endl;
608     return;
609 } /* __sendGameStateRequest() */

```

#### 4.13.3.13 \_\_sendInsufficientCreditsMessage()

```

void TileImprovement::__sendInsufficientCreditsMessage (
    void ) [protected]

```

Helper method to format and send an insufficient credits message.

```

654 {
655     Message insufficient_credits_message;
656
657     insufficient_credits_message.channel = GAME_CHANNEL;
658     insufficient_credits_message.subject = "insufficient credits";
659
660     this->message_hub_ptr->sendMessage(insufficient_credits_message);
661
662     std::cout << "Insufficient credits message sent by " << this << std::endl;
663
664     return;
665 } /* __sendInsufficientCreditsMessage() */

```

#### 4.13.3.14 \_\_sendTileStateRequest()

```

void TileImprovement::__sendTileStateRequest (
    void ) [protected]

```

Helper method to format and send a request for the parent [HexTile](#) to send a tile state message.

```

574 {
575     Message tile_state_request;
576
577     tile_state_request.channel = TILE_STATE_CHANNEL;
578     tile_state_request.subject = "state request";
579
580     this->message_hub_ptr->sendMessage(tile_state_request);
581
582     std::cout << "Tile state request sent by " << this << std::endl;
583     return;
584 } /* __sendTileStateRequest() */

```

#### 4.13.3.15 \_\_setUpDispatchIllustration()

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

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

```
178 {
179     // 1. set up backing
180     this->dispatch_backing.setRadius(16);
181
182     this->dispatch_backing.setOrigin(
183         this->dispatch_backing.getLocalBounds().width / 2,
184         this->dispatch_backing.getLocalBounds().height / 2
185     );
186
187     this->dispatch_backing.setPosition(
188         this->position_x,
189         this->position_y
190     );
191
192     this->dispatch_backing.setFillColor(MONOCROME_SCREEN_BACKGROUND);
193     this->dispatch_backing.setOutlineThickness(2);
194     this->dispatch_backing.setOutlineColor(sf::Color(0, 0, 0, 255));
195
196
197     // 2. set up text
198     this->dispatch_text.setFont(*(assets_manager_ptr->getFont("Glass_TTY_VT220")));
199     this->dispatch_text.setFillColor(MONOCROME_TEXT_GREEN);
200     this->dispatch_text.setCharacterSize(16);
201     this->dispatch_text.setPosition(
202         this->position_x,
203         this->position_y - 4
204     );
205
206     return;
207 } /* __setUpDispatchIllustration() */
```

#### 4.13.3.16 \_\_setUpProductionMenu()

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

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

```
68 {
69     // 1. set up and place production menu backing and text
70     this->production_menu_backing.setSize(sf::Vector2f(400, 256));
71     this->production_menu_backing.setOrigin(200, 128);
72     this->production_menu_backing.setPosition(400, 400);
73     this->production_menu_backing.setFillColor(MONOCROME_SCREEN_BACKGROUND);
74     this->production_menu_backing.setOutlineColor(MENU_FRAME_GREY);
75     this->production_menu_backing.setOutlineThickness(4);
76
77     this->production_menu_backing_text.setString("**** PRODUCTION MENU ****");
78     this->production_menu_backing_text.setFont(
79         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220"))
80     );
81     this->production_menu_backing_text.setCharacterSize(16);
82     this->production_menu_backing_text.setFillColor(MONOCROME_TEXT_GREEN);
83     this->production_menu_backing_text.setOrigin(
84         this->production_menu_backing_text.getLocalBounds().width / 2, 0
85     );
86     this->production_menu_backing_text.setPosition(400, 400 - 128 + 4);
87
88     return;
89 } /* __setUpProductionMenu() */
```

**4.13.3.17 \_\_setUpUpgradeMenu()**

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

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

```
104 {
105     // 1. set up and place upgrade menu backing and text
106     this->upgrade_menu_backing.setSize(sf::Vector2f(400, 256));
107     this->upgrade_menu_backing.setOrigin(200, 128);
108     this->upgrade_menu_backing.setPosition(400, 400);
109     this->upgrade_menu_backing.setFillColor(MONOCHROME_SCREEN_BACKGROUND);
110     this->upgrade_menu_backing.setOutlineColor(MENU_FRAME_GREY);
111     this->upgrade_menu_backing.setOutlineThickness(4);
112
113     this->upgrade_menu_backing_text.setString("**** UPGRADE MENU ****");
114     this->upgrade_menu_backing_text.setFont(
115         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220"))
116     );
117     this->upgrade_menu_backing_text.setCharacterSize(16);
118     this->upgrade_menu_backing_text.setFillColor(MONOCHROME_TEXT_GREEN);
119     this->upgrade_menu_backing_text.setOrigin(
120         this->upgrade_menu_backing_text.getLocalBounds().width / 2, 0
121     );
122     this->upgrade_menu_backing_text.setPosition(400, 400 - 128 + 4);
123
124
125     // 2. set up and place storage upgrade sprite (with upgrade plus)
126     this->storage_upgrade_sprite = sf::Sprite(
127         *(this->assets_manager_ptr->getTexture("energy storage system"))
128     );
129
130     this->storage_upgrade_sprite.setOrigin(
131         this->storage_upgrade_sprite.getLocalBounds().width / 2,
132         this->storage_upgrade_sprite.getLocalBounds().height
133     );
134
135     this->storage_upgrade_sprite.setPosition(400 + 100, 400 - 32);
136
137     this->upgrade_plus_sprite = sf::Sprite(
138         *(this->assets_manager_ptr->getTexture("upgrade plus"))
139     );
140
141     this->upgrade_plus_sprite.setOrigin(
142         this->upgrade_plus_sprite.getLocalBounds().width / 2,
143         this->upgrade_plus_sprite.getLocalBounds().height / 2
144     );
145
146     this->upgrade_plus_sprite.setPosition(400 + 130, 400 - 64);
147
148
149     // 3. set up and place upgrade arrow sprite
150     this->upgrade_arrow_sprite = sf::Sprite(
151         *(this->assets_manager_ptr->getTexture("upgrade arrow"))
152     );
153
154     this->upgrade_arrow_sprite.setOrigin(
155         this->upgrade_arrow_sprite.getLocalBounds().width / 2,
156         this->upgrade_arrow_sprite.getLocalBounds().height / 2
157     );
158
159     this->upgrade_arrow_sprite.setPosition(400 - 64, 400 - 64);
160
161
162     return;
163 } /* __setUpUpgradeMenu() */
```

**4.13.3.18 \_\_upgradeStorageCapacity()**

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

Helper method to upgrade storage capacity.

```
222 {
223     if (this->credits < ENERGY_STORAGE_SYSTEM_BUILD_COST) {
```

```

224         std::cout << "Cannot add energy storage: insufficient credits (need "
225             << ENERGY_STORAGE_SYSTEM_BUILD_COST << " K)" << std::endl;
226
227         this->__sendInsufficientCreditsMessage();
228         return;
229     }
230
231     if (this->storage_level >= MAX_STORAGE_LEVELS) {
232         return;
233     }
234
235     this->storage_level++;
236     this->storage_kWh += 200;
237
238     this->storage_upgrade_sprite_vec.push_back(
239         sf::Sprite(
240             *(this->assets_manager_ptr->getTexture("storage_level"))
241         )
242     );
243
244     this->storage_upgrade_sprite_vec.back().setOrigin(
245         this->storage_upgrade_sprite_vec.back().getLocalBounds().width / 2,
246         this->storage_upgrade_sprite_vec.back().getLocalBounds().height
247     );
248
249     this->storage_upgrade_sprite_vec.back().setPosition(
250         this->position_x + 18,
251         this->position_y + 25 - 7 * this->storage_upgrade_sprite_vec.size()
252     );
253
254     this->just_upgraded = true;
255
256     this->assets_manager_ptr->getSound("upgrade")->play();
257
258     this->__sendCreditsSpentMessage(ENERGY_STORAGE_SYSTEM_BUILD_COST);
259     this->__sendTileStateRequest();
260
261     return;
262 } /* __upgradeStorageCapacity() */

```

#### 4.13.3.19 advanceTurn()

```

virtual void TileImprovement::advanceTurn (
    void ) [inline], [virtual]

```

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), and [DieselGenerator](#).

```
192 {return;}
```

#### 4.13.3.20 draw()

```

void TileImprovement::draw (
    void ) [virtual]

```

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

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```

947 {
948     if (this->tile_improvement_sprite_static.getTexture() != NULL) {
949         int alpha = this->tile_improvement_sprite_static.getColor().a;
950
951         alpha += 0.08 * FRAMES_PER_SECOND;
952
953         this->tile_improvement_sprite_static.setColor(
954             sf::Color(255, 255, 255, alpha)
955         );
956
957         this->tile_improvement_sprite_static.move(0, 50 * SECONDS_PER_FRAME);

```

```

958
959     if (
960         (alpha >= 255) or
961         (this->tile_improvement_sprite_static.getPosition().y >= this->position_y + 12)
962     ) {
963         this->tile_improvement_sprite_static.setColor(
964             sf::Color(255, 255, 255, 255)
965         );
966
967         this->tile_improvement_sprite_static.setPosition(
968             this->position_x,
969             this->position_y + 12
970         );
971
972         this->just_built = false;
973         this->assets_manager_ptr->getSound("place improvement")->play();
974     }
975
976     this->render_window_ptr->draw(this->tile_improvement_sprite_static);
977 }
978
979
980 else {
981     int alpha = 0;
982
983     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
984         alpha = this->tile_improvement_sprite_animated[i].getColor().a;
985
986         alpha += 0.08 * FRAMES_PER_SECOND;
987
988         this->tile_improvement_sprite_animated[i].setColor(
989             sf::Color(255, 255, 255, alpha)
990         );
991
992         this->tile_improvement_sprite_animated[i].move(0, 50 * SECONDS_PER_FRAME);
993
994         if (
995             (alpha >= 255) or
996             (this->tile_improvement_sprite_animated[i].getPosition().y >= this->position_y + 12)
997         ) {
998             this->tile_improvement_sprite_animated[i].setColor(
999                 sf::Color(255, 255, 255, 255)
1000             );
1001
1002             this->tile_improvement_sprite_animated[i].setPosition(
1003                 this->position_x,
1004                 this->position_y + 12
1005             );
1006         }
1007
1008         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
1009     }
1010
1011     if (
1012         (alpha >= 255) or
1013         (this->tile_improvement_sprite_animated[0].getPosition().y >= this->position_y + 12)
1014     ) {
1015         this->just_built = false;
1016         this->assets_manager_ptr->getSound("place improvement")->play();
1017
1018         switch (this->tile_improvement_type) {
1019             case (TileImprovementType :: WIND_TURBINE): {
1020                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1021                     this->tile_improvement_sprite_animated[i].setOrigin(32, 32);
1022                     this->tile_improvement_sprite_animated[i].move(0, -32);
1023                 }
1024
1025                 break;
1026             }
1027
1028             case (TileImprovementType :: TIDAL_TURBINE): {
1029                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1030                     this->tile_improvement_sprite_animated[i].setOrigin(32, 45);
1031                     this->tile_improvement_sprite_animated[i].move(0, -19);
1032                 }
1033
1034                 break;
1035             }
1036
1037             case (TileImprovementType :: WAVE_ENERGY_CONVERTER): {
1038                 for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1039                     this->tile_improvement_sprite_animated[i].setOrigin(32, 32);
1040                     this->tile_improvement_sprite_animated[i].move(0, -32);
1041                 }
1042             }
1043         }
1044     }

```

```

1045             break;
1046         }
1047
1048
1049         default: {
1050             // do nothing!
1051
1052             break;
1053         }
1054     }
1055 }
1056 }
1057
1058
1059     this->frame++;
1060     return;
1061 } /* draw() */

```

#### 4.13.3.21 `getTileOptionsSubstring()`

```

virtual std::string TileImprovement::getTileOptionsSubstring (
    void ) [inline], [virtual]

```

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```

196 {return "";}

```

#### 4.13.3.22 `processEvent()`

```

void TileImprovement::processEvent (
    void ) [virtual]

```

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

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```

887 {
888     if (this->event_ptr->type == sf::Event::KeyPressed) {
889         this->__handleKeyPressEvents();
890     }
891
892     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
893         this->__handleMouseButtonEvents();
894     }
895
896     return;
897 } /* processEvent() */

```

#### 4.13.3.23 processMessage()

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

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

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```
912 {
913     if (not this->message_hub_ptr->isEmpty(GAME_STATE_CHANNEL)) {
914         Message game_state_message = this->message_hub_ptr->receiveMessage(
915             GAME_STATE_CHANNEL
916         );
917
918         if (game_state_message.subject == "turn advance") {
919             this->credits = game_state_message.int_payload["credits"];
920             this->month = game_state_message.int_payload["month"];
921             this->demand_MWh = game_state_message.int_payload["demand_MWh"];
922
923             this->advanceTurn();
924
925             this->message_hub_ptr->incrementMessageRead(GAME_STATE_CHANNEL);
926             std::cout << "Turn advance message read and passed by " << this << std::endl;
927         }
928     }
929
930     return;
931 } /* processMessage() */
```

#### 4.13.3.24 setIsSelected()

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

Method to set the is selected attribute.

##### Parameters

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

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), [SolarPV](#), [Settlement](#), [EnergyStorageSystem](#), and [DieselGenerator](#).

```
860 {
861     this->is_selected = is_selected;
862
863     if ((not is_selected) and this->production_menu_open) {
864         this->__closeProductionMenu();
865     }
866
867     if ((not is_selected) and this->upgrade_menu_open) {
868         this->__closeUpgradeMenu();
869     }
870
871     return;
872 } /* setIsSelected() */
```

#### 4.13.3.25 update()

```
virtual void TileImprovement::update (
    void ) [inline], [virtual]
```

Reimplemented in [WindTurbine](#), [WaveEnergyConverter](#), [TidalTurbine](#), and [SolarPV](#).

```
194 {return;}
```

## 4.13.4 Member Data Documentation

### 4.13.4.1 assets\_manager\_ptr

```
AssetsManager* TileImprovement::assets_manager_ptr [protected]
```

A pointer to the assets manager.

### 4.13.4.2 credits

```
int TileImprovement::credits
```

The current balance of credits.

### 4.13.4.3 demand\_MWh

```
int TileImprovement::demand_MWh
```

The current demand [MWh].

### 4.13.4.4 demand\_vec\_MWh

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

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

### 4.13.4.5 dispatch\_backing

```
sf::CircleShape TileImprovement::dispatch_backing
```

A backing circle for dispatch text illustration.



#### 4.13.4.6 dispatch\_text

```
sf::Text TileImprovement::dispatch_text
```

Text for illustrating dispatch.

#### 4.13.4.7 event\_ptr

```
sf::Event* TileImprovement::event_ptr [protected]
```

A pointer to the event class.

#### 4.13.4.8 frame

```
unsigned long long int TileImprovement::frame
```

The current frame of this object.

#### 4.13.4.9 game\_phase

```
std::string TileImprovement::game_phase
```

The current phase of the game.

#### 4.13.4.10 health

```
int TileImprovement::health
```

The health of the improvement.

#### 4.13.4.11 is\_broken

```
bool TileImprovement::is_broken
```

A boolean which indicated whether or not improvement is broken.

#### 4.13.4.12 is\_running

```
bool TileImprovement::is_running
```

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

#### 4.13.4.13 is\_selected

```
bool TileImprovement::is_selected
```

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

#### 4.13.4.14 just\_built

```
bool TileImprovement::just_built
```

A boolean which indicates that the improvement was just built.

#### 4.13.4.15 just\_upgraded

```
bool TileImprovement::just_upgraded
```

A boolean which indicates that the improvement was just upgraded.

#### 4.13.4.16 message\_hub\_ptr

```
MessageHub* TileImprovement::message_hub_ptr [protected]
```

A pointer to the message hub.

#### 4.13.4.17 month

```
int TileImprovement::month
```

The current month of play.

#### 4.13.4.18 operation\_maintenance\_cost

```
int TileImprovement::operation_maintenance_cost
```

The operation and maintenance costs for this turn.

#### 4.13.4.19 position\_x

```
double TileImprovement::position_x
```

The x position of the tile improvement.

#### 4.13.4.20 position\_y

```
double TileImprovement::position_y
```

The y position of the tile improvement.

#### 4.13.4.21 production\_menu\_backing

```
sf::RectangleShape TileImprovement::production_menu_backing
```

A backing for the production menu.

#### 4.13.4.22 production\_menu\_backing\_text

```
sf::Text TileImprovement::production_menu_backing_text
```

Text for the production menu backing.

#### 4.13.4.23 production\_menu\_open

```
bool TileImprovement::production_menu_open
```

A boolean which indicates whether or not the production menu is open.

#### 4.13.4.24 render\_window\_ptr

```
sf::RenderWindow* TileImprovement::render_window_ptr [protected]
```

A pointer to the render window.

#### 4.13.4.25 storage\_kWh

```
int TileImprovement::storage_kWh
```

The rated energy capacity [kWh] of the storage.

#### 4.13.4.26 storage\_level

```
int TileImprovement::storage_level
```

The level of storage installed alongside the tile improvement.

#### 4.13.4.27 storage\_upgrade\_sprite

```
sf::Sprite TileImprovement::storage_upgrade_sprite
```

A sprite for illustrating storage (in upgrade menu).

#### 4.13.4.28 storage\_upgrade\_sprite\_vec

```
std::vector<sf::Sprite> TileImprovement::storage_upgrade_sprite_vec
```

A vector of sprites for illustrating the storage upgrade level (on tile).

#### 4.13.4.29 tile\_improvement\_sprite\_animated

```
std::vector<sf::Sprite> TileImprovement::tile_improvement_sprite_animated
```

An animated sprite, for the [ContextMenu](#) visual screen.

#### 4.13.4.30 tile\_improvement\_sprite\_static

```
sf::Sprite TileImprovement::tile_improvement_sprite_static
```

A static sprite, for decorating the tile.

#### 4.13.4.31 tile\_improvement\_string

```
std::string TileImprovement::tile_improvement_string
```

A string representation of the tile improvement type.

#### 4.13.4.32 tile\_improvement\_type

```
TileImprovementType TileImprovement::tile_improvement_type
```

The type of the tile improvement.

#### 4.13.4.33 tile\_resource

```
int TileImprovement::tile_resource
```

The renewable resource quality of the tile.

#### 4.13.4.34 tile\_resource\_scalar

```
double TileImprovement::tile_resource_scalar
```

A scalar associated with the renewable resource quality.

#### 4.13.4.35 upgrade\_arrow\_sprite

```
sf::Sprite TileImprovement::upgrade_arrow_sprite
```

An upgrade arrow sprite.

#### 4.13.4.36 upgrade\_frame

```
int TileImprovement::upgrade_frame
```

The frame of the upgrade animation.

#### 4.13.4.37 upgrade\_level

```
int TileImprovement::upgrade_level
```

The upgrade level of the improvement.

#### 4.13.4.38 upgrade\_menu\_backing

```
sf::RectangleShape TileImprovement::upgrade_menu_backing
```

A backing for the upgrade menu.

#### 4.13.4.39 upgrade\_menu\_backing\_text

```
sf::Text TileImprovement::upgrade_menu_backing_text
```

Text for the upgrade menu backing.

#### 4.13.4.40 upgrade\_menu\_open

```
bool TileImprovement::upgrade_menu_open
```

A boolean which indicates whether or not the build menu is open.

#### 4.13.4.41 upgrade\_plus\_sprite

```
sf::Sprite TileImprovement::upgrade_plus_sprite
```

An upgrade plus sprite.

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

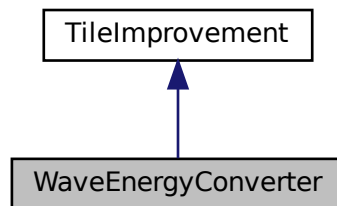
- header/[TileImprovement.h](#)
- source/[TileImprovement.cpp](#)

## 4.14 WaveEnergyConverter Class Reference

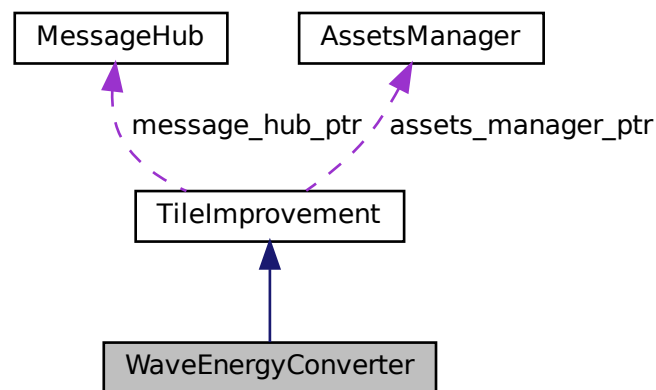
A settlement class (child class of [TileImprovement](#)).

```
#include <WaveEnergyConverter.h>
```

Inheritance diagram for WaveEnergyConverter:



Collaboration diagram for WaveEnergyConverter:



### Public Member Functions

- [WaveEnergyConverter](#) (double, double, int, sf::Event \*, sf::RenderWindow \*, [AssetsManager](#) \*, [MessageHub](#) \*)  
*Constructor for the [WaveEnergyConverter](#) class.*
- std::string [getTileOptionsSubstring](#) (void)  
*Helper method to assemble and return tile options substring.*
- void [setIsSelected](#) (bool)  
*Method to set the is selected attribute.*

- void [advanceTurn](#) (void)  
*Method to handle turn advance.*
- void [update](#) (void)  
*Method to trigger production and dispatchable updates.*
- void [processEvent](#) (void)  
*Method to process [WaveEnergyConverter](#). To be called once per event.*
- void [processMessage](#) (void)  
*Method to process [WaveEnergyConverter](#). To be called once per message.*
- void [draw](#) (void)  
*Method to draw the hex tile to the render window. To be called once per frame.*
- virtual [~WaveEnergyConverter](#) (void)  
*Destructor for the [WaveEnergyConverter](#) class.*

## Public Attributes

- int [capacity\\_kW](#)  
*The rated production capacity [kW] of the solar PV array.*
- int [production\\_MWh](#)  
*The current production [MWh] of the solar PV array.*
- int [dispatch\\_MWh](#)  
*The current dispatch [MWh] of the solar PV array.*
- int [dispatchable\\_MWh](#)  
*The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).*
- double [max\\_daily\\_production\\_MWh](#)  
*The maximum daily production [MWh] of the solar PV array.*
- double [bobbing\\_y](#)  
*The bobbing extent of the wave energy converter.*
- std::vector< double > [capacity\\_factor\\_vec](#)  
*A vector of daily capacity factors for the current month.*
- std::vector< double > [production\\_vec\\_MWh](#)  
*A vector of daily production [MWh] for the current month.*
- std::vector< double > [dispatch\\_vec\\_MWh](#)  
*A vector of daily dispatch [MWh] for the current month.*

## Private Member Functions

- void [\\_\\_setUpTileImprovementSpriteAnimated](#) (void)  
*Helper method to set up tile improvement sprite (static).*
- void [\\_\\_drawProductionMenu](#) (void)  
*Helper method to draw production menu assets.*
- void [\\_\\_upgradePowerCapacity](#) (void)  
*Helper method to upgrade power capacity.*
- void [\\_\\_computeProductionCosts](#) (void)  
*Helper method to compute production costs (O&M) based on current production level.*
- void [\\_\\_breakdown](#) (void)  
*Helper method to trigger an equipment breakdown.*
- void [\\_\\_repair](#) (void)  
*Helper method to repair the wave energy converter.*
- void [\\_\\_computeCapacityFactors](#) (void)



- Helper method to compute capacity factors (by definition in the closed interval [0, 1]).*
- void [\\_\\_computeProduction](#) (void)  
*Helper method to compute production values.*
- void [\\_\\_computeDispatch](#) (void)  
*Helper method to compute dispatch values.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_drawUpgradeOptions](#) (void)  
*Helper method to set up and draw upgrade options.*
- void [\\_\\_sendImprovementStateMessage](#) (void)  
*Helper method to format and sent improvement state message.*

## Additional Inherited Members

### 4.14.1 Detailed Description

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

### 4.14.2 Constructor & Destructor Documentation

#### 4.14.2.1 WaveEnergyConverter()

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

Constructor for the [WaveEnergyConverter](#) class.

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

#### Parameters

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

```

795 :
796 TileImprovement (
797     position_x,
798     position_y,
799     tile_resource,
800     event_ptr,
801     render_window_ptr,
802     assets_manager_ptr,
803     message_hub_ptr
804 )
805 {
806     // 1. set attributes
807
808     // 1.1. private
809     //...
810
811     // 1.2. public
812     this->tile_improvement_type = TileImprovementType :: WAVE_ENERGY_CONVERTER;
813
814     this->is_running = false;
815
816     this->health = 100;
817
818     this->capacity_kW = 100;
819     this->upgrade_level = 1;
820
821     this->storage_kWh = 0;
822     this->storage_level = 0;
823
824     this->production_MWh = 0;
825     this->dispatch_MWh = 0;
826     this->dispatchable_MWh = 0;
827
828     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
829
830     this->bobbing_y = 4;
831
832     this->capacity_factor_vec.resize(30, 0);
833     this->production_vec_MWh.resize(30, 0);
834     this->dispatch_vec_MWh.resize(30, 0);
835
836     this->tile_improvement_string = "WAVE ENERGY";
837
838     this->__setUpTileImprovementSpriteAnimated();
839     this->__computeCapacityFactors();
840     this->update();
841
842     std::cout << "WaveEnergyConverter constructed at " << this << std::endl;
843
844     return;
845 } /* WaveEnergyConverter() */

```

#### 4.14.2.2 ~WaveEnergyConverter()

```

WaveEnergyConverter::~WaveEnergyConverter (
    void ) [virtual]

```

Destructor for the [WaveEnergyConverter](#) class.

```

1222 {
1223     std::cout << "WaveEnergyConverter at " << this << " destroyed" << std::endl;
1224
1225     return;
1226 } /* ~WaveEnergyConverter() */

```

#### 4.14.3 Member Function Documentation

**4.14.3.1 \_\_breakdown()**

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

Helper method to trigger an equipment breakdown.

```
257 {
258     TileImprovement :: __breakdown();
259
260     this->production_MWh = 0;
261     this->dispatch_MWh = 0;
262     this->dispatchable_MWh = 0;
263     this->operation_maintenance_cost = 0;
264
265     return;
266 } /* __breakdown() */
```

**4.14.3.2 \_\_computeCapacityFactors()**

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

Helper method to compute capacity factors (by definition in the closed interval [0, 1]).

```
315 {
316     if (this->is_broken) {
317         return;
318     }
319
320     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
321     std::default_random_engine generator(seed);
322
323     double mean =
324         this->tile_resource_scalar * MEAN_DAILY_WAVE_CAPACITY_FACTORS[this->month - 1];
325
326     double stdev = STDEV_DAILY_WAVE_CAPACITY_FACTORS[this->month - 1];
327
328     if (this->tile_resource_scalar > 1) {
329         stdev /= this->tile_resource_scalar;
330     }
331
332     double performance_factor = this->__getPerformanceFactor();
333
334     std::normal_distribution<double> normal_dist(mean, stdev);
335
336     double capacity_factor = 0;
337
338     for (int i = 0; i < 30; i++) {
339         capacity_factor = performance_factor * normal_dist(generator);
340
341         if (capacity_factor < 0) {
342             capacity_factor = 0;
343         }
344
345         else if (capacity_factor > 1) {
346             capacity_factor = 1;
347         }
348
349         this->capacity_factor_vec[i] = capacity_factor;
350     }
351
352     return;
353 } /* __computeCapacityFactors() */
```

#### 4.14.3.3 \_\_computeDispatch()

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

Helper method to compute dispatch values.

```
401 {
402     if (this->is_broken) {
403         this->dispatchable_MWh = 0;
404         return;
405     }
406
407     double stored_energy_MWh = 0;
408     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
409
410     double demand_MWh = 0;
411     double production_MWh = 0;
412     double dispatchable_MWh = 0;
413     double difference_MWh = 0;
414
415     double room_MWh = 0;
416
417     for (int i = 0; i < 30; i++) {
418         demand_MWh = this->demand_vec_MWh[i];
419         production_MWh = this->production_vec_MWh[i];
420
421         if (production_MWh <= demand_MWh) {
422             this->dispatch_vec_MWh[i] = production_MWh;
423             dispatchable_MWh += this->dispatch_vec_MWh[i];
424
425             difference_MWh = demand_MWh - production_MWh;
426
427             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
428                 if (difference_MWh > stored_energy_MWh) {
429                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
430                     dispatchable_MWh += stored_energy_MWh;
431                     stored_energy_MWh = 0;
432                 }
433
434                 else {
435                     this->dispatch_vec_MWh[i] += difference_MWh;
436                     dispatchable_MWh += difference_MWh;
437                     stored_energy_MWh -= difference_MWh;
438                 }
439             }
440         }
441
442         else {
443             this->dispatch_vec_MWh[i] = demand_MWh;
444             dispatchable_MWh += this->dispatch_vec_MWh[i];
445
446             difference_MWh = production_MWh - demand_MWh;
447
448             if (
449                 (storage_capacity_MWh > 0) and
450                 (stored_energy_MWh < storage_capacity_MWh)
451             ) {
452                 room_MWh = storage_capacity_MWh - stored_energy_MWh;
453
454                 if (difference_MWh > room_MWh) {
455                     stored_energy_MWh += room_MWh;
456                 }
457
458                 else {
459                     stored_energy_MWh += difference_MWh;
460                 }
461             }
462         }
463     }
464
465     this->dispatchable_MWh = round(dispatchable_MWh);
466
467     if (this->dispatch_MWh <= 0) {
468         this->dispatch_MWh = 0;
469     }
470
471     else if (this->dispatch_MWh != this->dispatchable_MWh) {
472         this->dispatch_MWh = this->dispatchable_MWh;
473     }
474
475     return;
476 } /* __computeDispatch() */
```

#### 4.14.3.4 \_\_computeProduction()

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

Helper method to compute production values.

```
368 {
369     if (this->is_broken) {
370         this->production_MWh = 0;
371         return;
372     }
373
374     double production_MWh = 0;
375
376     for (int i = 0; i < 30; i++) {
377         this->production_vec_MWh[i] =
378             this->max_daily_production_MWh * this->capacity_factor_vec[i];
379
380         production_MWh += this->production_vec_MWh[i];
381     }
382
383     this->production_MWh = round(production_MWh);
384
385     return;
386 } /* __computeProduction() */
```

#### 4.14.3.5 \_\_computeProductionCosts()

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

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

```
229 {
230     if (this->is_running) {
231         double operation_maintenance_cost =
232             (this->production_MWh * WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
233
234         this->operation_maintenance_cost = round(operation_maintenance_cost);
235     }
236
237     else {
238         this->operation_maintenance_cost = 0;
239     }
240
241     return;
242 } /* __computeProductionCosts() */
```

#### 4.14.3.6 \_\_drawProductionMenu()

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

Helper method to draw production menu assets.

```
114 {
115     // 1. draw static sprite
116     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
117         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
118         this->tile_improvement_sprite_animated[i].setPosition(400 - 138, 400 + 16);
119
120         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
121         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
122
123         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
124         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
125
126         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
```

```

127         this->tile_improvement_sprite_animated[i].setRotation(0);
128
129         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
130
131         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
132         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
133         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
134         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
135     }
136
137     // 2. draw production text
138     std::string production_string = "[W]:  INCREASE DISPATCH\n";
139     production_string             += "[S]:  DECREASE DISPATCH\n";
140     production_string             += "      \n";
141
142     production_string             += "DISPATCH:  ";
143     production_string             += std::to_string(this->dispatch_MWh);
144     production_string             += " MWh (MAX ";
145     production_string             += std::to_string(this->dispatchable_MWh);
146     production_string             += ") \n";
147
148     production_string             += "O&M COST:  ";
149     production_string             += std::to_string(this->operation_maintenance_cost);
150     production_string             += " K\n";
151
152     sf::Text production_text(
153         production_string,
154         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
155         16
156     );
157
158     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
159     production_text.setFillColor(MONOCHROME_TEXT_GREEN);
160
161     production_text.setPosition(400 + 30, 400 - 45);
162
163     this->render_window_ptr->draw(production_text);
164
165     return;
166 } /* __drawProductionMenu() */

```

#### 4.14.3.7 \_\_drawUpgradeOptions()

```

void WaveEnergyConverter::__drawUpgradeOptions (
    void ) [private]

```

Helper method to set up and draw upgrade options.

```

616 {
617     // 1. draw power capacity upgrade sprite
618     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
619         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
620         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 32 - 20);
621
622         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
623         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
624
625         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
626         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
627
628         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
629
630         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
631         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
632         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
633     }
634
635     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
636
637
638     // 2. draw power capacity upgrade text
639     //      16 char line = "          \n"
640     std::string power_upgrade_string = "POWER CAPACITY \n";
641     power_upgrade_string             += "          \n";
642
643     power_upgrade_string             += "CAPACITY:  ";
644     power_upgrade_string             += std::to_string(this->capacity_kW);
645     power_upgrade_string             += " kW\n";
646

```

```

647     power_upgrade_string      += "LEVEL:      ";
648     power_upgrade_string      += std::to_string(this->upgrade_level);
649     power_upgrade_string      += "\n\n";
650
651     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
652         power_upgrade_string    += "[W]: + 100 kW (";
653         power_upgrade_string    += std::to_string(WAVE_ENERGY_CONVERTER_BUILD_COST);
654         power_upgrade_string    += " K)\n";
655     }
656
657     else {
658         power_upgrade_string    += " * MAX LEVEL *  \n";
659     }
660
661     sf::Text power_upgrade_text = sf::Text(
662         power_upgrade_string,
663         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
664         16
665     );
666
667     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
668     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
669     power_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
670
671     this->render_window_ptr->draw(power_upgrade_text);
672
673
674     // 3. draw energy capacity (storage) upgrade sprite
675     this->render_window_ptr->draw(this->storage_upgrade_sprite);
676     this->render_window_ptr->draw(this->upgrade_plus_sprite);
677
678
679     // 4. draw energy capacity (storage) upgrade text
680     //      16 char line = "          \n"
681     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
682     energy_upgrade_string            += "          \n";
683
684     energy_upgrade_string            += "CAPACITY:  ";
685     energy_upgrade_string            += std::to_string(this->storage_level * 200);
686     energy_upgrade_string            += " kWh\n";
687
688     energy_upgrade_string            += "LEVEL:      ";
689     energy_upgrade_string            += std::to_string(this->storage_level);
690     energy_upgrade_string            += "\n\n";
691
692     if (this->storage_level < MAX_STORAGE_LEVELS) {
693         energy_upgrade_string    += "[D]: + 200 kWh (";
694         energy_upgrade_string    += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
695         energy_upgrade_string    += " K)\n";
696     }
697
698     else {
699         energy_upgrade_string += " * MAX LEVEL *  \n";
700     }
701
702     sf::Text energy_upgrade_text = sf::Text(
703         energy_upgrade_string,
704         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
705         16
706     );
707
708     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
709     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
710     energy_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
711
712     this->render_window_ptr->draw(energy_upgrade_text);
713
714     return;
715 } /* __drawUpgradeOptions() */

```

#### 4.14.3.8 \_\_handleKeyPressEvents()

```

void WaveEnergyConverter::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

491 {
492     if (this->just_built) {

```

```

493         return;
494     }
495
496     switch (this->event_ptr->key.code) {
497         case (sf::Keyboard::U): {
498             this->__openUpgradeMenu();
499
500             break;
501         }
502
503
504         case (sf::Keyboard::W): {
505             if (this->production_menu_open) {
506                 this->dispatch_MWh++;
507
508                 if (this->dispatch_MWh > this->dispatchable_MWh) {
509                     this->dispatch_MWh = 0;
510                 }
511
512                 this->__computeProductionCosts();
513                 this->assets_manager_ptr->getSound("interface click")->play();
514             }
515
516             else if (this->upgrade_menu_open) {
517                 this->__upgradePowerCapacity();
518             }
519
520             break;
521         }
522
523
524         case (sf::Keyboard::S): {
525             if (this->production_menu_open) {
526                 this->dispatch_MWh--;
527
528                 if (this->dispatch_MWh < 0) {
529                     this->dispatch_MWh = this->dispatchable_MWh;
530                 }
531
532                 this->__computeProductionCosts();
533                 this->assets_manager_ptr->getSound("interface click")->play();
534             }
535
536             break;
537         }
538
539
540         case (sf::Keyboard::D): {
541             if (this->upgrade_menu_open) {
542                 this->__upgradeStorageCapacity();
543                 this->__computeProduction();
544                 this->__computeDispatch();
545             }
546
547             break;
548         }
549
550
551         default: {
552             // do nothing!
553
554             break;
555         }
556     }
557
558     return;
559 } /* __handleKeyPressEvents() */

```

#### 4.14.3.9 \_\_handleMouseButtonEvents()

```

void WaveEnergyConverter::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

574 {
575     if (this->just_built) {
576         return;
577     }

```



```

578     switch (this->event_ptr->mouseButton.button) {
579         case (sf::Mouse::Left): {
580             //...
581
582             break;
583         }
584
585
586         case (sf::Mouse::Right): {
587             //...
588
589             break;
590         }
591
592
593         default: {
594             // do nothing!
595
596             break;
597         }
598     }
599
600     return;
601 } /* __handleMouseButtonEvents() */

```

#### 4.14.3.10 \_\_repair()

```

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

```

Helper method to repair the wave energy converter.

Reimplemented from [TileImprovement](#).

```

281 {
282     if (this->credits < WAVE_ENERGY_CONVERTER_BUILD_COST) {
283         std::cout << "Cannot repair wave energy converter: insufficient credits (need "
284             << WAVE_ENERGY_CONVERTER_BUILD_COST << " K)" << std::endl;
285
286         this->__sendInsufficientCreditsMessage();
287         return;
288     }
289
290     TileImprovement :: __repair();
291
292     this->just_upgraded = true;
293
294     this->__sendCreditsSpentMessage(WAVE_ENERGY_CONVERTER_BUILD_COST);
295     this->__sendTileStateRequest();
296     this->__sendGameStateRequest();
297
298     return;
299 } /* __repair() */

```

#### 4.14.3.11 \_\_sendImprovementStateMessage()

```

void WaveEnergyConverter::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

730 {
731     Message improvement_state_message;
732
733     improvement_state_message.channel = GAME_CHANNEL;
734     improvement_state_message.subject = "improvement state";
735
736     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
737     improvement_state_message.int_payload["operation_maintenance_cost"] =
738         this->operation_maintenance_cost;

```

```

739
740     this->message_hub_ptr->sendMessage(improvement_state_message);
741
742     std::cout << "Improvement state message sent by " << this << std::endl;
743
744     return;
745 } /* __sendImprovementStateMessage() */

```

#### 4.14.3.12 \_\_setUpTileImprovementSpriteAnimated()

```

void WaveEnergyConverter::__setUpTileImprovementSpriteAnimated (
    void ) [private]

```

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

```

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

```

#### 4.14.3.13 \_\_upgradePowerCapacity()

```

void WaveEnergyConverter::__upgradePowerCapacity (
    void ) [private]

```

Helper method to upgrade power capacity.

```

181 {
182     if (this->credits < WAVE_ENERGY_CONVERTER_BUILD_COST) {
183         std::cout << "Cannot upgrade wave energy converter: insufficient credits (need "
184             << WAVE_ENERGY_CONVERTER_BUILD_COST << " K)" << std::endl;
185
186         this->__sendInsufficientCreditsMessage();
187         return;
188     }
189
190     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
191         return;
192     }
193
194     TileImprovement :: __repair();
195
196     this->capacity_kW += 100;

```

```

197     this->upgrade_level++;
198
199     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
200
201     this->__computeProduction();
202     this->__computeDispatch();
203
204     this->just_upgraded = true;
205
206     this->assets_manager_ptr->getSound("upgrade")->play();
207
208     this->__sendCreditsSpentMessage(WAVE_ENERGY_CONVERTER_BUILD_COST);
209     this->__sendTileStateRequest();
210     this->__sendGameStateRequest();
211
212     return;
213 } /* __upgradePowerCapacity() */

```

#### 4.14.3.14 advanceTurn()

```

void WaveEnergyConverter::advanceTurn (
    void ) [virtual]

```

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```

950 {
951     // 1. send improvement state message
952     this->__sendImprovementStateMessage();
953
954     // 2. update
955     this->__computeCapacityFactors();
956     this->update();
957
958     // 3. handle start/stop
959     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
960         this->is_running = true;
961     }
962
963     else if (this->is_running and (this->dispatch_MWh <= 0)) {
964         this->is_running = false;
965     }
966
967     // 4. handle equipment health and breakdowns
968     if (this->is_running) {
969         this->health--;
970
971         if (this->health <= 50) {
972             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
973
974             if ((double)rand() / RAND_MAX <= breakdown_prob) {
975                 this->health = 0;
976             }
977         }
978
979         if (this->health <= 0) {
980             this->__breakdown();
981         }
982     }
983
984     // 5. send tile state request (if selected)
985     if (this->is_selected) {
986         this->__sendTileStateRequest();
987     }
988
989     return;
990 } /* advanceTurn() */

```

#### 4.14.3.15 draw()

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

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

Reimplemented from [TileImprovement](#).

```
1079 {
1080     // 1. if just built, call base method and return
1081     if (this->just_built) {
1082         TileImprovement :: draw();
1083     }
1084     return;
1085 }
1086
1087 // 2. handle upgrade effects
1088 if (this->just_upgraded) {
1089     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1090         this->tile_improvement_sprite_animated[i].setColor(
1091             sf::Color(
1092                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1093                 255,
1094                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1095                 255
1096             )
1097         );
1098     }
1099     this->tile_improvement_sprite_animated[i].setScale(
1100         sf::Vector2f(
1101             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1102             1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1103         )
1104     );
1105 }
1106
1107 this->upgrade_frame++;
1108 }
1109
1110 if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1111     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1112         this->tile_improvement_sprite_animated[i].setColor(
1113             sf::Color(255,255,255,255)
1114         );
1115     }
1116     this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1117 }
1118
1119 this->just_upgraded = false;
1120 this->upgrade_frame = 0;
1121 }
1122
1123 // 3. draw first element of animated sprite
1124 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1125
1126 // 4. draw second element of animated sprite
1127 if (this->is_running) {
1128     this->tile_improvement_sprite_animated[0].setPosition(
1129         this->position_x,
1130         this->position_y + this->bobbing_y * cos(
1131             (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1132         )
1133     );
1134     this->tile_improvement_sprite_animated[1].setPosition(
1135         this->position_x,
1136         this->position_y + 1.25 * this->bobbing_y * sin(
1137             (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1138         )
1139     );
1140 }
1141
1142 else {
1143     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1144         this->tile_improvement_sprite_animated[i].setPosition(
1145             this->position_x,
1146             this->position_y + this->bobbing_y * cos(
1147                 (double)(0.4 * M_PI * this->frame) / FRAMES_PER_SECOND
1148             )
1149         );
1150     }
1151 }
```

```

1154     }
1155 }
1156
1157 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1158
1159
1160 // 5. draw storage upgrades
1161 for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1162     this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1163 }
1164
1165
1166 // 6. handle dispatch illustration
1167 if (this->dispatch_MWh > 0) {
1168     this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1169     this->__drawDispatch();
1170 }
1171
1172
1173 // 7. draw production menu
1174 if (this->production_menu_open) {
1175     this->render_window_ptr->draw(this->production_menu_backing);
1176     this->render_window_ptr->draw(this->production_menu_backing_text);
1177
1178     this->__drawProductionMenu();
1179 }
1180
1181
1182 // 8. draw upgrade menu
1183 if (this->upgrade_menu_open) {
1184     this->render_window_ptr->draw(this->upgrade_menu_backing);
1185     this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1186
1187     this->__drawUpgradeOptions();
1188 }
1189
1190
1191 // 9. handle broken effects
1192 if (this->is_broken) {
1193     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1194         this->tile_improvement_sprite_animated[i].setColor(
1195             sf::Color(
1196                 255,
1197                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1198                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1199                 255
1200             )
1201         );
1202     }
1203 }
1204
1205 this->frame++;
1206 return;
1207 } /* draw() */

```

#### 4.14.3.16 getTileOptionsSubstring()

```

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

```

Helper method to assemble and return tile options substring.

#### Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

862 {
863     // 32 char x 17 line console "-----\n";
864     std::string options_substring = "CAPACITY: ";
865     options_substring += std::to_string(this->capacity_kW);
866     options_substring += " kW (level ";
867     options_substring += std::to_string(this->upgrade_level);
868     options_substring += ")\n";

```

```

869
870 options_substring      += "PRODUCTION:      ";
871 options_substring      += std::to_string(this->production_MWh);
872 options_substring      += " MWh\n";
873
874 options_substring      += "DISPATCHABLE:    ";
875 options_substring      += std::to_string(this->dispatchable_MWh);
876 options_substring      += " MWh\n";
877
878 options_substring      += "HEALTH:          ";
879 options_substring      += std::to_string(this->health);
880 options_substring      += "/100";
881
882 if (this->health <= 0) {
883     options_substring      += " ** BROKEN! **\n";
884 }
885
886 else {
887     options_substring      += "\n";
888 }
889
890 options_substring      += "
891 options_substring      += " **** WAVE ENERGY OPTIONS ****
892 options_substring      += "
893
894 if (this->is_broken) {
895     options_substring      += "          [R]: REPAIR (";
896     options_substring      += std::to_string(WAVE_ENERGY_CONVERTER_BUILD_COST);
897     options_substring      += " K)\n";
898 }
899
900 else {
901     options_substring      += "          [E]: OPEN PRODUCTION MENU \n";
902 }
903
904 options_substring      += "          [U]: OPEN UPGRADE MENU
905 options_substring      += "HOLD [P]: SCRAP (";
906 options_substring      += std::to_string(SCRAP_COST);
907 options_substring      += " K)";
908
909 return options_substring;
910 } /* getTileOptionsSubstring() */

```

#### 4.14.3.17 processEvent()

```

void WaveEnergyConverter::processEvent (
    void ) [virtual]

```

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

Reimplemented from [TileImprovement](#).

```

1030 {
1031     TileImprovement :: processEvent();
1032
1033     if (this->event_ptr->type == sf::Event::KeyPressed) {
1034         this->__handleKeyPressEvents();
1035     }
1036
1037     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1038         this->__handleMouseButtonEvents();
1039     }
1040
1041     return;
1042 } /* processEvent() */

```

**4.14.3.18 processMessage()**

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

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

Reimplemented from [TileImprovement](#).

```
1057 {
1058     TileImprovement :: processMessage();
1059
1060     //...
1061
1062     return;
1063 } /* processMessage() */
```

**4.14.3.19 setIsSelected()**

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

Method to set the is selected attribute.

**Parameters**

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

Reimplemented from [TileImprovement](#).

```
927 {
928     TileImprovement :: setIsSelected(is_selected);
929
930     if (this->is_running and this->is_selected) {
931         this->assets_manager_ptr->getSound("ocean waves")->play();
932     }
933
934     return;
935 } /* setIsSelected() */
```

**4.14.3.20 update()**

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

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```
1005 {
1006     this->__computeProduction();
1007     this->__computeProductionCosts();
1008     this->__computeDispatch();
1009
1010     if (this->is_selected) {
1011         this->__sendTileStateRequest();
1012     }
1013
1014     return;
1015 } /* update() */
```

#### 4.14.4 Member Data Documentation

##### 4.14.4.1 bobbing\_y

```
double WaveEnergyConverter::bobbing_y
```

The bobbing extent of the wave energy converter.

##### 4.14.4.2 capacity\_factor\_vec

```
std::vector<double> WaveEnergyConverter::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

##### 4.14.4.3 capacity\_kW

```
int WaveEnergyConverter::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

##### 4.14.4.4 dispatch\_MWh

```
int WaveEnergyConverter::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

##### 4.14.4.5 dispatch\_vec\_MWh

```
std::vector<double> WaveEnergyConverter::dispatch_vec_MWh
```

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



#### 4.14.4.6 dispatchable\_MWh

```
int WaveEnergyConverter::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

#### 4.14.4.7 max\_daily\_production\_MWh

```
double WaveEnergyConverter::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

#### 4.14.4.8 production\_MWh

```
int WaveEnergyConverter::production_MWh
```

The current production [MWh] of the solar PV array.

#### 4.14.4.9 production\_vec\_MWh

```
std::vector<double> WaveEnergyConverter::production_vec_MWh
```

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

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

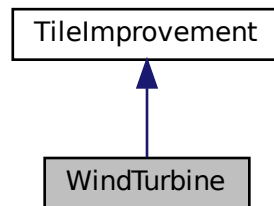
- header/[WaveEnergyConverter.h](#)
- source/[WaveEnergyConverter.cpp](#)

## 4.15 WindTurbine Class Reference

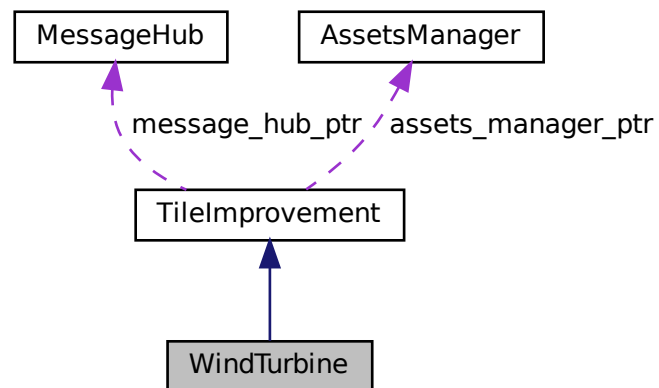
A settlement class (child class of [TileImprovement](#)).

```
#include <WindTurbine.h>
```

Inheritance diagram for WindTurbine:



Collaboration diagram for WindTurbine:



### Public Member Functions

- [WindTurbine](#) (double, double, int, sf::Event \*, sf::RenderWindow \*, [AssetsManager](#) \*, [MessageHub](#) \*)  
*Constructor for the [WindTurbine](#) class.*
- std::string [getTileOptionsSubstring](#) (void)  
*Helper method to assemble and return tile options substring.*
- void [setIsSelected](#) (bool)  
*Method to set the is selected attribute.*
- void [advanceTurn](#) (void)

- *Method to handle turn advance.*
- void [update](#) (void)
- *Method to trigger production and dispatchable updates.*
- void [processEvent](#) (void)
- *Method to process [WindTurbine](#). To be called once per event.*
- void [processMessage](#) (void)
- *Method to process [WindTurbine](#). To be called once per message.*
- void [draw](#) (void)
- *Method to draw the hex tile to the render window. To be called once per frame.*
- virtual [~WindTurbine](#) (void)
- *Destructor for the [WindTurbine](#) class.*

## Public Attributes

- int [capacity\\_kW](#)
- *The rated production capacity [kW] of the solar PV array.*
- int [production\\_MWh](#)
- *The current production [MWh] of the solar PV array.*
- int [dispatch\\_MWh](#)
- *The current dispatch [MWh] of the solar PV array.*
- int [dispatchable\\_MWh](#)
- *The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).*
- double [max\\_daily\\_production\\_MWh](#)
- *The maximum daily production [MWh] of the solar PV array.*
- double [rotor\\_drotation](#)
- *The rotation rate of the rotor.*
- std::vector< double > [capacity\\_factor\\_vec](#)
- *A vector of daily capacity factors for the current month.*
- std::vector< double > [production\\_vec\\_MWh](#)
- *A vector of daily production [MWh] for the current month.*
- std::vector< double > [dispatch\\_vec\\_MWh](#)
- *A vector of daily dispatch [MWh] for the current month.*

## Private Member Functions

- void [\\_\\_setUpTileImprovementSpriteAnimated](#) (void)
- *Helper method to set up tile improvement sprite (static).*
- void [\\_\\_drawProductionMenu](#) (void)
- *Helper method to draw production menu assets.*
- void [\\_\\_upgradePowerCapacity](#) (void)
- *Helper method to upgrade the power capacity.*
- void [\\_\\_computeProductionCosts](#) (void)
- *Helper method to compute production costs (O&M) based on current production level.*
- void [\\_\\_breakdown](#) (void)
- *Helper method to trigger an equipment breakdown.*
- void [\\_\\_repair](#) (void)
- *Helper method to repair the wind turbine.*
- void [\\_\\_computeCapacityFactors](#) (void)
- *Helper method to compute capacity factors (by definition in the closed interval [0, 1]).*

- void [\\_\\_computeProduction](#) (void)  
*Helper method to compute production values.*
- void [\\_\\_computeDispatch](#) (void)  
*Helper method to compute dispatch values.*
- void [\\_\\_handleKeyPressEvents](#) (void)  
*Helper method to handle key press events.*
- void [\\_\\_handleMouseButtonEvents](#) (void)  
*Helper method to handle mouse button events.*
- void [\\_\\_drawUpgradeOptions](#) (void)  
*Helper method to set up and draw upgrade options.*
- void [\\_\\_sendImprovementStateMessage](#) (void)  
*Helper method to format and sent improvement state message.*

## Additional Inherited Members

### 4.15.1 Detailed Description

A settlement class (child class of [TileImprovement](#)).

### 4.15.2 Constructor & Destructor Documentation

#### 4.15.2.1 WindTurbine()

```
WindTurbine::WindTurbine (
    double position_x,
    double position_y,
    int tile_resource,
    sf::Event * event_ptr,
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr,
    MessageHub * message_hub_ptr )
```

Constructor for the [WindTurbine](#) class.

Ref: [Wikipedia \[2023\]](#)

#### Parameters

<a href="#">position_x</a>	The x position of the tile.
<a href="#">position_y</a>	The y position of the tile.
<a href="#">tile_resource</a>	The renewable resource quality of the tile.
<a href="#">event_ptr</a>	Pointer to the event class.
<a href="#">render_window_ptr</a>	Pointer to the render window.
<a href="#">assets_manager_ptr</a>	Pointer to the assets manager.
<a href="#">message_hub_ptr</a>	Pointer to the message hub.

```

800 :
801 TileImprovement (
802     position_x,
803     position_y,
804     tile_resource,
805     event_ptr,
806     render_window_ptr,
807     assets_manager_ptr,
808     message_hub_ptr
809 )
810 {
811     // 1. set attributes
812
813     // 1.1. private
814     //...
815
816     // 1.2. public
817     this->tile_improvement_type = TileImprovementType :: WIND_TURBINE;
818
819     this->is_running = false;
820
821     this->health = 100;
822
823     this->capacity_kW = 100;
824     this->upgrade_level = 1;
825
826     this->storage_kWh = 0;
827     this->storage_level = 0;
828
829     this->production_MWh = 0;
830     this->dispatch_MWh = 0;
831     this->dispatchable_MWh = 0;
832
833     this->max_daily_production_MWh = (double)(24 * this->capacity_kW) / 1000;
834
835     this->rotor_drotation = 256 * SECONDS_PER_FRAME;
836
837     this->capacity_factor_vec.resize(30, 0);
838     this->production_vec_MWh.resize(30, 0);
839     this->dispatch_vec_MWh.resize(30, 0);
840
841     this->tile_improvement_string = "WIND TURBINE";
842
843     this->__setUpTileImprovementSpriteAnimated();
844     this->__computeCapacityFactors();
845     this->update();
846
847     std::cout << "WindTurbine constructed at " << this << std::endl;
848
849     return;
850 } /* WindTurbine() */

```

#### 4.15.2.2 ~WindTurbine()

```

WindTurbine::~~WindTurbine (
    void ) [virtual]

```

Destructor for the [WindTurbine](#) class.

```

1205 {
1206     std::cout << "WindTurbine at " << this << " destroyed" << std::endl;
1207
1208     return;
1209 } /* ~WindTurbine() */

```

### 4.15.3 Member Function Documentation

#### 4.15.3.1 \_\_breakdown()

```
void WindTurbine::__breakdown (
    void ) [private]
```

Helper method to trigger an equipment breakdown.

```
257 {
258     TileImprovement :: __breakdown();
259
260     this->production_MWh = 0;
261     this->dispatch_MWh = 0;
262     this->dispatchable_MWh = 0;
263     this->operation_maintenance_cost = 0;
264
265     return;
266 } /* __breakdown() */
```

#### 4.15.3.2 \_\_computeCapacityFactors()

```
void WindTurbine::__computeCapacityFactors (
    void ) [private]
```

Helper method to compute capacity factors (by definition in the closed interval [0, 1]).

```
315 {
316     if (this->is_broken) {
317         return;
318     }
319
320     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
321     std::default_random_engine generator(seed);
322
323     double mean =
324         this->tile_resource_scalar * MEAN_DAILY_WIND_CAPACITY_FACTORS[this->month - 1];
325
326     double stdev = STDEV_DAILY_WIND_CAPACITY_FACTORS[this->month - 1];
327
328     if (this->tile_resource_scalar > 1) {
329         stdev /= this->tile_resource_scalar;
330     }
331
332     double performance_factor = this->__getPerformanceFactor();
333
334     std::normal_distribution<double> normal_dist(mean, stdev);
335
336     double capacity_factor = 0;
337
338     for (int i = 0; i < 30; i++) {
339         capacity_factor = performance_factor * normal_dist(generator);
340
341         if (capacity_factor < 0) {
342             capacity_factor = 0;
343         }
344
345         else if (capacity_factor > 1) {
346             capacity_factor = 1;
347         }
348
349         this->capacity_factor_vec[i] = capacity_factor;
350     }
351
352     return;
353 } /* __computeCapacityFactors() */
```

## 4.15.3.3 \_\_computeDispatch()

```
void WindTurbine::__computeDispatch (
    void ) [private]
```

Helper method to compute dispatch values.

```
401 {
402     if (this->is_broken) {
403         this->dispatchable_MWh = 0;
404         return;
405     }
406
407     double stored_energy_MWh = 0;
408     double storage_capacity_MWh = (double)(this->storage_kWh) / 1000;
409
410     double demand_MWh = 0;
411     double production_MWh = 0;
412     double dispatchable_MWh = 0;
413     double difference_MWh = 0;
414
415     double room_MWh = 0;
416
417     for (int i = 0; i < 30; i++) {
418         demand_MWh = this->demand_vec_MWh[i];
419         production_MWh = this->production_vec_MWh[i];
420
421         if (production_MWh <= demand_MWh) {
422             this->dispatch_vec_MWh[i] = production_MWh;
423             dispatchable_MWh += this->dispatch_vec_MWh[i];
424
425             difference_MWh = demand_MWh - production_MWh;
426
427             if ((storage_capacity_MWh > 0) and (stored_energy_MWh > 0)) {
428                 if (difference_MWh > stored_energy_MWh) {
429                     this->dispatch_vec_MWh[i] += stored_energy_MWh;
430                     dispatchable_MWh += stored_energy_MWh;
431                     stored_energy_MWh = 0;
432                 }
433
434                 else {
435                     this->dispatch_vec_MWh[i] += difference_MWh;
436                     dispatchable_MWh += difference_MWh;
437                     stored_energy_MWh -= difference_MWh;
438                 }
439             }
440         }
441
442         else {
443             this->dispatch_vec_MWh[i] = demand_MWh;
444             dispatchable_MWh += this->dispatch_vec_MWh[i];
445
446             difference_MWh = production_MWh - demand_MWh;
447
448             if (
449                 (storage_capacity_MWh > 0) and
450                 (stored_energy_MWh < storage_capacity_MWh)
451             ) {
452                 room_MWh = storage_capacity_MWh - stored_energy_MWh;
453
454                 if (difference_MWh > room_MWh) {
455                     stored_energy_MWh += room_MWh;
456                 }
457
458                 else {
459                     stored_energy_MWh += difference_MWh;
460                 }
461             }
462         }
463     }
464
465     this->dispatchable_MWh = round(dispatchable_MWh);
466
467     if (this->dispatch_MWh <= 0) {
468         this->dispatch_MWh = 0;
469     }
470
471     else if (this->dispatch_MWh != this->dispatchable_MWh) {
472         this->dispatch_MWh = this->dispatchable_MWh;
473     }
474
475     return;
476 } /* __computeDispatch() */
```

#### 4.15.3.4 \_\_computeProduction()

```
void WindTurbine::__computeProduction (
    void ) [private]
```

Helper method to compute production values.

```
368 {
369     if (this->is_broken) {
370         this->production_MWh = 0;
371         return;
372     }
373
374     double production_MWh = 0;
375
376     for (int i = 0; i < 30; i++) {
377         this->production_vec_MWh[i] =
378             this->max_daily_production_MWh * this->capacity_factor_vec[i];
379
380         production_MWh += this->production_vec_MWh[i];
381     }
382
383     this->production_MWh = round(production_MWh);
384
385     return;
386 } /* __computeProduction() */
```

#### 4.15.3.5 \_\_computeProductionCosts()

```
void WindTurbine::__computeProductionCosts (
    void ) [private]
```

Helper method to compute production costs (O&M) based on current production level.

```
229 {
230     if (this->is_running) {
231         double operation_maintenance_cost =
232             (this->production_MWh * WIND_OP_MAINT_COST_PER_MWH_PRODUCTION) / 1000;
233
234         this->operation_maintenance_cost = round(operation_maintenance_cost);
235     }
236
237     else {
238         this->operation_maintenance_cost = 0;
239     }
240
241     return;
242 } /* __computeProductionCosts() */
```

#### 4.15.3.6 \_\_drawProductionMenu()

```
void WindTurbine::__drawProductionMenu (
    void ) [private]
```

Helper method to draw production menu assets.

```
114 {
115     // 1. draw static sprite
116     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
117         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
118         this->tile_improvement_sprite_animated[i].setPosition(400 - 138, 400 + 16);
119
120         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
121         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
122
123         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
124         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
125
126         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
```



```

127         this->tile_improvement_sprite_animated[i].setRotation(0);
128
129         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
130
131         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
132         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
133         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
134         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
135     }
136
137     // 2. draw production text
138     std::string production_string = "[W]:  INCREASE DISPATCH\n";
139     production_string             += "[S]:  DECREASE DISPATCH\n";
140     production_string             += "\n";
141
142     production_string             += "DISPATCH:  ";
143     production_string             += std::to_string(this->dispatch_MWh);
144     production_string             += " MWh (MAX ";
145     production_string             += std::to_string(this->dispatchable_MWh);
146     production_string             += ") \n";
147
148     production_string             += "O&M COST:  ";
149     production_string             += std::to_string(this->operation_maintenance_cost);
150     production_string             += " K\n";
151
152     sf::Text production_text(
153         production_string,
154         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
155         16
156     );
157
158     production_text.setOrigin(production_text.getLocalBounds().width / 2, 0);
159     production_text.setFillColor(MONOCROME_TEXT_GREEN);
160
161     production_text.setPosition(400 + 30, 400 - 45);
162
163     this->render_window_ptr->draw(production_text);
164
165     return;
166 } /* __drawProductionMenu() */

```

#### 4.15.3.7 \_\_drawUpgradeOptions()

```

void WindTurbine::__drawUpgradeOptions (
    void ) [private]

```

Helper method to set up and draw upgrade options.

```

617 {
618     // 1. draw power capacity upgrade sprite
619     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
620         sf::Vector2f initial_position = this->tile_improvement_sprite_animated[i].getPosition();
621         this->tile_improvement_sprite_animated[i].setPosition(400 - 100, 400 - 56);
622
623         sf::Color initial_colour = this->tile_improvement_sprite_animated[i].getColor();
624         this->tile_improvement_sprite_animated[i].setColor(sf::Color(255, 255, 255, 255));
625
626         sf::Vector2f initial_scale = this->tile_improvement_sprite_animated[i].getScale();
627         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1, 1));
628
629         double initial_rotation = this->tile_improvement_sprite_animated[i].getRotation();
630         this->tile_improvement_sprite_animated[i].setRotation(0);
631
632         this->render_window_ptr->draw(this->tile_improvement_sprite_animated[i]);
633
634         this->tile_improvement_sprite_animated[i].setPosition(initial_position);
635         this->tile_improvement_sprite_animated[i].setColor(initial_colour);
636         this->tile_improvement_sprite_animated[i].setScale(initial_scale);
637         this->tile_improvement_sprite_animated[i].setRotation(initial_rotation);
638     }
639
640     this->render_window_ptr->draw(this->upgrade_arrow_sprite);
641
642
643     // 2. draw power capacity upgrade text
644     // 16 char line = "                                \n"
645     std::string power_upgrade_string = "POWER CAPACITY \n";
646     power_upgrade_string             += "                                \n";
647

```

```

648     power_upgrade_string      += "CAPACITY:  ";
649     power_upgrade_string      += std::to_string(this->capacity_kW);
650     power_upgrade_string      += " kW\n";
651
652     power_upgrade_string      += "LEVEL:      ";
653     power_upgrade_string      += std::to_string(this->upgrade_level);
654     power_upgrade_string      += "\n\n";
655
656     if (this->upgrade_level < MAX_UPGRADE_LEVELS) {
657         power_upgrade_string  += "[W]: + 100 kW (";
658         power_upgrade_string  += std::to_string(WIND_TURBINE_BUILD_COST);
659         power_upgrade_string  += " K)\n";
660     }
661
662     else {
663         power_upgrade_string  += " * MAX LEVEL *  \n";
664     }
665
666     sf::Text power_upgrade_text = sf::Text(
667         power_upgrade_string,
668         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
669         16
670     );
671
672     power_upgrade_text.setOrigin(power_upgrade_text.getLocalBounds().width / 2, 0);
673     power_upgrade_text.setPosition(400 - 100, 400 - 32 + 16);
674     power_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
675
676     this->render_window_ptr->draw(power_upgrade_text);
677
678
679     // 3. draw energy capacity (storage) upgrade sprite
680     this->render_window_ptr->draw(this->storage_upgrade_sprite);
681     this->render_window_ptr->draw(this->upgrade_plus_sprite);
682
683
684     // 4. draw energy capacity (storage) upgrade text
685     // 16 char line = " \n"
686     std::string energy_upgrade_string = "ENERGY CAPACITY \n";
687     energy_upgrade_string            += " \n";
688
689     energy_upgrade_string            += "CAPACITY:  ";
690     energy_upgrade_string            += std::to_string(this->storage_level * 200);
691     energy_upgrade_string            += " kWh\n";
692
693     energy_upgrade_string            += "LEVEL:      ";
694     energy_upgrade_string            += std::to_string(this->storage_level);
695     energy_upgrade_string            += "\n\n";
696
697     if (this->storage_level < MAX_STORAGE_LEVELS) {
698         energy_upgrade_string  += "[D]: + 200 kWh (";
699         energy_upgrade_string  += std::to_string(ENERGY_STORAGE_SYSTEM_BUILD_COST);
700         energy_upgrade_string  += " K)\n";
701     }
702
703     else {
704         energy_upgrade_string += " * MAX LEVEL *  \n";
705     }
706
707     sf::Text energy_upgrade_text = sf::Text(
708         energy_upgrade_string,
709         *(this->assets_manager_ptr->getFont("Glass_TTY_VT220")),
710         16
711     );
712
713     energy_upgrade_text.setOrigin(energy_upgrade_text.getLocalBounds().width / 2, 0);
714     energy_upgrade_text.setPosition(400 + 100, 400 - 32 + 16);
715     energy_upgrade_text.setFillColor(MONOCROME_TEXT_GREEN);
716
717     this->render_window_ptr->draw(energy_upgrade_text);
718
719     return;
720 } /* __drawUpgradeOptions() */

```

#### 4.15.3.8 \_\_handleKeyPressEvents()

```

void WindTurbine::__handleKeyPressEvents (
    void ) [private]

```

Helper method to handle key press events.

```

491 {
492     if (this->just_built) {
493         return;
494     }
495
496     switch (this->event_ptr->key.code) {
497         case (sf::Keyboard::U): {
498             this->__openUpgradeMenu();
499
500             break;
501         }
502
503
504         case (sf::Keyboard::W): {
505             if (this->production_menu_open) {
506                 this->dispatch_MWh++;
507
508                 if (this->dispatch_MWh > this->dispatchable_MWh) {
509                     this->dispatch_MWh = 0;
510                 }
511
512                 this->__computeProductionCosts();
513                 this->assets_manager_ptr->getSound("interface click")->play();
514             }
515
516             else if (this->upgrade_menu_open) {
517                 this->__upgradePowerCapacity();
518             }
519
520             break;
521         }
522
523
524         case (sf::Keyboard::S): {
525             if (this->production_menu_open) {
526                 this->dispatch_MWh--;
527
528                 if (this->dispatch_MWh < 0) {
529                     this->dispatch_MWh = this->dispatchable_MWh;
530                 }
531
532                 this->__computeProductionCosts();
533                 this->assets_manager_ptr->getSound("interface click")->play();
534             }
535
536             break;
537         }
538
539
540         case (sf::Keyboard::D): {
541             if (this->upgrade_menu_open) {
542                 this->__upgradeStorageCapacity();
543                 this->__computeProduction();
544                 this->__computeDispatch();
545             }
546
547             break;
548         }
549
550
551         default: {
552             // do nothing!
553
554             break;
555         }
556     }
557
558     return;
559 } /* __handleKeyPressEvents() */

```

#### 4.15.3.9 \_\_handleMouseButtonEvents()

```

void WindTurbine::__handleMouseButtonEvents (
    void ) [private]

```

Helper method to handle mouse button events.

```

574 {

```

```

575     if (this->just_built) {
576         return;
577     }
578
579     switch (this->event_ptr->mouseButton.button) {
580         case (sf::Mouse::Left): {
581             //...
582
583             break;
584         }
585
586
587         case (sf::Mouse::Right): {
588             //...
589
590             break;
591         }
592
593
594         default: {
595             // do nothing!
596
597             break;
598         }
599     }
600
601     return;
602 } /* __handleMouseButtonEvents() */

```

#### 4.15.3.10 \_\_repair()

```

void WindTurbine::__repair (
    void ) [private], [virtual]

```

Helper method to repair the wind turbine.

Reimplemented from [TileImprovement](#).

```

281 {
282     if (this->credits < WIND_TURBINE_BUILD_COST) {
283         std::cout << "Cannot repair wind turbine: insufficient credits (need "
284             << WIND_TURBINE_BUILD_COST << " K)" << std::endl;
285
286         this->__sendInsufficientCreditsMessage();
287         return;
288     }
289
290     TileImprovement :: __repair();
291
292     this->just_upgraded = true;
293
294     this->__sendCreditsSpentMessage(WIND_TURBINE_BUILD_COST);
295     this->__sendTileStateRequest();
296     this->__sendGameStateRequest();
297
298     return;
299 } /* __repair() */

```

#### 4.15.3.11 \_\_sendImprovementStateMessage()

```

void WindTurbine::__sendImprovementStateMessage (
    void ) [private]

```

Helper method to format and sent improvement state message.

```

735 {
736     Message improvement_state_message;
737
738     improvement_state_message.channel = GAME_CHANNEL;
739     improvement_state_message.subject = "improvement state";

```

```

740
741     improvement_state_message.int_payload["dispatch_MWh"] = this->dispatch_MWh;
742     improvement_state_message.int_payload["operation_maintenance_cost"] =
743         this->operation_maintenance_cost;
744
745     this->message_hub_ptr->sendMessage(improvement_state_message);
746
747     std::cout << "Improvement state message sent by " << this << std::endl;
748
749     return;
750 } /* __sendImprovementStateMessage() */

```

#### 4.15.3.12 \_\_setUpTileImprovementSpriteAnimated()

```

void WindTurbine::__setUpTileImprovementSpriteAnimated (
    void ) [private]

```

Helper method to set up tile improvement sprite (static).

```

68 {
69     sf::Sprite diesel_generator_sheet (
70         *(this->assets_manager_ptr->getTexture("wind turbine"))
71     );
72
73     int n_elements = diesel_generator_sheet.getLocalBounds().height / 64;
74
75     for (int i = 0; i < n_elements; i++) {
76         this->tile_improvement_sprite_animated.push_back(
77             sf::Sprite(
78                 *(this->assets_manager_ptr->getTexture("wind turbine")),
79                 sf::IntRect(0, i * 64, 64, 64)
80             )
81         );
82
83         this->tile_improvement_sprite_animated.back().setOrigin(
84             this->tile_improvement_sprite_animated.back().getLocalBounds().width / 2,
85             this->tile_improvement_sprite_animated.back().getLocalBounds().height
86         );
87
88         this->tile_improvement_sprite_animated.back().setPosition(
89             this->position_x,
90             this->position_y - 32
91         );
92
93         this->tile_improvement_sprite_animated.back().setColor(
94             sf::Color(255, 255, 255, 0)
95         );
96     }
97
98     return;
99 } /* __setUpTileImprovementSpriteAnimated() */

```

#### 4.15.3.13 \_\_upgradePowerCapacity()

```

void WindTurbine::__upgradePowerCapacity (
    void ) [private]

```

Helper method to upgrade the power capacity.

```

181 {
182     if (this->credits < WIND_TURBINE_BUILD_COST) {
183         std::cout << "Cannot upgrade wind turbine: insufficient credits (need "
184             << WIND_TURBINE_BUILD_COST << " K)" << std::endl;
185
186         this->__sendInsufficientCreditsMessage();
187         return;
188     }
189
190     if (this->upgrade_level >= MAX_UPGRADE_LEVELS) {
191         return;
192     }

```

```

193
194     TileImprovement :: __repair();
195
196     this->capacity_kW += 100;
197     this->upgrade_level++;
198
199     this->max_daily_production_MWh = (double) (24 * this->capacity_kW) / 1000;
200
201     this->__computeProduction();
202     this->__computeDispatch();
203
204     this->just_upgraded = true;
205
206     this->assets_manager_ptr->getSound("upgrade")->play();
207
208     this->__sendCreditsSpentMessage(WIND_TURBINE_BUILD_COST);
209     this->__sendTileStateRequest();
210     this->__sendGameStateRequest();
211
212     return;
213 } /* __upgradePowerCapacity() */

```

#### 4.15.3.14 advanceTurn()

```

void WindTurbine::advanceTurn (
    void ) [virtual]

```

Method to handle turn advance.

Reimplemented from [TileImprovement](#).

```

955 {
956     // 1. send improvement state message
957     this->__sendImprovementStateMessage();
958
959     // 2. update
960     this->__computeCapacityFactors();
961     this->update();
962
963     // 3. handle start/stop
964     if ((not this->is_running) and (this->dispatch_MWh > 0)) {
965         this->is_running = true;
966     }
967
968     else if (this->is_running and (this->dispatch_MWh <= 0)) {
969         this->is_running = false;
970     }
971
972     // 4. handle equipment health and breakdowns
973     if (this->is_running) {
974         this->health--;
975
976         if (this->health <= 50) {
977             double breakdown_prob = (51 - this->health) * BREAKDOWN_PROBABILITY_INCREMENT;
978
979             if ((double)rand() / RAND_MAX <= breakdown_prob) {
980                 this->health = 0;
981             }
982         }
983
984         if (this->health <= 0) {
985             this->__breakdown();
986         }
987     }
988
989     // 5. send tile state request (if selected)
990     if (this->is_selected) {
991         this->__sendTileStateRequest();
992     }
993
994     return;
995 } /* advanceTurn() */

```

## 4.15.3.15 draw()

```
void WindTurbine::draw (
    void ) [virtual]
```

Method to draw the hex tile to the render window. To be called once per frame.

Reimplemented from [TileImprovement](#).

```
1086 {
1087     // 1. if just built, call base method and return
1088     if (this->just_built) {
1089         TileImprovement :: draw();
1090     }
1091     return;
1092 }
1093
1094 // 2. handle upgrade effects
1095 if (this->just_upgraded) {
1096     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1097         this->tile_improvement_sprite_animated[i].setColor(
1098             sf::Color(
1099                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1100                 255,
1101                 255 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1102                 255
1103             )
1104         );
1105
1106         this->tile_improvement_sprite_animated[i].setScale(
1107             sf::Vector2f(
1108                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2),
1109                 1 + 0.2 * pow(cos((M_PI * this->upgrade_frame) / FRAMES_PER_SECOND), 2)
1110             )
1111         );
1112     }
1113
1114     this->upgrade_frame++;
1115 }
1116
1117 if (this->upgrade_frame >= 2 * FRAMES_PER_SECOND) {
1118     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1119         this->tile_improvement_sprite_animated[i].setColor(
1120             sf::Color(255,255,255,255)
1121         );
1122
1123         this->tile_improvement_sprite_animated[i].setScale(sf::Vector2f(1,1));
1124     }
1125
1126     this->just_upgraded = false;
1127     this->upgrade_frame = 0;
1128 }
1129
1130 // 3. draw first element of animated sprite
1131 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[0]);
1132
1133 // 4. draw second element of animated sprite
1134 if (this->is_running) {
1135     this->tile_improvement_sprite_animated[1].rotate(this->rotor_drotation);
1136 }
1137
1138 this->render_window_ptr->draw(this->tile_improvement_sprite_animated[1]);
1139
1140 // 5. draw storage upgrades
1141 for (size_t i = 0; i < this->storage_upgrade_sprite_vec.size(); i++) {
1142     this->render_window_ptr->draw(this->storage_upgrade_sprite_vec[i]);
1143 }
1144
1145 // 6. handle dispatch illustration
1146 if (this->dispatch_MWh > 0) {
1147     this->dispatch_text.setString(std::to_string(this->dispatch_MWh));
1148     this->__drawDispatch();
1149 }
1150
1151 // 7. draw production menu
1152 if (this->production_menu_open) {
1153     this->render_window_ptr->draw(this->production_menu_backing);
1154     this->render_window_ptr->draw(this->production_menu_backing_text);
1155 }
1156 }
```

```

1161     this->__drawProductionMenu();
1162 }
1163
1164
1165 // 8. draw upgrade menu
1166 if (this->upgrade_menu_open) {
1167     this->render_window_ptr->draw(this->upgrade_menu_backing);
1168     this->render_window_ptr->draw(this->upgrade_menu_backing_text);
1169
1170     this->__drawUpgradeOptions();
1171 }
1172
1173
1174 // 9. handle broken effects
1175 if (this->is_broken) {
1176     for (size_t i = 0; i < this->tile_improvement_sprite_animated.size(); i++) {
1177         this->tile_improvement_sprite_animated[i].setColor(
1178             sf::Color(
1179                 255,
1180                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1181                 255 * pow(cos((M_PI * this->frame) / FRAMES_PER_SECOND), 2),
1182                 255
1183             )
1184         );
1185     }
1186 }
1187
1188 this->frame++;
1189 return;
1190 } /* draw() */

```

#### 4.15.3.16 getTileOptionsSubstring()

```

std::string WindTurbine::getTileOptionsSubstring (
    void ) [virtual]

```

Helper method to assemble and return tile options substring.

#### Returns

Tile options substring.

Reimplemented from [TileImprovement](#).

```

867 {
868     //          32 char x 17 line console "-----\n";
869     std::string options_substring = "CAPACITY: ";
870     options_substring += std::to_string(this->capacity_kW);
871     options_substring += " kW (level ";
872     options_substring += std::to_string(this->upgrade_level);
873     options_substring += ")\n";
874
875     options_substring += "PRODUCTION: ";
876     options_substring += std::to_string(this->production_MWh);
877     options_substring += " MWh\n";
878
879     options_substring += "DISPATCHABLE: ";
880     options_substring += std::to_string(this->dispatchable_MWh);
881     options_substring += " MWh\n";
882
883     options_substring += "HEALTH: ";
884     options_substring += std::to_string(this->health);
885     options_substring += "/100";
886
887     if (this->health <= 0) {
888         options_substring += " ** BROKEN! **\n";
889     }
890
891     else {
892         options_substring += "\n";
893     }
894
895     options_substring += "
896     options_substring += " **** WIND TURBINE OPTIONS ****
897     options_substring += "

```



```

898
899     if (this->is_broken) {
900         options_substring
901         options_substring
902         options_substring
903     }
904
905     else {
906         options_substring
907     }
908
909     options_substring
910     options_substring
911     options_substring
912     options_substring
913
914     return options_substring;
915 } /* getTileOptionsSubstring() */

```

```

+= "      [R]: REPAIR (";
+= std::to_string(WIND_TURBINE_BUILD_COST);
+= " K)\n";

+= "      [E]: OPEN PRODUCTION MENU \n";

+= "      [U]: OPEN UPGRADE MENU    \n";
+= "HOLD [P]: SCRAP (";
+= std::to_string(SCRAP_COST);
+= " K)";

```

#### 4.15.3.17 processEvent()

```

void WindTurbine::processEvent (
    void ) [virtual]

```

Method to process [WindTurbine](#). To be called once per event.

Reimplemented from [TileImprovement](#).

```

1037 {
1038     TileImprovement :: processEvent();
1039
1040     if (this->event_ptr->type == sf::Event::KeyPressed) {
1041         this->__handleKeyPressEvents();
1042     }
1043
1044     if (this->event_ptr->type == sf::Event::MouseButtonPressed) {
1045         this->__handleMouseButtonEvents();
1046     }
1047
1048     return;
1049 } /* processEvent() */

```

#### 4.15.3.18 processMessage()

```

void WindTurbine::processMessage (
    void ) [virtual]

```

Method to process [WindTurbine](#). To be called once per message.

Reimplemented from [TileImprovement](#).

```

1064 {
1065     TileImprovement :: processMessage();
1066
1067     //...
1068
1069     return;
1070 } /* processMessage() */

```

#### 4.15.3.19 setIsSelected()

```

void WindTurbine::setIsSelected (
    bool is_selected ) [virtual]

```

Method to set the is selected attribute.

## Parameters

<i>is_selected</i>	The value to set the is selected attribute to.
--------------------	--

Reimplemented from [TileImprovement](#).

```

932 {
933     TileImprovement :: setIsSelected(is_selected);
934
935     if (this->is_running and this->is_selected) {
936         this->assets_manager_ptr->getSound("wind turbine running")->play();
937     }
938
939     return;
940 } /* setIsSelected() */

```

#### 4.15.3.20 update()

```

void WindTurbine::update (
    void ) [virtual]

```

Method to trigger production and dispatchable updates.

Reimplemented from [TileImprovement](#).

```

1010 {
1011     std::cout << "WindTurbine :: update()" << std::endl;
1012
1013     this->__computeProduction();
1014     this->__computeProductionCosts();
1015     this->__computeDispatch();
1016
1017     if (this->is_selected) {
1018         this->__sendTileStateRequest();
1019     }
1020
1021     return;
1022 } /* update() */

```

### 4.15.4 Member Data Documentation

#### 4.15.4.1 capacity\_factor\_vec

```
std::vector<double> WindTurbine::capacity_factor_vec
```

A vector of daily capacity factors for the current month.

#### 4.15.4.2 capacity\_kW

```
int WindTurbine::capacity_kW
```

The rated production capacity [kW] of the solar PV array.

#### 4.15.4.3 dispatch\_MWh

```
int WindTurbine::dispatch_MWh
```

The current dispatch [MWh] of the solar PV array.

#### 4.15.4.4 dispatch\_vec\_MWh

```
std::vector<double> WindTurbine::dispatch_vec_MWh
```

A vector of daily dispatch [MWh] for the current month.

#### 4.15.4.5 dispatchable\_MWh

```
int WindTurbine::dispatchable_MWh
```

The amount of production that is directly dispatchable to the grid (i.e. production correlated with demand).

#### 4.15.4.6 max\_daily\_production\_MWh

```
double WindTurbine::max_daily_production_MWh
```

The maximum daily production [MWh] of the solar PV array.

#### 4.15.4.7 production\_MWh

```
int WindTurbine::production_MWh
```

The current production [MWh] of the solar PV array.

#### 4.15.4.8 production\_vec\_MWh

```
std::vector<double> WindTurbine::production_vec_MWh
```

A vector of daily production [MWh] for the current month.

#### 4.15.4.9 rotor\_drotation

```
double WindTurbine::rotor_drotation
```

The rotation rate of the rotor.

The documentation for this class was generated from the following files:

- header/[WindTurbine.h](#)
- source/[WindTurbine.cpp](#)



## Chapter 5

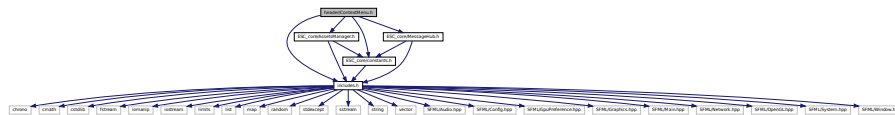
# File Documentation

### 5.1 header/ContextMenu.h File Reference

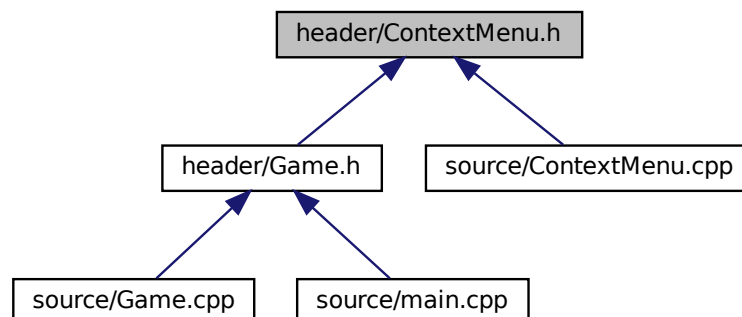
Header file for the [ContextMenu](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
```

Include dependency graph for ContextMenu.h:



This graph shows which files directly or indirectly include this file:



## Classes

- class [ContextMenu](#)

*A class which defines a context menu for the game.*

## Enumerations

- enum [ConsoleState](#) {  
[NONE\\_STATE](#) , [READY](#) , [MENU](#) , [TILE](#) ,  
[N\\_CONSOLE\\_STATES](#) }

*An enumeration of the different console screen states.*

### 5.1.1 Detailed Description

Header file for the [ContextMenu](#) class.

### 5.1.2 Enumeration Type Documentation

#### 5.1.2.1 ConsoleState

enum [ConsoleState](#)

An enumeration of the different console screen states.

##### Enumerator

<a href="#">NONE_STATE</a>	None state (for initialization)
<a href="#">READY</a>	Ready (default) state.
<a href="#">MENU</a>	<a href="#">Game</a> menu state.
<a href="#">TILE</a>	Tile context state.
<a href="#">N_CONSOLE_STATES</a>	A simple hack to get the number of console screen states.

```

68         {
69     NONE\_STATE,
70     READY,
71     MENU,
72     TILE,
73     N\_CONSOLE\_STATES
74 };

```

## 5.2 header/DieselGenerator.h File Reference

Header file for the [DieselGenerator](#) class.

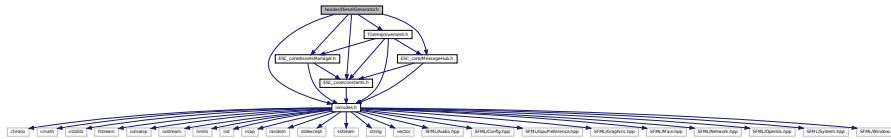
```

#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"

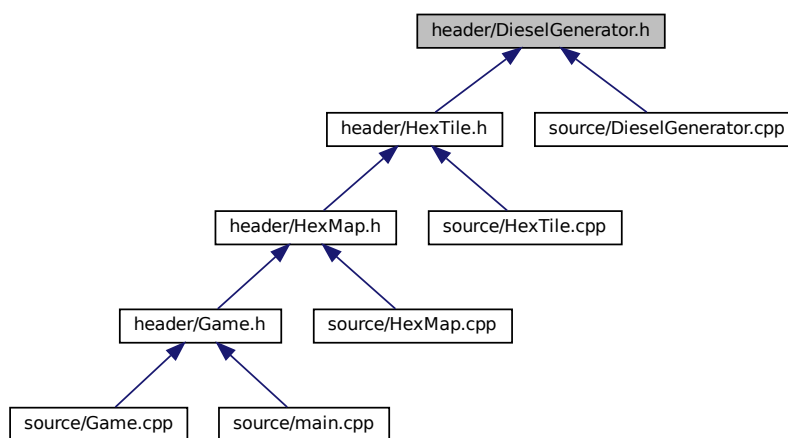
```

```
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"
```

Include dependency graph for DieselGenerator.h:



This graph shows which files directly or indirectly include this file:



## Classes

- class [DieselGenerator](#)  
A settlement class (child class of [TileImprovement](#)).

### 5.2.1 Detailed Description

Header file for the [DieselGenerator](#) class.

## 5.3 header/EnergyStorageSystem.h File Reference

Header file for the [EnergyStorageSystem](#) class. DEPRECATED / NOT USED.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
```





[illegible]

- class `AssetsManager`  
*A class which manages visual and sound assets.*

Header file for the `AssetsManager` class.

Header file for various constants.

[illegible][illegible]

## Functions

- `const sf::Color FOREST_GREEN` (34, 139, 34)  
*The base colour of a forest tile.*
- `const sf::Color LAKE_BLUE` (0, 102, 204)  
*The base colour of a lake (water) tile.*
- `const sf::Color MOUNTAINS_GREY` (97, 110, 113)  
*The base colour of a mountains tile.*
- `const sf::Color OCEAN_BLUE` (0, 51, 102)  
*The base colour of an ocean (water) tile.*
- `const sf::Color PLAINS_YELLOW` (245, 222, 133)  
*The base colour of a plains tile.*
- `const sf::Color RESOURCE_CHIP_GREY` (175, 175, 175, 250)  
*The base colour of the resource chip (backing).*
- `const sf::Color MENU_FRAME_GREY` (185, 187, 182)  
*The base colour of the context menu frame.*
- `const sf::Color MONOCHROME_SCREEN_BACKGROUND` (40, 40, 40)  
*The base colour of old monochrome screens.*
- `const sf::Color VISUAL_SCREEN_FRAME_GREY` (151, 151, 143)  
*The base colour of the framing of the visual screen.*
- `const sf::Color MONOCHROME_TEXT_GREEN` (0, 255, 102)  
*The base colour of old monochrome text (green).*
- `const sf::Color MONOCHROME_TEXT_AMBER` (255, 176, 0)  
*The base colour of old monochrome text (amber).*
- `const sf::Color MONOCHROME_TEXT_RED` (255, 44, 0)  
*The base colour of old monochrome text (red).*

## Variables

- `const double FLOAT_TOLERANCE` = 1e-6  
*Tolerance for floating point equality tests.*
- `const std::string GAME_VERSION` = "1.1"  
*The current version of the game.*
- `const unsigned long long int SECONDS_PER_YEAR` = 31537970  
*The (average) number of seconds per year.*
- `const unsigned long long int SECONDS_PER_MONTH` = 2628164  
*The (average) number of seconds per month.*
- `const int FRAMES_PER_SECOND` = 60  
*Target frames per second.*
- `const double SECONDS_PER_FRAME` = 1.0 / 60  
*Target seconds per frame (just reciprocal of target frames per second).*
- `const int GAME_WIDTH` = 1200  
*Width of the game space.*
- `const int GAME_HEIGHT` = 800  
*Height of the game space.*
- `const std::vector< double > TILE_TYPE_CUMULATIVE_PROBABILITIES`  
*Cumulative probabilities for each tile type (to support procedural generation).*
- `const std::vector< double > TILE_RESOURCE_CUMULATIVE_PROBABILITIES`  
*Cumulative probabilities for each tile resource (to support procedural generation).*
- `const std::string TILE_SELECTED_CHANNEL` = "TILE SELECTED CHANNEL"

- A message channel for tile selection messages.*
- const std::string `NO_TILE_SELECTED_CHANNEL` = "NO TILE SELECTED CHANNEL"
- A message channel for no tile selected messages.*
- const std::string `TILE_STATE_CHANNEL` = "TILE STATE CHANNEL"
- A message channel for tile state messages.*
- const std::string `HEX_MAP_CHANNEL` = "HEX MAP CHANNEL"
- A message channel for hex map messages.*
- const std::string `SETTLEMENT_CHANNEL` = "SETTLEMENT CHANNEL"
- A message channel for the settlement.*
- const int `CLEAR_FOREST_COST` = 160
- The cost of clearing a forest tile.*
- const int `CLEAR_MOUNTAINS_COST` = 500
- The cost of clearing a mountains tile.*
- const int `CLEAR_PLAINS_COST` = 80
- The cost of clearing a plains tile.*
- const int `DIESEL_GENERATOR_BUILD_COST` = 200
- The cost of building (or upgrading) a diesel generator in 200 kW increments.*
- const int `WIND_TURBINE_BUILD_COST` = 450
- The cost of building (or upgrading) a wind turbine in 100 kW increments.*
- const double `WIND_TURBINE_WATER_BUILD_MULTIPLIER` = 1.222222
- The additional cost of building on water.*
- const int `SOLAR_PV_BUILD_COST` = 350
- The cost of building (or upgrading) a solar PV array in 100 kW increments.*
- const double `SOLAR_PV_WATER_BUILD_MULTIPLIER` = 1.285714
- The additional cost of building on water.*
- const int `TIDAL_TURBINE_BUILD_COST` = 550
- The cost of building (or upgrading) a tidal turbine in 100 kW increments.*
- const int `WAVE_ENERGY_CONVERTER_BUILD_COST` = 850
- The cost of building (or upgrading) a wave energy converter in 100 kW increments.*
- const int `ENERGY_STORAGE_SYSTEM_BUILD_COST` = 160
- The cost of adding energy storage in 200 kWh increments.*
- const double `BREAKDOWN_PROBABILITY_INCREMENT` = 0.01
- The amount by which equipment breakdown probability is incremented for each point of health below 50.*
- const double `PERFORMANCE_FACTOR_COEFFICIENT` = 0.33771
- The coefficient of the performance factor curve (power expression).*
- const double `PERFORMANCE_FACTOR_EXPONENT` = 0.23708
- The exponent of the performance factor curve (power expression).*
- const int `SCRAP_COST` = 50
- The cost of scrapping a tile improvement (other than settlement).*
- const int `MAX_UPGRADE_LEVELS` = 5
- The maximum upgrade level of any tile improvement.*
- const int `MAX_STORAGE_LEVELS` = 5
- The maximum storage level of any tile improvement.*
- const int `STARTING_CREDITS` = 1000
- The starting balance of credits.*
- const double `CREDITS_PER_MWH_SERVED` = 1.15
- The number of credits (x1000) earned.*
- const int `EMISSIONS_LIFETIME_LIMIT_TONNES` = 3200
- The lifetime limit on CO2-equivalent emissions (1 tonne CO2e ~ = 667 L diesel).*
- const int `RESOURCE_ASSESSMENT_COST` = 20
- The cost of doing a resource assessment.*

- const int BUILD\_SETTLEMENT\_COST = 250  
*The cost of building a settlement.*
- const int STARTING\_POPULATION = 100  
*The starting population of a settlement.*
- const double MEAN\_POPULATION\_GROWTH\_RATE = 0.020  
*The mean monthly population growth rate.*
- const double STDEV\_POPULATION\_GROWTH\_RATE = 0.005  
*The standard deviation in monthly population growth rate.*
- const double LITRES\_DIESEL\_PER\_MWH\_PRODUCTION = 375  
*The litres of diesel consumed in producing 1 MWh (assumes higher heating value and constant thermal efficiency of  $\sim 0.25$ ).*
- const double COST\_PER\_LITRE\_DIESEL = 1.75  
*The cost of a litre of diesel.*
- const double KG\_CO2E\_PER\_LITRE\_DIESEL = 3.16  
*The CO<sub>2</sub>-equivalent mass of emissions that result from burning one litre of diesel fuel.*
- const double DIESEL\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION = 50  
*The operation and maintenance cost of running a diesel generator (assumed 0.05 credits per kWh produced).*
- const double SOLAR\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION = 10  
*The operation and maintenance cost of running a solar PV array (assumed 0.01 credits per kWh produced).*
- const double TIDAL\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION = 50  
*The operation and maintenance cost of running a tidal turbine (assumed 0.05 credits per kWh produced).*
- const double WAVE\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION = 50  
*The operation and maintenance cost of running a wave energy converter (assumed 0.05 credits per kWh produced).*
- const double WIND\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION = 50  
*The operation and maintenance cost of running a wind turbine (assumed 0.05 credits per kWh produced).*
- const std::vector< double > MEAN\_DAILY\_DEMAND\_RATIOS  
*The mean daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply (24)(max load [kW]) / 1000.*
- const std::vector< double > STDEV\_DAILY\_DEMAND\_RATIOS  
*The standard deviation in daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply (24)(max load [kW]) / 1000.*
- const double MAXIMUM\_DAILY\_DEMAND\_PER\_CAPITA = 0.05  
*The maximum daily demand [MWh] (at any point in the year) per capita.*
- const std::vector< double > MEAN\_DAILY\_SOLAR\_CAPACITY\_FACTORS  
*The mean daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.*
- const std::vector< double > STDEV\_DAILY\_SOLAR\_CAPACITY\_FACTORS  
*The standard deviation in daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.*
- const double DAILY\_TIDAL\_CAPACITY\_FACTOR = 0.275  
*The daily tidal capacity factor, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000. The tides are not a random process (usually semi-diurnal, mostly driven by orbits of moon and sun).*
- const std::vector< double > MEAN\_DAILY\_WAVE\_CAPACITY\_FACTORS  
*The mean daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.*
- const std::vector< double > STDEV\_DAILY\_WAVE\_CAPACITY\_FACTORS  
*The standard deviation in daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.*
- const std::vector< double > MEAN\_DAILY\_WIND\_CAPACITY\_FACTORS  
*The mean daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.*
- const std::vector< double > STDEV\_DAILY\_WIND\_CAPACITY\_FACTORS

*The standard deviation in daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.*

- `const std::string GAME_CHANNEL = "GAME CHANNEL"`  
*A message channel for game messages.*
- `const std::string GAME_STATE_CHANNEL = "GAME STATE CHANNEL"`  
*A message channel for game state messages.*
- `const std::vector< std::string > TUTORIAL_PAGES`

### 5.5.1 Detailed Description

Header file for various constants.

### 5.5.2 Function Documentation

#### 5.5.2.1 FOREST\_GREEN()

```
const sf::Color FOREST_GREEN (
    34 ,
    139 ,
    34 )
```

The base colour of a forest tile.

#### 5.5.2.2 LAKE\_BLUE()

```
const sf::Color LAKE_BLUE (
    0 ,
    102 ,
    204 )
```

The base colour of a lake (water) tile.

#### 5.5.2.3 MENU\_FRAME\_GREY()

```
const sf::Color MENU_FRAME_GREY (
    185 ,
    187 ,
    182 )
```

The base colour of the context menu frame.

#### 5.5.2.4 MONOCHROME\_SCREEN\_BACKGROUND()

```
const sf::Color MONOCHROME_SCREEN_BACKGROUND (
    40 ,
    40 ,
    40 )
```

The base colour of old monochrome screens.

#### 5.5.2.5 MONOCHROME\_TEXT\_AMBER()

```
const sf::Color MONOCHROME_TEXT_AMBER (
    255 ,
    176 ,
    0 )
```

The base colour of old monochrome text (amber).

#### 5.5.2.6 MONOCHROME\_TEXT\_GREEN()

```
const sf::Color MONOCHROME_TEXT_GREEN (
    0 ,
    255 ,
    102 )
```

The base colour of old monochrome text (green).

#### 5.5.2.7 MONOCHROME\_TEXT\_RED()

```
const sf::Color MONOCHROME_TEXT_RED (
    255 ,
    44 ,
    0 )
```

The base colour of old monochrome text (red).

#### 5.5.2.8 MOUNTAINS\_GREY()

```
const sf::Color MOUNTAINS_GREY (
    97 ,
    110 ,
    113 )
```

The base colour of a mountains tile.

#### 5.5.2.9 OCEAN\_BLUE()

```
const sf::Color OCEAN_BLUE (
    0 ,
    51 ,
    102 )
```

The base colour of an ocean (water) tile.

#### 5.5.2.10 PLAINS\_YELLOW()

```
const sf::Color PLAINS_YELLOW (
    245 ,
    222 ,
    133 )
```

The base colour of a plains tile.

#### 5.5.2.11 RESOURCE\_CHIP\_GREY()

```
const sf::Color RESOURCE_CHIP_GREY (
    175 ,
    175 ,
    175 ,
    250 )
```

The base colour of the resource chip (backing).

#### 5.5.2.12 VISUAL\_SCREEN\_FRAME\_GREY()

```
const sf::Color VISUAL_SCREEN_FRAME_GREY (
    151 ,
    151 ,
    143 )
```

The base colour of the framing of the visual screen.

### 5.5.3 Variable Documentation

#### 5.5.3.1 BREAKDOWN\_PROBABILITY\_INCREMENT

```
const double BREAKDOWN_PROBABILITY_INCREMENT = 0.01
```

The amount by which equipment breakdown probability is incremented for each point of health below 50.

#### 5.5.3.2 BUILD\_SETTLEMENT\_COST

```
const int BUILD_SETTLEMENT_COST = 250
```

The cost of building a settlement.

#### 5.5.3.3 CLEAR\_FOREST\_COST

```
const int CLEAR_FOREST_COST = 160
```

The cost of clearing a forest tile.

#### 5.5.3.4 CLEAR\_MOUNTAINS\_COST

```
const int CLEAR_MOUNTAINS_COST = 500
```

The cost of clearing a mountains tile.

#### 5.5.3.5 CLEAR\_PLAINS\_COST

```
const int CLEAR_PLAINS_COST = 80
```

The cost of clearing a plains tile.

#### 5.5.3.6 COST\_PER\_LITRE\_DIESEL

```
const double COST_PER_LITRE_DIESEL = 1.75
```

The cost of a litre of diesel.



#### 5.5.3.7 CREDITS\_PER\_MWH\_SERVED

```
const double CREDITS_PER_MWH_SERVED = 1.15
```

The number of credits (x1000) earned.

#### 5.5.3.8 DAILY\_TIDAL\_CAPACITY\_FACTOR

```
const double DAILY_TIDAL_CAPACITY_FACTOR = 0.275
```

The daily tidal capacity factor, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000. The tides are not a random process (usually semi-diurnal, mostly driven by orbits of moon and sun).

#### 5.5.3.9 DIESEL\_GENERATOR\_BUILD\_COST

```
const int DIESEL_GENERATOR_BUILD_COST = 200
```

The cost of building (or upgrading) a diesel generator in 200 kW increments.

#### 5.5.3.10 DIESEL\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION

```
const double DIESEL_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenace cost of running a diesel generator (assumed 0.05 credits per kWh produced).

#### 5.5.3.11 EMISSIONS\_LIFETIME\_LIMIT\_TONNES

```
const int EMISSIONS_LIFETIME_LIMIT_TONNES = 3200
```

The lifetime limit on CO2-equivalent emissions (1 tonne CO2e  $\sim$  667 L diesel).

#### 5.5.3.12 ENERGY\_STORAGE\_SYSTEM\_BUILD\_COST

```
const int ENERGY_STORAGE_SYSTEM_BUILD_COST = 160
```

The cost of adding energy storage in 200 kWh increments.

#### 5.5.3.13 FLOAT\_TOLERANCE

```
const double FLOAT_TOLERANCE = 1e-6
```

Tolerance for floating point equality tests.

#### 5.5.3.14 FRAMES\_PER\_SECOND

```
const int FRAMES_PER_SECOND = 60
```

Target frames per second.

#### 5.5.3.15 GAME\_CHANNEL

```
const std::string GAME_CHANNEL = "GAME CHANNEL"
```

A message channel for game messages.

#### 5.5.3.16 GAME\_HEIGHT

```
const int GAME_HEIGHT = 800
```

Height of the game space.

#### 5.5.3.17 GAME\_STATE\_CHANNEL

```
const std::string GAME_STATE_CHANNEL = "GAME STATE CHANNEL"
```

A message channel for game state messages.

#### 5.5.3.18 GAME\_VERSION

```
const std::string GAME_VERSION = "1.1"
```

The current version of the game.

#### 5.5.3.19 GAME\_WIDTH

```
const int GAME_WIDTH = 1200
```

Width of the game space.

#### 5.5.3.20 HEX\_MAP\_CHANNEL

```
const std::string HEX_MAP_CHANNEL = "HEX MAP CHANNEL"
```

A message channel for hex map messages.

#### 5.5.3.21 KG\_CO2E\_PER\_LITRE\_DIESEL

```
const double KG_CO2E_PER_LITRE_DIESEL = 3.16
```

The CO2-equivalent mass of emissions that result from burning one litre of diesel fuel.

#### 5.5.3.22 LITRES\_DIESEL\_PER\_MWH\_PRODUCTION

```
const double LITRES_DIESEL_PER_MWH_PRODUCTION = 375
```

The litres of diesel consumed in producing 1 MWh (assumes higher heating value and constant thermal efficiency of  $\sim 0.25$ ).

#### 5.5.3.23 MAX\_STORAGE\_LEVELS

```
const int MAX_STORAGE_LEVELS = 5
```

The maximum storage level of any tile improvement.

#### 5.5.3.24 MAX\_UPGRADE\_LEVELS

```
const int MAX_UPGRADE_LEVELS = 5
```

The maximum upgrade level of any tile improvement.

### 5.5.3.25 MAXIMUM\_DAILY\_DEMAND\_PER\_CAPITA

```
const double MAXIMUM_DAILY_DEMAND_PER_CAPITA = 0.05
```

The maximum daily demand [MWh] (at any point in the year) per capita.

### 5.5.3.26 MEAN\_DAILY\_DEMAND\_RATIOS

```
const std::vector<double> MEAN_DAILY_DEMAND_RATIOS
```

**Initial value:**

```
= {
    0.702, 0.704, 0.652,
    0.546, 0.445, 0.362,
    0.261, 0.261, 0.379,
    0.518, 0.622, 0.716
}
```

The mean daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply (24)(max load [kW]) / 1000.

### 5.5.3.27 MEAN\_DAILY\_SOLAR\_CAPACITY\_FACTORS

```
const std::vector<double> MEAN_DAILY_SOLAR_CAPACITY_FACTORS
```

**Initial value:**

```
= {
    0.040, 0.083, 0.160,
    0.250, 0.312, 0.319,
    0.300, 0.253, 0.190,
    0.111, 0.055, 0.027
}
```

The mean daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

### 5.5.3.28 MEAN\_DAILY\_WAVE\_CAPACITY\_FACTORS

```
const std::vector<double> MEAN_DAILY_WAVE_CAPACITY_FACTORS
```

**Initial value:**

```
= {
    0.483, 0.451, 0.402,
    0.304, 0.238, 0.190,
    0.182, 0.191, 0.243,
    0.276, 0.431, 0.390
}
```

The mean daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

### 5.5.3.29 MEAN\_DAILY\_WIND\_CAPACITY\_FACTORS

```
const std::vector<double> MEAN_DAILY_WIND_CAPACITY_FACTORS
```

#### Initial value:

```
= {  
    0.360, 0.361, 0.382,  
    0.383, 0.352, 0.327,  
    0.269, 0.308, 0.357,  
    0.376, 0.372, 0.353  
}
```

The mean daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

### 5.5.3.30 MEAN\_POPULATION\_GROWTH\_RATE

```
const double MEAN_POPULATION_GROWTH_RATE = 0.020
```

The mean monthly population growth rate.

### 5.5.3.31 NO\_TILE\_SELECTED\_CHANNEL

```
const std::string NO_TILE_SELECTED_CHANNEL = "NO TILE SELECTED CHANNEL"
```

A message channel for no tile selected messages.

### 5.5.3.32 PERFORMANCE\_FACTOR\_COEFFICIENT

```
const double PERFORMANCE_FACTOR_COEFFICIENT = 0.33771
```

The coefficient of the performance factor curve (power expression).

### 5.5.3.33 PERFORMANCE\_FACTOR\_EXPONENT

```
const double PERFORMANCE_FACTOR_EXPONENT = 0.23708
```

The exponent of the performance factor curve (power expression).

#### 5.5.3.34 RESOURCE\_ASSESSMENT\_COST

```
const int RESOURCE_ASSESSMENT_COST = 20
```

The cost of doing a resource assessment.

#### 5.5.3.35 SCRAP\_COST

```
const int SCRAP_COST = 50
```

The cost of scrapping a tile improvement (other than settlement).

#### 5.5.3.36 SECONDS\_PER\_FRAME

```
const double SECONDS_PER_FRAME = 1.0 / 60
```

Target seconds per frame (just reciprocal of target frames per second).

#### 5.5.3.37 SECONDS\_PER\_MONTH

```
const unsigned long long int SECONDS_PER_MONTH = 2628164
```

The (average) number of seconds per month.

#### 5.5.3.38 SECONDS\_PER\_YEAR

```
const unsigned long long int SECONDS_PER_YEAR = 31537970
```

The (average) number of seconds per year.

#### 5.5.3.39 SETTLEMENT\_CHANNEL

```
const std::string SETTLEMENT_CHANNEL = "SETTLEMENT CHANNEL"
```

A message channel for the settlement.

#### 5.5.3.40 SOLAR\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION

```
const double SOLAR_OP_MAINT_COST_PER_MWH_PRODUCTION = 10
```

The operation and maintenance cost of running a solar PV array (assumed 0.01 credits per kWh produced).

#### 5.5.3.41 SOLAR\_PV\_BUILD\_COST

```
const int SOLAR_PV_BUILD_COST = 350
```

The cost of building (or upgrading) a solar PV array in 100 kW increments.

#### 5.5.3.42 SOLAR\_PV\_WATER\_BUILD\_MULTIPLIER

```
const double SOLAR_PV_WATER_BUILD_MULTIPLIER = 1.285714
```

The additional cost of building on water.

#### 5.5.3.43 STARTING\_CREDITS

```
const int STARTING_CREDITS = 1000
```

The starting balance of credits.

#### 5.5.3.44 STARTING\_POPULATION

```
const int STARTING_POPULATION = 100
```

The starting population of a settlement.

#### 5.5.3.45 STDEV\_DAILY\_DEMAND\_RATIOS

```
const std::vector<double> STDEV_DAILY_DEMAND_RATIOS
```

**Initial value:**

```
= {  
    0.069, 0.074, 0.072,  
    0.072, 0.063, 0.060,  
    0.012, 0.031, 0.040,  
    0.049, 0.063, 0.053  
}
```

The standard deviation in daily demand ratio for each month, where demand ratio is demand [MWh] divided by maximum daily demand [MWh]. Maximum daily demand is simply (24)(max load [kW]) / 1000.

#### 5.5.3.46 STDEV\_DAILY\_SOLAR\_CAPACITY\_FACTORS

```
const std::vector<double> STDEV_DAILY_SOLAR_CAPACITY_FACTORS
```

**Initial value:**

```
= {  
    0.018, 0.033, 0.059,  
    0.067, 0.099, 0.099,  
    0.104, 0.089, 0.066,  
    0.036, 0.025, 0.012  
}
```

The standard deviation in daily solar capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

#### 5.5.3.47 STDEV\_DAILY\_WAVE\_CAPACITY\_FACTORS

```
const std::vector<double> STDEV_DAILY_WAVE_CAPACITY_FACTORS
```

**Initial value:**

```
= {  
    0.095, 0.088, 0.106,  
    0.094, 0.103, 0.069,  
    0.055, 0.038, 0.094,  
    0.111, 0.120, 0.201  
}
```

The standard deviation in daily wave capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

#### 5.5.3.48 STDEV\_DAILY\_WIND\_CAPACITY\_FACTORS

```
const std::vector<double> STDEV_DAILY_WIND_CAPACITY_FACTORS
```

**Initial value:**

```
= {  
    0.089, 0.086, 0.120,  
    0.094, 0.099, 0.123,  
    0.109, 0.132, 0.120,  
    0.103, 0.085, 0.103  
}
```

The standard deviation in daily wind capacity factors for each month, where capacity factor is daily production [MWh] divided by maximum daily production [MWh]. Maximum daily production is simply (24)(power capacity [kW]) / 1000.

#### 5.5.3.49 STDEV\_POPULATION\_GROWTH\_RATE

```
const double STDEV_POPULATION_GROWTH_RATE = 0.005
```

The standard deviation in monthly population growth rate.



#### 5.5.3.50 TIDAL\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION

```
const double TIDAL_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenance cost of running a tidal turbine (assumed 0.05 credits per kWh produced).

#### 5.5.3.51 TIDAL\_TURBINE\_BUILD\_COST

```
const int TIDAL_TURBINE_BUILD_COST = 550
```

The cost of building (or upgrading) a tidal turbine in 100 kW increments.

#### 5.5.3.52 TILE\_RESOURCE\_CUMULATIVE\_PROBABILITIES

```
const std::vector<double> TILE_RESOURCE_CUMULATIVE_PROBABILITIES
```

**Initial value:**

```
= {  
    0.10,  
    0.30,  
    0.70,  
    0.90,  
    1.00  
}
```

Cumulative probabilities for each tile resource (to support procedural generation).

#### 5.5.3.53 TILE\_SELECTED\_CHANNEL

```
const std::string TILE_SELECTED_CHANNEL = "TILE SELECTED CHANNEL"
```

A message channel for tile selection messages.

#### 5.5.3.54 TILE\_STATE\_CHANNEL

```
const std::string TILE_STATE_CHANNEL = "TILE STATE CHANNEL"
```

A message channel for tile state messages.

#### 5.5.3.55 TILE\_TYPE\_CUMULATIVE\_PROBABILITIES

```
const std::vector<double> TILE_TYPE_CUMULATIVE_PROBABILITIES
```

**Initial value:**

```
= {  
    0.25,  
    0.50,  
    0.75,  
    1.00  
}
```

Cumulative probabilities for each tile type (to support procedural generation).

#### 5.5.3.56 TUTORIAL\_PAGES

```
const std::vector<std::string> TUTORIAL_PAGES
```

#### 5.5.3.57 WAVE\_ENERGY\_CONVERTER\_BUILD\_COST

```
const int WAVE_ENERGY_CONVERTER_BUILD_COST = 850
```

The cost of building (or upgrading) a wave energy converter in 100 kW increments.

#### 5.5.3.58 WAVE\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION

```
const double WAVE_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenance cost of running a wave energy converter (assumed 0.05 credits per kWh produced).

#### 5.5.3.59 WIND\_OP\_MAINT\_COST\_PER\_MWH\_PRODUCTION

```
const double WIND_OP_MAINT_COST_PER_MWH_PRODUCTION = 50
```

The operation and maintenance cost of running a wind turbine (assumed 0.05 credits per kWh produced).

#### 5.5.3.60 WIND\_TURBINE\_BUILD\_COST

```
const int WIND_TURBINE_BUILD_COST = 450
```

The cost of building (or upgrading) a wind turbine in 100 kW increments.

### 5.5.3.61 WIND\_TURBINE\_WATER\_BUILD\_MULTIPLIER

```
const double WIND_TURBINE_WATER_BUILD_MULTIPLIER = 1.222222
```

The additional cost of building on water.

## 5.6 header/ESC\_core/doxygen\_cite.h File Reference

Header file which simply cites the doxygen tool.

### 5.6.1 Detailed Description

Header file which simply cites the doxygen tool.

Ref: [van Heesch. \[2023\]](#)

## 5.7 header/ESC\_core/includes.h File Reference

Header file for various includes.

```
#include <chrono>
#include <cmath>
#include <cstdlib>
#include <fstream>
#include <iomanip>
#include <iostream>
#include <limits>
#include <list>
#include <map>
#include <random>
#include <stdexcept>
#include <sstream>
#include <string>
#include <vector>
#include <SFML/Audio.hpp>
#include <SFML/Config.hpp>
#include <SFML/GpuPreference.hpp>
#include <SFML/Graphics.hpp>
#include <SFML/Main.hpp>
#include <SFML/Network.hpp>
#include <SFML/OpenGL.hpp>
#include <SFML/System.hpp>
#include <SFML/Window.hpp>
```

Include dependency graph for includes.h:





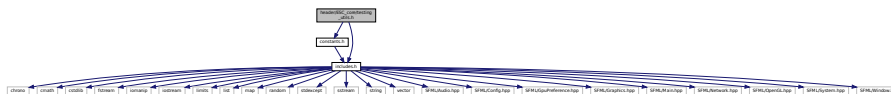
### 5.8.1 Detailed Description

Header file for the [MessageHub](#) class.

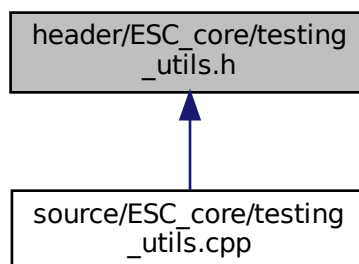
## 5.9 header/ESC\_core/testing\_utils.h File Reference

Header file for various testing utilities.

```
#include "constants.h"
#include "includes.h"
Include dependency graph for testing_utils.h:
```



This graph shows which files directly or indirectly include this file:



## Functions

- void [printGreen](#) (std::string)  
A function that sends green text to std::cout.
- void [printGold](#) (std::string)  
A function that sends gold text to std::cout.
- void [printRed](#) (std::string)  
A function that sends red text to std::cout.
- void [testFloatEquals](#) (double, double, std::string, int)  
Tests for the equality of two floating point numbers x and y (to within FLOAT\_TOLERANCE).
- void [testGreaterThan](#) (double, double, std::string, int)  
Tests if  $x > y$ .
- void [testGreaterThanOrEqualTo](#) (double, double, std::string, int)  
Tests if  $x \geq y$ .

- void `testLessThan` (double, double, std::string, int)  
*Tests if  $x < y$ .*
- void `testLessThanOrEqualTo` (double, double, std::string, int)  
*Tests if  $x \leq y$ .*
- void `testTruth` (bool, std::string, int)  
*Tests if the given statement is true.*
- void `expectedErrorNotDetected` (std::string, int)  
*A utility function to print out a meaningful error message whenever an expected error fails to be thrown/caught/detected.*

### 5.9.1 Detailed Description

Header file for various testing utilities.

This is a library of utility functions used throughout the various test suites.

### 5.9.2 Function Documentation

#### 5.9.2.1 `expectedErrorNotDetected()`

```
void expectedErrorNotDetected (
    std::string file,
    int line )
```

A utility function to print out a meaningful error message whenever an expected error fails to be thrown/caught/detected.

##### Parameters

<i>file</i>	The file in which the test is applied (you should be able to just pass in " <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> ").

```
434 {
435     std::string error_str = "\n ERROR   failed to throw expected error prior to line ";
436     error_str += std::to_string(line);
437     error_str += " of ";
438     error_str += file;
439
440     #ifdef _WIN32
441         std::cout << error_str << std::endl;
442     #endif
443
444     throw std::runtime_error(error_str);
445     return;
446 } /* expectedErrorNotDetected() */
```

#### 5.9.2.2 `printGold()`

```
void printGold (
    std::string input_str )
```

A function that sends gold text to std::cout.

**Parameters**

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```
86 {  
87     std::cout << "\x1B[33m" << input_str << "\033[0m";  
88     return;  
89 } /* printGold() */
```

**5.9.2.3 printGreen()**

```
void printGreen (  
    std::string input_str )
```

A function that sends green text to std::cout.

**Parameters**

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```
66 {  
67     std::cout << "\x1B[32m" << input_str << "\033[0m";  
68     return;  
69 } /* printGreen() */
```

**5.9.2.4 printRed()**

```
void printRed (  
    std::string input_str )
```

A function that sends red text to std::cout.

**Parameters**

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```
106 {  
107     std::cout << "\x1B[31m" << input_str << "\033[0m";  
108     return;  
109 } /* printRed() */
```

**5.9.2.5 testFloatEquals()**

```
void testFloatEquals (  
    double x,  
    double y,  
    std::string file,  
    int line )
```

Tests for the equality of two floating point numbers *x* and *y* (to within FLOAT\_TOLERANCE).

## Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

140 {
141     if (fabs(x - y) <= FLOAT_TOLERANCE) {
142         return;
143     }
144
145     std::string error_str = "ERROR: testFloatEquals():\t in ";
146     error_str += file;
147     error_str += "\tline ";
148     error_str += std::to_string(line);
149     error_str += ":\t\n";
150     error_str += std::to_string(x);
151     error_str += " and ";
152     error_str += std::to_string(y);
153     error_str += " are not equal to within +/- ";
154     error_str += std::to_string(FLOAT_TOLERANCE);
155     error_str += "\n";
156
157     #ifdef _WIN32
158         std::cout << error_str << std::endl;
159     #endif
160
161     throw std::runtime_error(error_str);
162     return;
163 } /* testFloatEquals() */

```

## 5.9.2.6 testGreaterThan()

```

void testGreaterThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x > y$ .

## Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

193 {
194     if (x > y) {
195         return;
196     }
197
198     std::string error_str = "ERROR: testGreaterThan():\t in ";
199     error_str += file;
200     error_str += "\tline ";
201     error_str += std::to_string(line);
202     error_str += ":\t\n";
203     error_str += std::to_string(x);
204     error_str += " is not greater than ";
205     error_str += std::to_string(y);
206     error_str += "\n";
207
208     #ifdef _WIN32
209         std::cout << error_str << std::endl;
210     #endif

```



```

211
212     throw std::runtime_error(error_str);
213     return;
214 }    /* testGreaterThan() */

```

### 5.9.2.7 testGreaterThanOrEqualTo()

```

void testGreaterThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x \geq y$ .

#### Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

244 {
245     if (x >= y) {
246         return;
247     }
248
249     std::string error_str = "ERROR: testGreaterThanOrEqualTo():\t in ";
250     error_str += file;
251     error_str += "\tline ";
252     error_str += std::to_string(line);
253     error_str += ":\t\n";
254     error_str += std::to_string(x);
255     error_str += " is not greater than or equal to ";
256     error_str += std::to_string(y);
257     error_str += "\n";
258
259     #ifdef _WIN32
260         std::cout << error_str << std::endl;
261     #endif
262
263     throw std::runtime_error(error_str);
264     return;
265 }    /* testGreaterThanOrEqualTo() */

```

### 5.9.2.8 testLessThan()

```

void testLessThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x < y$ .

#### Parameters

<i>x</i>	The first of two numbers to test.
----------	-----------------------------------

## 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__").

```

295 {
296     if (x < y) {
297         return;
298     }
299
300     std::string error_str = "ERROR: testLessThan():\t in ";
301     error_str += file;
302     error_str += "\tline ";
303     error_str += std::to_string(line);
304     error_str += ":\t\n";
305     error_str += std::to_string(x);
306     error_str += " is not less than ";
307     error_str += std::to_string(y);
308     error_str += "\n";
309
310     #ifdef _WIN32
311         std::cout << error_str << std::endl;
312     #endif
313
314     throw std::runtime_error(error_str);
315     return;
316 } /* testLessThan() */

```

## 5.9.2.9 testLessThanOrEqualTo()

```

void testLessThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x \leq y$ .

## Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

346 {
347     if (x <= y) {
348         return;
349     }
350
351     std::string error_str = "ERROR: testLessThanOrEqualTo():\t in ";
352     error_str += file;
353     error_str += "\tline ";
354     error_str += std::to_string(line);
355     error_str += ":\t\n";
356     error_str += std::to_string(x);
357     error_str += " is not less than or equal to ";
358     error_str += std::to_string(y);
359     error_str += "\n";
360
361     #ifdef _WIN32
362         std::cout << error_str << std::endl;
363     #endif
364
365     throw std::runtime_error(error_str);
366     return;

```

```
367 }    /* testLessThanOrEqualTo() */
```

### 5.9.2.10 testTruth()

```
void testTruth (
    bool statement,
    std::string file,
    int line )
```

Tests if the given statement is true.

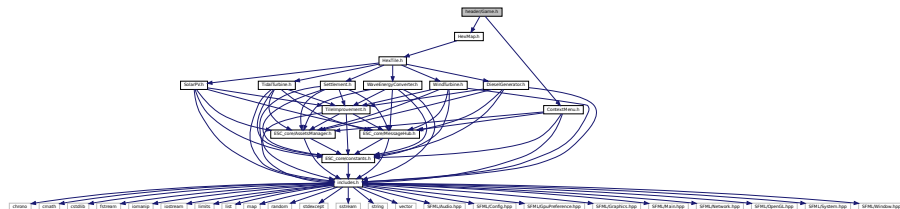
#### Parameters

<i>statement</i>	The statement whose truth is to be tested ("1 == 0", for example).
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

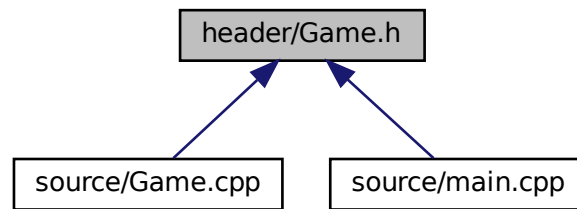
```
394 {
395     if (statement) {
396         return;
397     }
398
399     std::string error_str = "ERROR: testTruth():\t in ";
400     error_str += file;
401     error_str += "\tline ";
402     error_str += std::to_string(line);
403     error_str += ":\t\n";
404     error_str += "Given statement is not true";
405
406     #ifdef _WIN32
407         std::cout << error_str << std::endl;
408     #endif
409
410     throw std::runtime_error(error_str);
411     return;
412 }    /* testTruth() */
```

## 5.10 header/Game.h File Reference

```
#include "HexMap.h"
#include "ContextMenu.h"
Include dependency graph for Game.h:
```



This graph shows which files directly or indirectly include this file:



## Classes

- class [Game](#)

*A class which acts as the central class for the game, by containing all other classes and implementing the game loop.*

## Enumerations

- enum [GamePhase](#) {  
[BUILD\\_SETTLEMENT](#) , [SYSTEM\\_MANAGEMENT](#) , [LOSS\\_EMISSIONS](#) , [LOSS\\_DEMAND](#) ,  
[LOSS\\_CREDITS](#) , [VICTORY](#) , [N\\_GAME\\_PHASES](#) }

*An enumeration of the various game phases.*

### 5.10.1 Enumeration Type Documentation

#### 5.10.1.1 GamePhase

enum [GamePhase](#)

An enumeration of the various game phases.

##### Enumerator

BUILD_SETTLEMENT	The settlement building phase.
SYSTEM_MANAGEMENT	The system management phase (main phase of play).
LOSS_EMISSIONS	A loss due to excessive emissions.
LOSS_DEMAND	A loss due to failing to meet the demand.
LOSS_CREDITS	A loss due to running out of credits.
VICTORY	A victory (12 consecutive months of zero emissions).
N_GAME_PHASES	A simple hack to get the number of elements in GamePhase.

```

66     {
67         BUILD_SETTLEMENT,
68         SYSTEM_MANAGEMENT,
69         LOSS_EMISSIONS,
70         LOSS_DEMAND,
71         LOSS_CREDITS,
72         VICTORY,
73         N_GAME_PHASES
74     }; /* GamePhase */

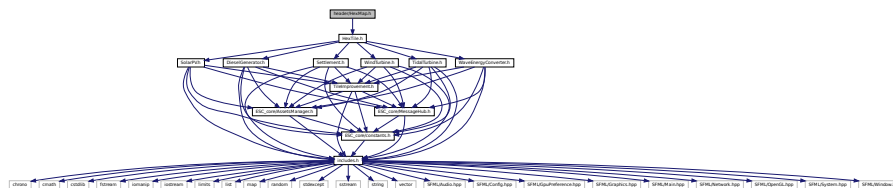
```

## 5.11 header/HexMap.h File Reference

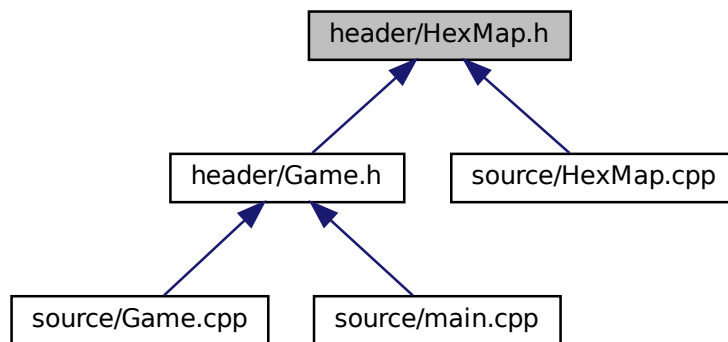
Header file for the [HexMap](#) class.

```
#include "HexTile.h"
```

Include dependency graph for HexMap.h:



This graph shows which files directly or indirectly include this file:



### Classes

- class [HexMap](#)

*A class which defines a hex map of hex tiles.*

#### 5.11.1 Detailed Description

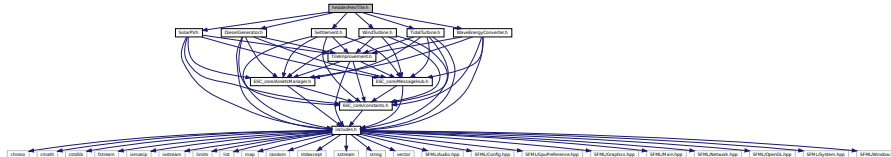
Header file for the [HexMap](#) class.

## 5.12 header/HexTile.h File Reference

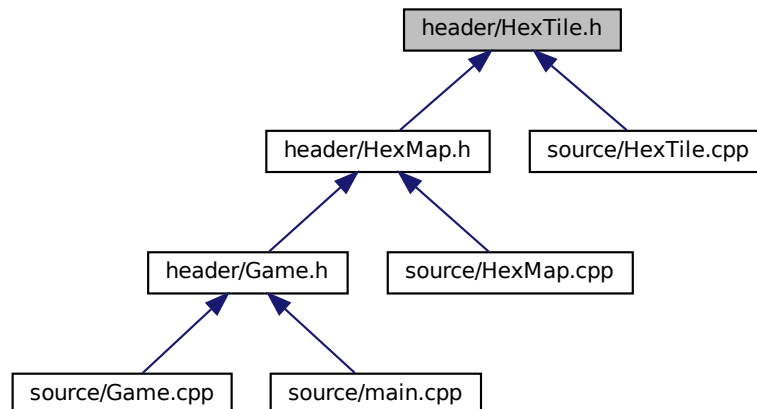
Header file for the [Game](#) class.

```
#include "DieselGenerator.h"
#include "Settlement.h"
#include "SolarPV.h"
#include "TidalTurbine.h"
#include "WaveEnergyConverter.h"
#include "WindTurbine.h"
```

Include dependency graph for HexTile.h:



This graph shows which files directly or indirectly include this file:



### Classes

- class [HexTile](#)

*A class which defines a hex tile of the hex map.*

### Enumerations

- enum [TileType](#) {  
[NONE\\_TYPE](#) , [FOREST](#) , [LAKE](#) , [MOUNTAINS](#) ,  
[OCEAN](#) , [PLAINS](#) , [N\\_TILE\\_TYPES](#) }  
*An enumeration of the different tile types.*
- enum [TileResource](#) {  
[POOR](#) , [BELOW\\_AVERAGE](#) , [AVERAGE](#) , [ABOVE\\_AVERAGE](#) ,  
[GOOD](#) , [N\\_TILE\\_RESOURCES](#) }  
*An enumeration of the different tile resource values.*

### 5.12.1 Detailed Description

Header file for the [Game](#) class.

Header file for the [HexTile](#) class.

### 5.12.2 Enumeration Type Documentation

#### 5.12.2.1 TileResource

enum [TileResource](#)

An enumeration of the different tile resource values.

Enumerator

POOR	A poor resource value.
BELOW_AVERAGE	A below average resource value.
AVERAGE	An average resource value.
ABOVE_AVERAGE	An above average resource value.
GOOD	A good resource value.
N_TILE_RESOURCES	A simple hack to get the number of elements in TileResource.

```
88         {
89     POOR,
90     BELOW_AVERAGE,
91     AVERAGE,
92     ABOVE_AVERAGE,
93     GOOD,
94     N_TILE_RESOURCES
95 }; /* TileResource */
```

#### 5.12.2.2 TileType

enum [TileType](#)

An enumeration of the different tile types.

Enumerator

NONE_TYPE	A dummy tile (for initialization).
FOREST	A forest tile.
LAKE	A lake tile.
MOUNTAINS	A mountains tile.
OCEAN	An ocean tile.
PLAINS	A plains tile.
N_TILE_TYPES	A simple hack to get the number of elements in TileType.





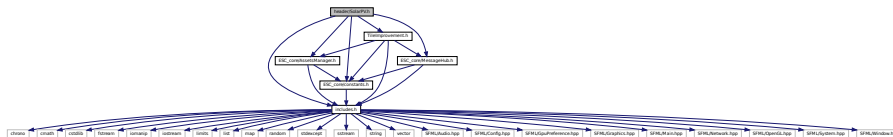
### 5.13.1 Detailed Description

Header file for the [Settlement](#) class.

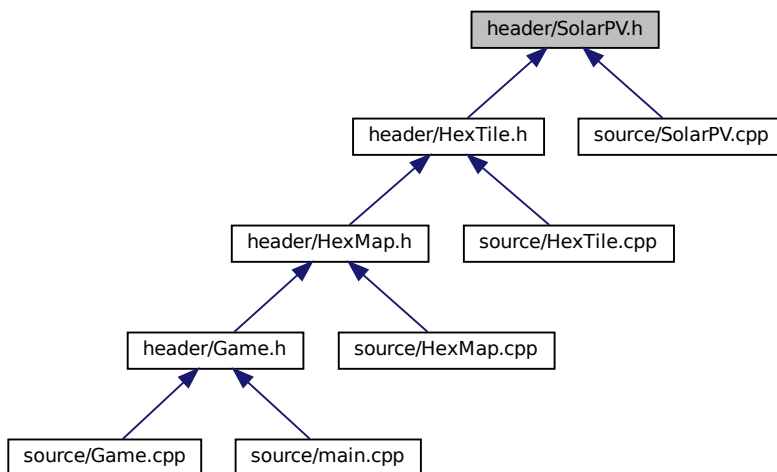
## 5.14 header/SolarPV.h File Reference

Header file for the [SolarPV](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"
Include dependency graph for SolarPV.h:
```



This graph shows which files directly or indirectly include this file:



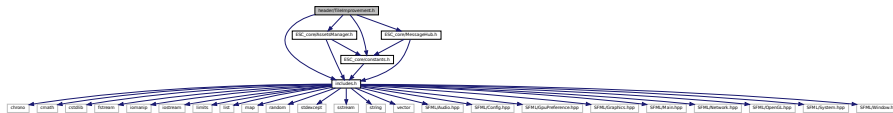
## Classes

- class [SolarPV](#)  
A settlement class (child class of [TileImprovement](#)).



Header file for the `TileImprovement` class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
Include dependency graph for TileImprovement.h:
```



```

graph TD
    TimeInterval[header/TimeInterval.h] --> Settlement[header/Settlement.h]
    TimeInterval --> SolarPV[header/SolarPV.h]
    TimeInterval --> TidalTurbine[header/TidalTurbine.h]
    TimeInterval --> WaveEnergyConverter[header/WaveEnergyConverter.h]
    TimeInterval --> WindTurbine[header/WindTurbine.h]
    TimeInterval --> DieselGenerator[header/DieselGenerator.h]
    TimeInterval --> EnergyStorageSystem[header/EnergyStorageSystem.h]
    TimeInterval --> TimeIntervalCpp[source/TimeInterval.cpp]
    
    Settlement --> SettlementCpp[source/Settlement.cpp]
    SolarPV --> SolarPVCpp[source/SolarPV.cpp]
    TidalTurbine --> TidalTurbineCpp[source/TidalTurbine.cpp]
    WaveEnergyConverter --> WaveEnergyConverterCpp[source/WaveEnergyConverter.cpp]
    WindTurbine --> WindTurbineCpp[source/WindTurbine.cpp]
    DieselGenerator --> DieselGeneratorCpp[source/DieselGenerator.cpp]
    EnergyStorageSystem --> EnergyStorageSystemCpp[source/EnergyStorageSystem.cpp]
    
    TimeIntervalCpp --> HexMap[header/HexMap.h]
    HexMap --> HexMapCpp[source/HexMap.cpp]
    HexMapCpp --> Game[header/Game.h]
    Game --> GameCpp[source/Game.cpp]
    GameCpp --> Main[source/main.cpp]
  
```

- class `TileImprovement`  
*A base class for the tile improvement hierarchy.*

- enum `TileImprovementType` {  
`SETTLEMENT`, `DIESEL_GENERATOR`, `SOLAR_PV`, `WIND_TURBINE`,  
`TIDAL_TURBINE`, `WAVE_ENERGY_CONVERTER`, `N_TILE_IMPROVEMENT_TYPES` }  
*An enumeration of the different tile improvement types.*

Header file for the `TileImprovement` class.

#### 5.16.2.1 TileImprovementType

enum `TileImprovementType`

An enumeration of the different tile improvement types.

## Enumerator

SETTLEMENT	A settlement.
DIESEL_GENERATOR	A diesel generator.
SOLAR_PV	A solar PV array.
WIND_TURBINE	A wind turbine.
TIDAL_TURBINE	A tidal turbine.
WAVE_ENERGY_CONVERTER	A wave energy converter.
N_TILE_IMPROVEMENT_TYPES	A simple hack to get the number of elements in TileImprovementType.

```

68         {
69             SETTLEMENT,
70             DIESEL_GENERATOR,
71             SOLAR_PV,
72             WIND_TURBINE,
73             TIDAL_TURBINE,
74             WAVE_ENERGY_CONVERTER,
75             N_TILE_IMPROVEMENT_TYPES
76 }; /* TileImprovementType */

```

## 5.17 header/WaveEnergyConverter.h File Reference

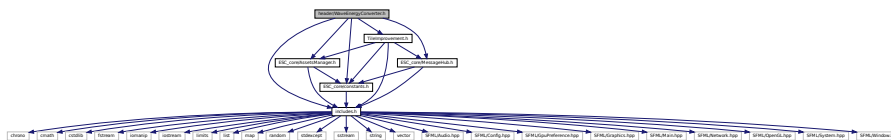
Header file for the [WaveEnergyConverter](#) class.

```

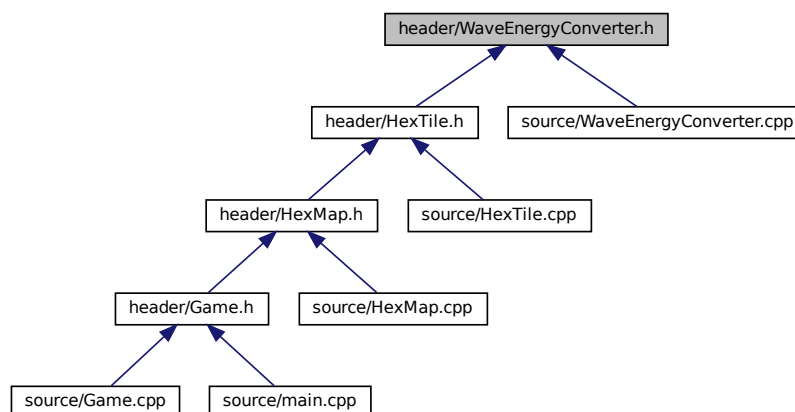
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"

```

Include dependency graph for WaveEnergyConverter.h:



This graph shows which files directly or indirectly include this file:



## Classes

- class [WaveEnergyConverter](#)  
A settlement class (child class of [TileImprovement](#)).

### 5.17.1 Detailed Description

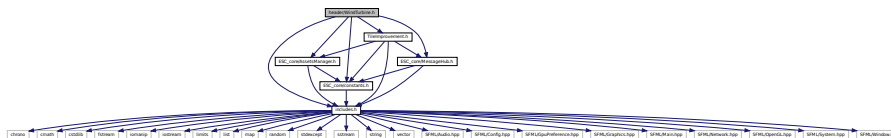
Header file for the [WaveEnergyConverter](#) class.

## 5.18 header/WindTurbine.h File Reference

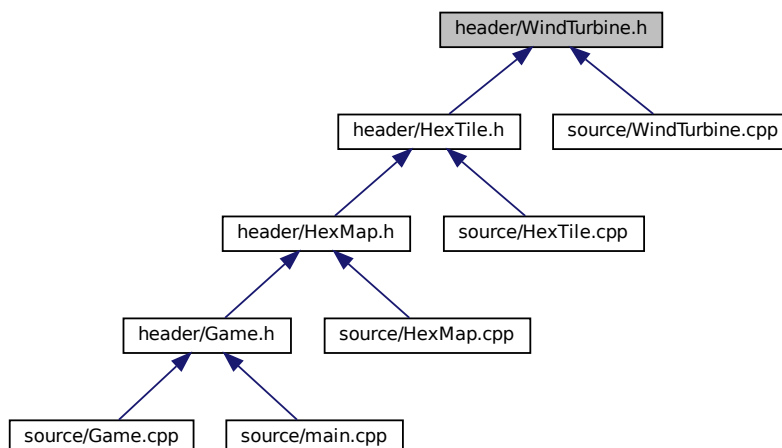
Header file for the [WindTurbine](#) class.

```
#include "ESC_core/constants.h"
#include "ESC_core/includes.h"
#include "ESC_core/AssetsManager.h"
#include "ESC_core/MessageHub.h"
#include "TileImprovement.h"
```

Include dependency graph for WindTurbine.h:



This graph shows which files directly or indirectly include this file:



## Classes

- class [WindTurbine](#)  
A settlement class (child class of [TileImprovement](#)).

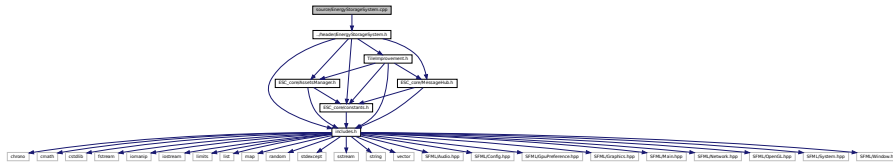


## 5.21 source/EnergyStorageSystem.cpp File Reference

Implementation file for the [EnergyStorageSystem](#) class. DEPRECATED / NOT USED.

```
#include "../header/EnergyStorageSystem.h"
```

Include dependency graph for EnergyStorageSystem.cpp:



### 5.21.1 Detailed Description

Implementation file for the [EnergyStorageSystem](#) class. DEPRECATED / NOT USED.

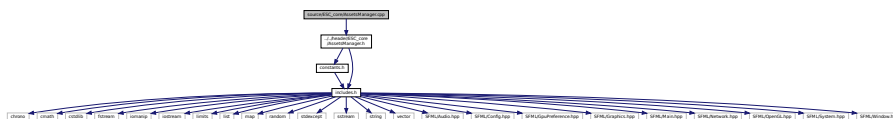
A base class for the tile improvement hierarchy.

## 5.22 source/ESC\_core/AssetsManager.cpp File Reference

Implementation file for the `AssetsManager` class.

```
#include "../..header/ESC_core/AssetsManager.h"
```

Include dependency graph for AssetsManager.cpp:



### 5.22.1 Detailed Description

Implementation file for the `AssetsManager` class.

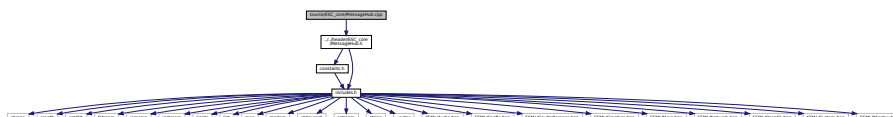
A class which manages visual and sound assets.

## 5.23 source/ESC\_core/MessageHub.cpp File Reference

Implementation file for the `MessageHub` class.

```
#include "../..header/ESC_core/MessageHub.h"
```

Include dependency graph for MessageHub.cpp:







## 5.24.2 Function Documentation

### 5.24.2.1 expectedErrorNotDetected()

```
void expectedErrorNotDetected (
    std::string file,
    int line )
```

A utility function to print out a meaningful error message whenever an expected error fails to be thrown/caught/detected.

#### Parameters

<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```
434 {
435     std::string error_str = "\n ERROR   failed to throw expected error prior to line ";
436     error_str += std::to_string(line);
437     error_str += " of ";
438     error_str += file;
439
440     #ifdef _WIN32
441         std::cout << error_str << std::endl;
442     #endif
443
444     throw std::runtime_error(error_str);
445     return;
446 } /* expectedErrorNotDetected() */
```

### 5.24.2.2 printGold()

```
void printGold (
    std::string input_str )
```

A function that sends gold text to std::cout.

#### Parameters

<i>input_str</i>	The text of the string to be sent to std::cout.
------------------	---

```
86 {
87     std::cout << "\x1B[33m" << input_str << "\033[0m";
88     return;
89 } /* printGold() */
```

### 5.24.2.3 printGreen()

```
void printGreen (
    std::string input_str )
```

A function that sends green text to std::cout.

**Parameters**

<i>input_str</i>	The text of the string to be sent to <code>std::cout</code> .
------------------	---

```

66 {
67     std::cout << "\xB{32m" << input_str << "\033[0m";
68     return;
69 } /* printGreen() */

```

**5.24.2.4 printRed()**

```

void printRed (
    std::string input_str )

```

A function that sends red text to `std::cout`.

**Parameters**

<i>input_str</i>	The text of the string to be sent to <code>std::cout</code> .
------------------	---

```

106 {
107     std::cout << "\xB{31m" << input_str << "\033[0m";
108     return;
109 } /* printRed() */

```

**5.24.2.5 testFloatEquals()**

```

void testFloatEquals (
    double x,
    double y,
    std::string file,
    int line )

```

Tests for the equality of two floating point numbers *x* and *y* (to within `FLOAT_TOLERANCE`).

**Parameters**

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in " <code>__FILE__</code> ").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in " <code>__LINE__</code> ").

```

140 {
141     if (fabs(x - y) <= FLOAT_TOLERANCE) {
142         return;
143     }
144
145     std::string error_str = "ERROR: testFloatEquals():\t in ";
146     error_str += file;
147     error_str += "\tline ";
148     error_str += std::to_string(line);
149     error_str += ":\t\n";
150     error_str += std::to_string(x);
151     error_str += " and ";
152     error_str += std::to_string(y);
153     error_str += " are not equal to within +/- ";

```

```

154     error_str += std::to_string(FLOAT_TOLERANCE);
155     error_str += "\n";
156
157     #ifdef _WIN32
158         std::cout << error_str << std::endl;
159     #endif
160
161     throw std::runtime_error(error_str);
162     return;
163 } /* testFloatEquals() */

```

### 5.24.2.6 testGreaterThan()

```

void testGreaterThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x > y$ .

#### Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

193 {
194     if (x > y) {
195         return;
196     }
197
198     std::string error_str = "ERROR: testGreaterThan():\t in ";
199     error_str += file;
200     error_str += "\tline ";
201     error_str += std::to_string(line);
202     error_str += ":\t\n";
203     error_str += std::to_string(x);
204     error_str += " is not greater than ";
205     error_str += std::to_string(y);
206     error_str += "\n";
207
208     #ifdef _WIN32
209         std::cout << error_str << std::endl;
210     #endif
211
212     throw std::runtime_error(error_str);
213     return;
214 } /* testGreaterThan() */

```

### 5.24.2.7 testGreaterThanOrEqualTo()

```

void testGreaterThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x \geq y$ .

## Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

244 {
245     if (x >= y) {
246         return;
247     }
248
249     std::string error_str = "ERROR: testGreaterThanOrEqualTo():\t in ";
250     error_str += file;
251     error_str += "\tline ";
252     error_str += std::to_string(line);
253     error_str += ":\t\n";
254     error_str += std::to_string(x);
255     error_str += " is not greater than or equal to ";
256     error_str += std::to_string(y);
257     error_str += "\n";
258
259     #ifdef _WIN32
260         std::cout << error_str << std::endl;
261     #endif
262
263     throw std::runtime_error(error_str);
264     return;
265 } /* testGreaterThanOrEqualTo() */

```

## 5.24.2.8 testLessThan()

```

void testLessThan (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x < y$ .

## Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

295 {
296     if (x < y) {
297         return;
298     }
299
300     std::string error_str = "ERROR: testLessThan():\t in ";
301     error_str += file;
302     error_str += "\tline ";
303     error_str += std::to_string(line);
304     error_str += ":\t\n";
305     error_str += std::to_string(x);
306     error_str += " is not less than ";
307     error_str += std::to_string(y);
308     error_str += "\n";
309
310     #ifdef _WIN32
311         std::cout << error_str << std::endl;
312     #endif
313
314     throw std::runtime_error(error_str);

```

```

315     return;
316 } /* testLessThan() */

```

### 5.24.2.9 testLessThanOrEqualTo()

```

void testLessThanOrEqualTo (
    double x,
    double y,
    std::string file,
    int line )

```

Tests if  $x \leq y$ .

#### Parameters

<i>x</i>	The first of two numbers to test.
<i>y</i>	The second of two numbers to test.
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").

```

346 {
347     if (x <= y) {
348         return;
349     }
350
351     std::string error_str = "ERROR: testLessThanOrEqualTo():\t in ";
352     error_str += file;
353     error_str += "\tline ";
354     error_str += std::to_string(line);
355     error_str += ":\t\n";
356     error_str += std::to_string(x);
357     error_str += " is not less than or equal to ";
358     error_str += std::to_string(y);
359     error_str += "\n";
360
361     #ifdef _WIN32
362         std::cout << error_str << std::endl;
363     #endif
364
365     throw std::runtime_error(error_str);
366     return;
367 } /* testLessThanOrEqualTo() */

```

### 5.24.2.10 testTruth()

```

void testTruth (
    bool statement,
    std::string file,
    int line )

```

Tests if the given statement is true.

#### Parameters

<i>statement</i>	The statement whose truth is to be tested ("1 == 0", for example).
<i>file</i>	The file in which the test is applied (you should be able to just pass in "__FILE__").
<i>line</i>	The line of the file in which the test is applied (you should be able to just pass in "__LINE__").





## Functions

- void [loadAssets](#) ([AssetsManager](#) \*assets\_manager\_ptr)  
*Helper function to load game assets.*
- sf::RenderWindow \* [constructRenderWindow](#) (void)  
*Helper function to construct render window.*
- void [playBrandAnimation](#) (sf::RenderWindow \*render\_window\_ptr)
- void [showTitleScreen](#) (sf::RenderWindow \*render\_window\_ptr, [AssetsManager](#) \*assets\_manager\_ptr)  
*Helper function.*
- int [main](#) (int argc, char \*\*argv)

### 5.28.1 Detailed Description

Implementation file for [main\(\)](#) for Road To Zero.

### 5.28.2 Function Documentation

#### 5.28.2.1 [constructRenderWindow\(\)](#)

```
sf::RenderWindow * constructRenderWindow (
    void )
```

Helper function to construct render window.

#### Returns

Pointer to the render window.

```
345 {
346     // 1. get desktop resolution
347     sf::VideoMode video_mode = sf::VideoMode::getDesktopMode();
348     int desktop_width = video_mode.width;
349     int desktop_height = video_mode.height;
350
351     // 2. adjust render window dimensions as necessary (maintain 3:2 aspect ratio)
352     int window_width = GAME_WIDTH;
353     int window_height = GAME_HEIGHT;
354
355     if (
356         (window_width > desktop_width) or
357         (window_height > desktop_height)
358     ) {
359         int width_diff = window_width - desktop_width;
360         int height_diff = window_height - desktop_height;
361
362         if (width_diff > height_diff) {
363             window_width = desktop_width;
364             window_height = (2.0 / 3.0) * desktop_width;
365         }
366         else {
367             window_height = desktop_height;
368             window_width = (3.0 / 2.0) * desktop_height;
369         }
370     }
371 }
372
373 // 3. construct render window
374 sf::RenderWindow* render_window_ptr = new sf::RenderWindow(
375     sf::VideoMode(window_width, window_height),
376     "Road To Zero"
377 );
```



```

378
379 // 4. reset render window view as necessary
380 if (
381     (window_width != GAME_WIDTH) or
382     (window_height != GAME_HEIGHT)
383 ) {
384     sf::View view;
385     view.reset(sf::FloatRect(0, 0, GAME_WIDTH, GAME_HEIGHT));
386     render_window_ptr->setView(view);
387 }
388
389 return render_window_ptr;
390 } /* constructRenderWindow() */

```

### 5.28.2.2 loadAssets()

```

void loadAssets (
    AssetsManager * assets_manager_ptr )

```

Helper function to load game assets.

#### Parameters

<code>assets_manager_ptr</code>	Pointer to the assets manager.
---------------------------------	--------------------------------

```

66 {
67     // 1. load font assets
68     assets_manager_ptr->loadFont("assets/fonts/DroidSansMono.ttf", "DroidSansMono");
69     assets_manager_ptr->loadFont("assets/fonts/Glass_TTY_VT220.ttf", "Glass_TTY_VT220");
70
71
72     // 2. load tile sheets
73     assets_manager_ptr->loadTexture(
74         "assets/tile_sheets/pine_tree_64x64_1_CC-BY.png",
75         "pine_tree_64x64_1"
76     );
77
78     assets_manager_ptr->loadTexture(
79         "assets/tile_sheets/wheat_64x64_1_CC-BY.png",
80         "wheat_64x64_1"
81     );
82
83     assets_manager_ptr->loadTexture(
84         "assets/tile_sheets/mountain_64x64_1_CC-BY.png",
85         "mountain_64x64_1"
86     );
87
88     assets_manager_ptr->loadTexture(
89         "assets/tile_sheets/water_waves_64x64_1_CC-BY.png",
90         "water_waves_64x64_1"
91     );
92
93     assets_manager_ptr->loadTexture(
94         "assets/tile_sheets/water_shimmer_64x64_1_CC-BY.png",
95         "water_shimmer_64x64_1"
96     );
97
98     assets_manager_ptr->loadTexture(
99         "assets/tile_sheets/brick_house_64x64_1_CC-BY.png",
100         "brick_house_64x64_1"
101     );
102
103     assets_manager_ptr->loadTexture(
104         "assets/tile_sheets/magnifying_glass_64x64_1_CC-BY.png",
105         "magnifying_glass_64x64_1"
106     );
107
108     assets_manager_ptr->loadTexture(
109         "assets/tile_sheets/exp2_0_CC0.png",
110         "tile clear explosion"
111     );
112
113     assets_manager_ptr->loadTexture(
114         "assets/tile_sheets/emissions_8x8_1_CC-BY.png",
115         "emissions"

```

```
116     );
117
118     assets_manager_ptr->loadTexture(
119         "assets/tile_sheets/diesel_generator_64x64_2_CC-BY.png",
120         "diesel generator"
121     );
122
123     assets_manager_ptr->loadTexture(
124         "assets/tile_sheets/solar_PV_64x64_1_CC-BY.png",
125         "solar PV array"
126     );
127
128     assets_manager_ptr->loadTexture(
129         "assets/tile_sheets/wind_turbine_64x64_2_CC-BY.png",
130         "wind turbine"
131     );
132
133     assets_manager_ptr->loadTexture(
134         "assets/tile_sheets/energy_storage_system_64x64_1_CC-BY.png",
135         "energy storage system"
136     );
137
138     assets_manager_ptr->loadTexture(
139         "assets/tile_sheets/tidal_turbine_64x64_2_CC-BY.png",
140         "tidal turbine"
141     );
142
143     assets_manager_ptr->loadTexture(
144         "assets/tile_sheets/wave_energy_converter_64x64_2_CC-BY.png",
145         "wave energy converter"
146     );
147
148     assets_manager_ptr->loadTexture(
149         "assets/tile_sheets/upgrade_arrow_16x16_1_CC-BY.png",
150         "upgrade arrow"
151     );
152
153     assets_manager_ptr->loadTexture(
154         "assets/tile_sheets/upgrade_plus_16x16_1_CC-BY.png",
155         "upgrade plus"
156     );
157
158     assets_manager_ptr->loadTexture(
159         "assets/tile_sheets/energy_storage_16x16_1_CC-BY.png",
160         "storage level"
161     );
162
163     assets_manager_ptr->loadTexture(
164         "assets/tile_sheets/coin_16x16_1_CC-BY.png",
165         "coin"
166     );
167
168     // 3. load sounds
169     assets_manager_ptr->loadSound(
170         "assets/audio/samples/mixkit-magical-coin-win-1936_MixkitFree.ogg",
171         "coin ring"
172     );
173
174     assets_manager_ptr->loadSound(
175         "assets/audio/samples/mixkit-positive-notification-951_MixkitFree.ogg",
176         "positive notification"
177     );
178
179     assets_manager_ptr->loadSound(
180         "assets/audio/samples/mixkit-sci-fi-click-900_MixkitFree.ogg",
181         "sci-fi click"
182     );
183
184     assets_manager_ptr->loadSound(
185         "assets/audio/samples/mixkit-apartment-buzzer-bell-press-932_MixkitFree.ogg",
186         "insufficient credits"
187     );
188
189     assets_manager_ptr->loadSound(
190         "assets/audio/samples/mixkit-data-scanner-2487_MixkitFree.ogg",
191         "resource assessment"
192     );
193
194     assets_manager_ptr->loadSound(
195         "assets/audio/samples/mixkit-interface-click-1126_MixkitFree.ogg",
196         "console string print"
197     );
198
199     assets_manager_ptr->loadSound(
200         "assets/audio/samples/mixkit-video-game-retro-click-237_MixkitFree.ogg",
201         "resource overlay toggle on"
202     );
```

```
203     );
204
205     assets_manager_ptr->loadSound(
206         "assets/audio/samples/mixkit-video-game-retro-click-237_REVERSED_MixkitFree.ogg",
207         "resource overlay toggle off"
208     );
209
210     assets_manager_ptr->loadSound(
211         "assets/audio/samples/mixkit-explosion-with-rocks-debris-1703_MixkitFree.ogg",
212         "clear mountains tile"
213     );
214
215     assets_manager_ptr->loadSound(
216         "assets/audio/samples/mixkit-arcade-game-explosion-2759_MixkitFree.ogg",
217         "clear non-mountains tile"
218     );
219
220     assets_manager_ptr->loadSound(
221         "assets/audio/samples/mixkit-electronic-retro-block-hit-2185_MixkitFree.ogg",
222         "place improvement"
223     );
224
225     assets_manager_ptr->loadSound(
226         "assets/audio/samples/mixkit-video-game-lock-2851_REVERSED_MixkitFree.ogg",
227         "build menu open"
228     );
229
230     assets_manager_ptr->loadSound(
231         "assets/audio/samples/mixkit-video-game-lock-2851_MixkitFree.ogg",
232         "build menu close"
233     );
234
235     assets_manager_ptr->loadSound(
236         "assets/audio/samples/mixkit-jump-into-the-water-1180_MixkitFree.ogg",
237         "splash"
238     );
239
240     assets_manager_ptr->loadSound(
241         "assets/audio/samples/505316__nuncaconoci__diesel_CC0.ogg",
242         "diesel running"
243     );
244
245     assets_manager_ptr->loadSound(
246         "assets/audio/samples/33460__pempi__320d_2_CC-BY.ogg",
247         "diesel start"
248     );
249
250     assets_manager_ptr->loadSound(
251         "assets/audio/samples/132724__andy_gardner__wind-turbine-blades_CC-BY.ogg",
252         "wind turbine running"
253     );
254
255     assets_manager_ptr->loadSound(
256         "assets/audio/samples/58416__darren1979__oceanwaves_CC-SAMPLING.ogg",
257         "ocean waves"
258     );
259
260     assets_manager_ptr->loadSound(
261         "assets/audio/samples/369927__mephisto_egmont__water-flowing-in-tubes_CC-BY.ogg",
262         "water flow"
263     );
264
265     assets_manager_ptr->loadSound(
266         "assets/audio/samples/647663__jotraing__electric-train-motor-idle-loop-new-generation-rollingstock_CC0.ogg",
267         "solar hum"
268     );
269
270     assets_manager_ptr->loadSound(
271         "assets/audio/samples/mixkit-epic-futuristic-movie-accent-2913_MixkitFree.ogg",
272         "game title screen"
273     );
274
275     assets_manager_ptr->loadSound(
276         "assets/audio/samples/mixkit-calm-park-with-people-and-children_MixkitFree.ogg",
277         "people and children"
278     );
279
280     assets_manager_ptr->loadSound(
281         "assets/audio/samples/mixkit-magical-coin-win-1936_MixkitFree.ogg",
282         "upgrade"
283     );
284
285     assets_manager_ptr->loadSound(
286         "assets/audio/samples/mixkit-cool-interface-click-tone-2568_MixkitFree.ogg",
287         "interface click"
288     );
```

```

289
290     assets_manager_ptr->loadSound(
291         "assets/audio/samples/mixkit-factory-metal-hard-hit-2980_MixkitFree.ogg",
292         "breakdown"
293     );
294
295     assets_manager_ptr->loadSound(
296         "assets/audio/samples/mixkit-fantasy-game-success-notification-270_MixkitFree.ogg",
297         "victory"
298     );
299
300     assets_manager_ptr->loadSound(
301         "assets/audio/samples/mixkit-player-losing-or-failing-2042_MixkitFree.ogg",
302         "loss"
303     );
304
305     assets_manager_ptr->loadSound(
306         "assets/audio/samples/mixkit-poker-card-flick-2002_MixkitFree.ogg",
307         "card flick"
308     );
309
310
311     // 4. load tracks
312     assets_manager_ptr->loadTrack(
313         "assets/audio/tracks/TreeStarMoon_Dobranoc_CC0.ogg",
314         "Tree Star Moon - Dobranoc"
315     );
316
317     assets_manager_ptr->loadTrack(
318         "assets/audio/tracks/TreeStarMoon_Lighthouse_CC0.ogg",
319         "Tree Star Moon - Lighthouse"
320     );
321
322     assets_manager_ptr->loadTrack(
323         "assets/audio/tracks/TreeStarMoon_SkyFarm_CC0.ogg",
324         "Tree Star Moon - Sky Farm"
325     );
326
327     return;
328 } /* loadAssets() */

```

### 5.28.2.3 main()

```

int main (
    int argc,
    char ** argv )
{
    // 1. load assets
    AssetsManager assets_manager;
    loadAssets(&assets_manager);

    // 2. construct render window
    sf::RenderWindow* render_window_ptr = constructRenderWindow();

    // 3. show brand animation and splash screen
    playBrandAnimation(render_window_ptr);

    // 4. show title screen
    if (render_window_ptr->isOpen()) {
        showTitleScreen(render_window_ptr, &assets_manager);
    }

    // 5. start game loop
    bool quit_game = false;
    bool transition_from_title = true;

    if (render_window_ptr->isOpen()) {
        assets_manager.playTrack();
    }

    else {
        quit_game = true;
    }

    while (not quit_game) {
        Game game(render_window_ptr, &assets_manager, transition_from_title);
        quit_game = game.run();
    }

    if (transition_from_title and (not quit_game)) {

```

```

1025         transition_from_title = false;
1026     }
1027 }
1028
1029 // 4. clean up
1030 render_window_ptr->close();
1031 delete render_window_ptr;
1032
1033 return 0;
1034 } /* main() */

```

#### 5.28.2.4 playBrandAnimation()

```

void playBrandAnimation (
    sf::RenderWindow * render_window_ptr )
{
    // 1. load assets
    AssetsManager brand_assets_manager;

    brand_assets_manager.loadFont (
        "assets/ESC_brand/OpenSans-Bold.ttf",
        "OpenSansBold"
    );

    brand_assets_manager.loadTexture (
        "assets/ESC_brand/ESC_key_109x90.png",
        "[ESC] large"
    );

    brand_assets_manager.loadTexture (
        "assets/ESC_brand/ESC_key_98x81.png",
        "[ESC] small"
    );

    brand_assets_manager.loadTexture (
        "assets/ESC_brand/SFML_256x128.png",
        "SFML"
    );

    brand_assets_manager.loadSound (
        "assets/ESC_brand/mixkit-single-key-type-2533-MixkitFree.ogg",
        "key press"
    );

    // 2. set up and position assets
    std::string brand_string = "INTERACTIVE";

    sf::Text brand_text (
        brand_string,
        *(brand_assets_manager.getFont("OpenSansBold")),
        64
    );

    brand_text.setOrigin (
        brand_text.getLocalBounds().width / 2,
        brand_text.getLocalBounds().height / 2
    );

    brand_text.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2);

    double key_position_x =
        (GAME_WIDTH / 2) - (brand_text.getLocalBounds().width / 2) - 64;

    double key_position_y =
        (GAME_HEIGHT / 2) - (brand_text.getLocalBounds().height / 2) - 32;

    sf::Sprite ESC_large (
        *(brand_assets_manager.getTexture("[ESC] large"))
    );

    ESC_large.setOrigin (
        ESC_large.getLocalBounds().width / 2,
        ESC_large.getLocalBounds().height / 2
    );

    ESC_large.setPosition(key_position_x, key_position_y);

    ESC_large.setColor(sf::Color(255, 255, 255, 0));
}

```

```

472
473     sf::Sprite ESC_small(
474         *(brand_assets_manager.getTexture("ESC] small"))
475     );
476
477     ESC_small.setOrigin(
478         ESC_small.getLocalBounds().width / 2,
479         ESC_small.getLocalBounds().height / 2
480     );
481
482     ESC_small.setPosition(key_position_x, key_position_y);
483
484     ESC_small.setColor(sf::Color(255, 255, 255, 255));
485
486     sf::Sprite SFML(
487         *(brand_assets_manager.getTexture("SFML"))
488     );
489
490     SFML.setOrigin(
491         SFML.getLocalBounds().width / 2,
492         SFML.getLocalBounds().height / 2
493     );
494
495     SFML.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2);
496
497     SFML.setColor(sf::Color(255, 255, 255, 0));
498
499
500     // 3. draw loop
501     bool sound_played = false;
502
503     int brand_frame = 0;
504     int click_frame = 0;
505     int brand_state = 0;
506
507     size_t substring_idx = 0;
508
509     double alpha = 0;
510     double dalpha = FRAMES_PER_SECOND / 18;
511     double time_since_start_s = 0;
512
513     sf::Clock brand_clock;
514     sf::Event brand_event;
515
516     while (brand_state < 6) {
517         time_since_start_s = brand_clock.getElapsedTime().asSeconds();
518
519         if (time_since_start_s >= (brand_frame + 1) * SECONDS_PER_FRAME) {
520             render_window_ptr->clear();
521
522             while (render_window_ptr->pollEvent(brand_event)) {
523                 if (brand_event.type == sf::Event::Closed) {
524                     render_window_ptr->close();
525                     return;
526                 }
527             }
528
529             // 3.1. brand state switch
530             switch (brand_state) {
531                 case (0): {
532                     // fade in key
533                     render_window_ptr->draw(ESC_large);
534
535                     if (alpha < 255) {
536
537                         alpha += dalpha;
538
539                         if (alpha > 255) {
540                             alpha = 255;
541                         }
542
543                         ESC_large.setColor(sf::Color(255, 255, 255, alpha));
544                     }
545
546                     else {
547                         brand_state++;
548                     }
549
550                     break;
551                 }
552
553                 case (1): {
554                     // key press
555                     render_window_ptr->draw(ESC_small);
556
557                     if (click_frame < FRAMES_PER_SECOND / 8) {

```

```
559         if (not sound_played) {
560             brand_assets_manager.getSound("key press")->play();
561             sound_played = true;
562         }
563
564         click_frame++;
565     }
566
567     else {
568         brand_state++;
569     }
570
571     break;
572 }
573
574
575 case (2): {
576     // text wave
577     brand_text.setString(brand_string.substr(0, substring_idx));
578
579     render_window_ptr->draw(brand_text);
580     render_window_ptr->draw(ESC_large);
581
582     if (substring_idx <= brand_string.size()) {
583         if (brand_frame % (FRAMES_PER_SECOND / 20) == 0) {
584             substring_idx++;
585         }
586     }
587
588     else {
589         brand_state++;
590     }
591
592     break;
593 }
594
595
596 case (3): {
597     // fade out brand
598     render_window_ptr->draw(brand_text);
599     render_window_ptr->draw(ESC_large);
600
601     if (alpha > 0) {
602         alpha -= dalpha;
603
604         if (alpha < 0) {
605             alpha = 0;
606         }
607
608         brand_text.setFillColor(sf::Color(255, 255, 255, alpha));
609         ESC_large.setColor(sf::Color(255, 255, 255, alpha));
610     }
611
612     else {
613         brand_state++;
614     }
615
616     break;
617 }
618
619
620 case (4): {
621     // fade in SFML
622     render_window_ptr->draw(SFML);
623
624     if (alpha < 255) {
625         alpha += dalpha;
626
627         if (alpha > 255) {
628             alpha = 255;
629         }
630
631         SFML.setColor(sf::Color(255, 255, 255, alpha));
632     }
633
634     else {
635         brand_state++;
636     }
637
638     break;
639 }
640
641
642 case (5): {
643     // fade out SFML
644     render_window_ptr->draw(SFML);
645 }
```

```

646         if (alpha > 0) {
647             alpha -= dalpha;
648
649             if (alpha < 0) {
650                 alpha = 0;
651             }
652
653             SFML.setColor(sf::Color(255, 255, 255, alpha));
654         }
655
656         else {
657             brand_state++;
658         }
659
660         break;
661     }
662
663     default: {
664         // do nothing!
665
666         break;
667     }
668 }
669
670 render_window_ptr->display();
671 brand_frame++;
672 }
673 }
674 }
675
676 return;
677 } /* playBrandAnimation() */

```

#### 5.28.2.5 showTitleScreen()

```

void showTitleScreen (
    sf::RenderWindow * render_window_ptr,
    AssetsManager * assets_manager_ptr )

```

Helper function.

##### Parameters

<i>render_window_ptr</i>	A pointer to the render window.
<i>assets_manager_ptr</i>	A pointer to the assets manager.

```

702 {
703     // 1. set up and position title assets
704     int outline_thickness = 32;
705
706     sf::RectangleShape title_console(
707         sf::Vector2f(
708             GAME_WIDTH - 2 * outline_thickness,
709             GAME_HEIGHT - 2 * outline_thickness
710         )
711     );
712
713     title_console.setPosition(outline_thickness, outline_thickness);
714
715     sf::Color title_fill_colour = MONOCHROME_SCREEN_BACKGROUND;
716     title_fill_colour.a = 0;
717
718     sf::Color title_outline_colour = MENU_FRAME_GREY;
719     title_outline_colour.a = 0;
720
721     title_console.setFillColor(title_fill_colour);
722     title_console.setOutlineColor(title_outline_colour);
723     title_console.setOutlineThickness(outline_thickness);
724
725     std::string title_string_upper = "ROAD TO ZERO";
726     sf::Text title_text_upper(
727         title_string_upper,
728         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
729         128

```



```

730     );
731
732     title_text_upper.setOrigin(
733         title_text_upper.getLocalBounds().width / 2,
734         title_text_upper.getLocalBounds().height / 2
735     );
736
737     title_text_upper.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2 - 128);
738     title_text_upper.setFillColor(MONOCROME_TEXT_GREEN);
739
740     std::string title_string_lower = "THE MICROGRID MANAGEMENT GAME";
741     sf::Text title_text_lower(
742         title_string_lower,
743         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
744         64
745     );
746
747     title_text_lower.setOrigin(
748         title_text_lower.getLocalBounds().width / 2,
749         title_text_lower.getLocalBounds().height / 2
750     );
751
752     title_text_lower.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2);
753     title_text_lower.setFillColor(MONOCROME_TEXT_GREEN);
754
755     std::string title_string_bottom = "ROAD TO ZERO V";
756     title_string_bottom += GAME_VERSION;
757     title_string_bottom += "    COPYRIGHT 2024 - [ESC] INTERACTIVE";
758     sf::Text title_text_bottom(
759         title_string_bottom,
760         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
761         16
762     );
763
764     title_text_bottom.setOrigin(
765         title_text_bottom.getLocalBounds().width / 2,
766         title_text_bottom.getLocalBounds().height / 2
767     );
768
769     title_text_bottom.setPosition(GAME_WIDTH / 2, GAME_HEIGHT - 64);
770     title_text_bottom.setFillColor(MONOCROME_TEXT_GREEN);
771
772     sf::Text prompt_text(
773         "PRESS ANY KEY TO CONTINUE",
774         *(assets_manager_ptr->getFont("Glass_TTY_VT220")),
775         24
776     );
777
778     prompt_text.setOrigin(
779         prompt_text.getLocalBounds().width / 2,
780         prompt_text.getLocalBounds().height / 2
781     );
782
783     prompt_text.setPosition(GAME_WIDTH / 2, GAME_HEIGHT / 2 + 175);
784     prompt_text.setFillColor(MONOCROME_TEXT_GREEN);
785
786     sf::RectangleShape fade_rectangle(sf::Vector2f(GAME_WIDTH, GAME_HEIGHT));
787     sf::Color fade_rectangle_colour(0, 0, 0, 0);
788     fade_rectangle.setFillColor(fade_rectangle_colour);
789
790
791     // 2. draw loop
792     bool draw_title = true;
793     bool sound_played = false;
794
795     int title_frame = 0;
796     int title_state = 0;
797
798     size_t upper_substring_idx = 0;
799     size_t lower_substring_idx = 0;
800     size_t bottom_substring_idx = 0;
801
802     double alpha = 0;
803     double dalpha = FRAMES_PER_SECOND / 18;
804     double time_since_start_s = 0;
805
806     sf::Clock title_clock;
807     sf::Event title_event;
808
809     while (draw_title) {
810         time_since_start_s = title_clock.getElapsedTime().asSeconds();
811
812         if (time_since_start_s >= (title_frame + 1) * SECONDS_PER_FRAME) {
813             render_window_ptr->clear();
814
815             // 2.1. title state switch
816             switch (title_state) {

```

```

817         case (0): {
818             while (render_window_ptr->pollEvent(title_event)) {
819                 if (title_event.type == sf::Event::Closed) {
820                     render_window_ptr->close();
821                     return;
822                 }
823             }
824
825             // fade in title console
826             render_window_ptr->draw(title_console);
827
828             if (alpha < 255) {
829                 alpha += dalpha;
830
831                 if (alpha > 255) {
832                     alpha = 255;
833                 }
834
835                 title_fill_colour.a = alpha;
836                 title_outline_colour.a = alpha;
837
838                 title_console.setFillColor(title_fill_colour);
839                 title_console.setOutlineColor(title_outline_colour);
840             }
841
842             else {
843                 title_state++;
844                 alpha = 0;
845             }
846
847             break;
848         }
849
850
851         case (1): {
852             while (render_window_ptr->pollEvent(title_event)) {
853                 if (title_event.type == sf::Event::Closed) {
854                     render_window_ptr->close();
855                     return;
856                 }
857             }
858
859             // fade in title text
860             if (not sound_played) {
861                 assets_manager_ptr->getSound("game title screen")->play();
862                 sound_played = true;
863             }
864
865             if (title_string_bottom.substr(0, bottom_substring_idx) != title_string_bottom) {
866                 title_text_upper.setString(title_string_upper.substr(0, upper_substring_idx));
867                 title_text_lower.setString(title_string_lower.substr(0, lower_substring_idx));
868                 title_text_bottom.setString(title_string_bottom.substr(0,
bottom_substring_idx));
869
870                 assets_manager_ptr->getSound("console string print")->play();
871
872                 upper_substring_idx++;
873                 lower_substring_idx++;
874                 bottom_substring_idx++;
875
876                 if (upper_substring_idx > title_string_upper.size()) {
877                     upper_substring_idx = title_string_upper.size();
878                 }
879
880                 if (lower_substring_idx > title_string_lower.size()) {
881                     lower_substring_idx = title_string_lower.size();
882                 }
883             }
884
885             else {
886                 title_text_upper.setString(title_string_upper.substr(0, upper_substring_idx));
887                 title_text_lower.setString(title_string_lower.substr(0, lower_substring_idx));
888                 title_text_bottom.setString(title_string_bottom.substr(0,
bottom_substring_idx));
889                 title_state++;
890             }
891
892             render_window_ptr->draw(title_console);
893             render_window_ptr->draw(title_text_upper);
894             render_window_ptr->draw(title_text_lower);
895             render_window_ptr->draw(title_text_bottom);
896
897             break;
898         }
899
900
901         case (2): {

```

```

902         while (render_window_ptr->pollEvent(title_event)) {
903             if (title_event.type == sf::Event::KeyPressed) {
904                 title_state++;
905             }
906
907             if (title_event.type == sf::Event::Closed) {
908                 render_window_ptr->close();
909                 return;
910             }
911         }
912
913         // flashing prompt
914         render_window_ptr->draw(title_console);
915         render_window_ptr->draw(title_text_upper);
916         render_window_ptr->draw(title_text_lower);
917         render_window_ptr->draw(title_text_bottom);
918
919         if (
920             (title_frame > 3.5 * FRAMES_PER_SECOND) and
921             ((title_frame % FRAMES_PER_SECOND) > FRAMES_PER_SECOND / 2)
922         ) {
923             render_window_ptr->draw(prompt_text);
924         }
925
926         break;
927     }
928
929     case (3): {
930         while (render_window_ptr->pollEvent(title_event)) {
931             if (title_event.type == sf::Event::Closed) {
932                 render_window_ptr->close();
933                 return;
934             }
935         }
936
937         // fade out
938         render_window_ptr->draw(title_console);
939         render_window_ptr->draw(title_text_upper);
940         render_window_ptr->draw(title_text_lower);
941         render_window_ptr->draw(title_text_bottom);
942
943         if ((title_frame % FRAMES_PER_SECOND) > FRAMES_PER_SECOND / 2) {
944             render_window_ptr->draw(prompt_text);
945         }
946
947         render_window_ptr->draw(fade_rectangle);
948
949         if (alpha < 255) {
950             alpha += dalpha;
951
952             if (alpha > 255) {
953                 alpha = 255;
954             }
955
956             fade_rectangle.colour.a = alpha;
957
958             fade_rectangle.setFillColor(fade_rectangle.colour);
959
960         }
961
962         else {
963             draw_title = false;
964         }
965
966         break;
967     }
968
969     default: {
970         // do nothing!
971
972         break;
973     }
974 }
975
976 render_window_ptr->display();
977 title_frame++;
978 }
979
980 }
981
982 return;
983 } /* showTitleScreen() */

```



### 5.31.1 Detailed Description

Implementation file for the `TidalTurbine` class.

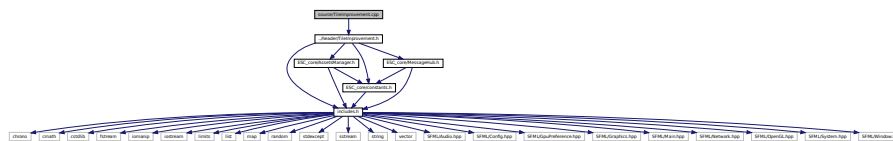
A base class for the tile improvement hierarchy.

### 5.32 source/TileImprovement.cpp File Reference

Implementation file for the `TileImprovement` class.

```
#include "../header/TileImprovement.h"
```

Include dependency graph for TileImprovement.cpp:



### 5.32.1 Detailed Description

Implementation file for the `TileImprovement` class.

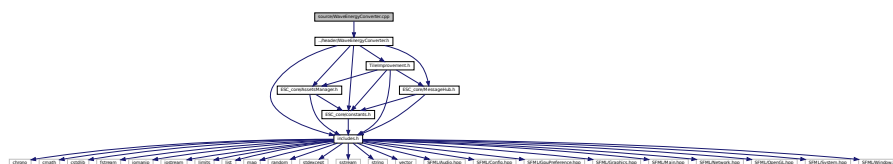
A base class for the tile improvement hierarchy.

### 5.33 source/WaveEnergyConverter.cpp File Reference

Implementation file for the [WaveEnergyConverter](#) class.

```
#include "../header/WaveEnergyConverter.h"
```

Include dependency graph for WaveEnergyConverter.cpp:



### 5.33.1 Detailed Description

Implementation file for the [WaveEnergyConverter](#) class.

A base class for the tile improvement hierarchy.



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