**PROJECT DESIGN DOCUMENT FORM**
**FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)**
**Version 04.1**

# PROJECT DESIGN DOCUMENT (PDD)

| | |
|---|---|
| **Title of the project activity** | Tongaat Hulett Sugar Refinery Steam Optimisation Project |
| **Version number of the PDD** | 1.2 |
| **Completion date of the PDD** | 01 November 2012 |
| **Project participant(s)** | Tongaat Hulett Sugar South Africa Limited |
| **Host Party(ies)** | South Africa |
| **Sectoral scope and selected methodology(ies)** | Sectoral Scope 3. AM0018 Version 03.0.0 |
| **Estimated amount of annual average GHG emission reductions** | 147719 $tCO_2e$ per annum |

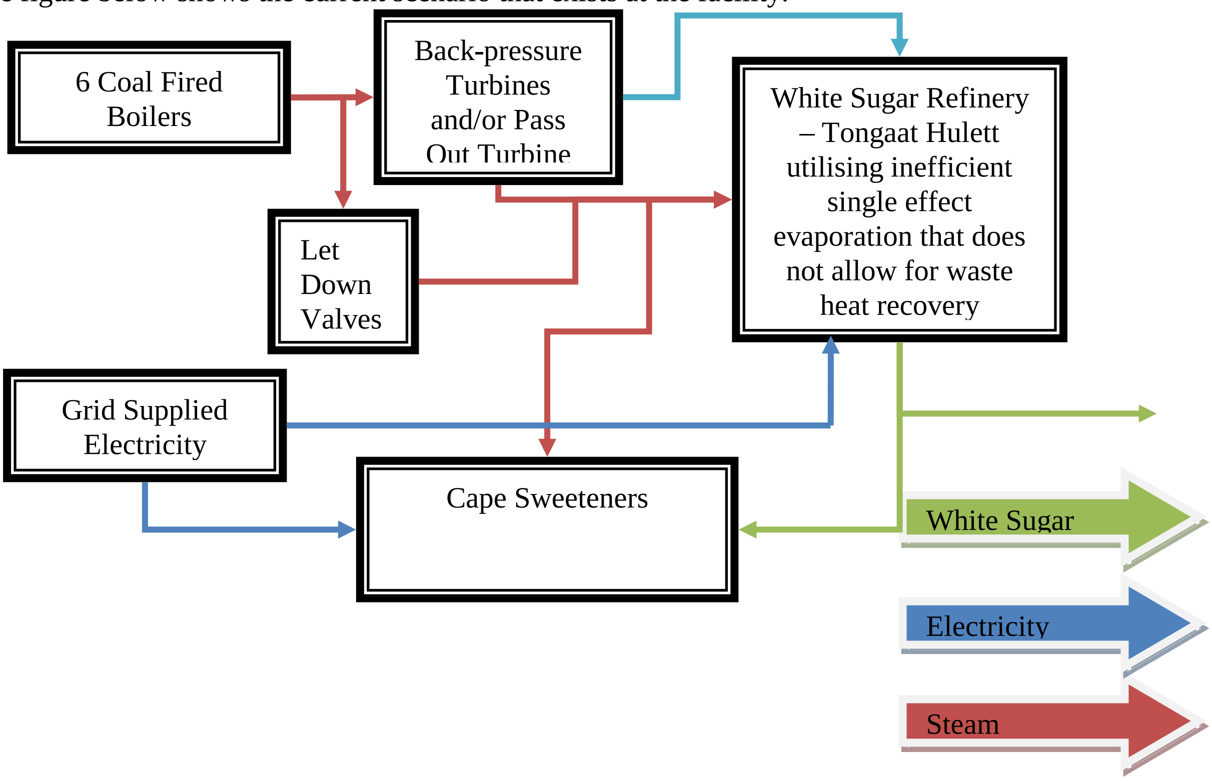
**SECTION A. Description of project activity**
**A.1. Purpose and general description of project activity**

>>
**Situation Existing Prior to the Project Activity**

Tongaat Hulett Sugar South Africa Limited operates the only central sugar refinery in Durban, South Africa that produces refined white sugar. The refinery requires a significant steam supply in order to produce the refined white sugar. The steam is supplied from a set of coal fired boilers. These boilers supply steam to both the white sugar refinery (Tongaat Hulett Sugar Business Unit) as well as the Fructose plant (Cape Sweeteners Business Unit.) Fructose is a small volume producer of specialty sugar products that utilises the product produced by the high volume commodity producer, the white sugar refinery, and is a very small energy user in comparison to the white sugar refinery. The Fructose plant purchases steam from the boilers, refined white sugar and electricity from the white sugar refinery in order to make a fructose product. Fructose maintains their own set of accounting records that includes accurately metered energy use that clearly separates the two business units. The primary steam users in the white sugar refinery are the evaporative crystallisers that are used for the crystallisation of refined white sugar. Evaporative crystallisation requires carefully controlled temperatures to produce the sugar crystals and as such it does not allow for the capture and use of waste heat for subsequent evaporation steps. This is known as single effect evaporation.

The baseline scenario is the continuation of the current scenario and therefore it is not repeated.

The figure below shows the current scenario that exists at the facility.

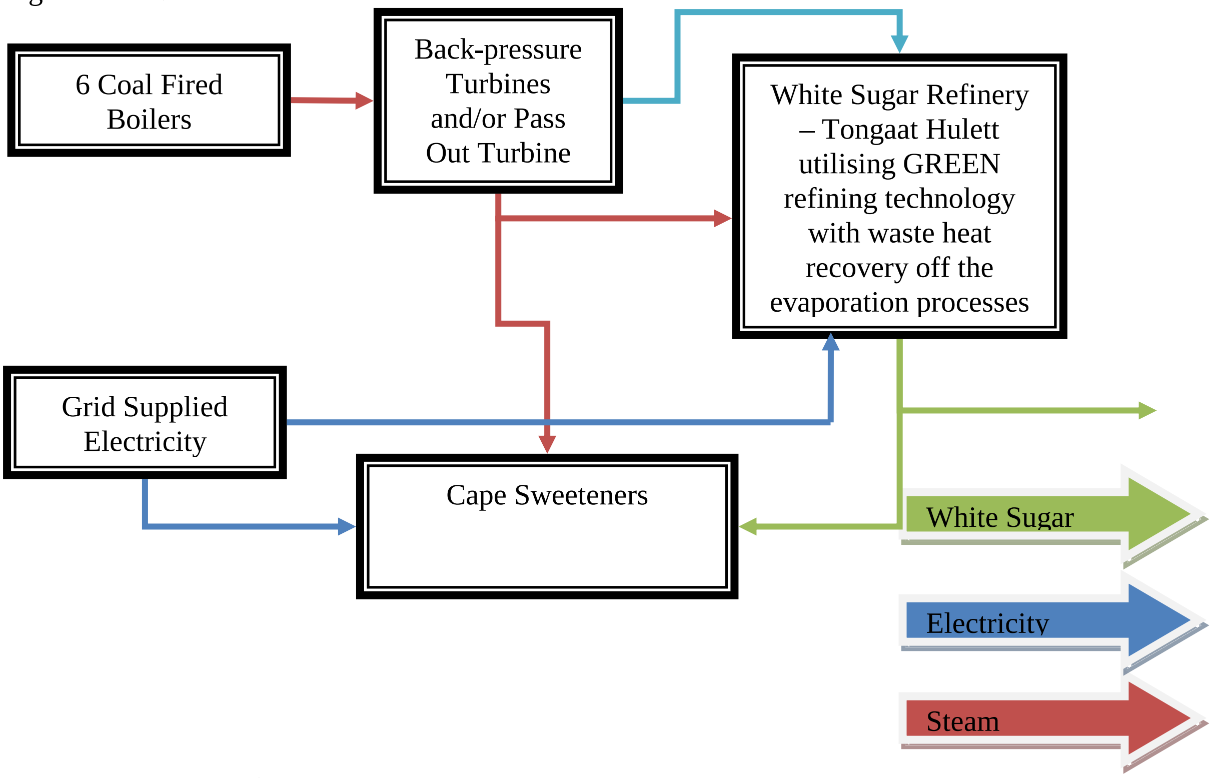



**Project Activity Description**

The proposed project activity is a steam optimisation project centred on a step change in the sugar crystallisation process that allows for the use of waste heat vapour in the evaporation process as an alternative energy source to the primary steam currently used. The waste heat vapour will also be used by other processes within the white sugar refinery that currently utilise primary steam as a heat source. This will significantly reduce the steam demand in the white sugar refining process.

The energy efficiency step change is an alternative to the current evaporative crystallization process known as cooling crystallization, or Greatly Reduced Energy and Equipment Needs (GREEN) Refining Technology as it is named by Tongaat Hulett Sugar South Africa Limited. GREEN Refining Technology decouples the evaporation and crystallization processes. This decoupling allows for the use of multiple effect evaporation, a far more efficient method of evaporation than the currently installed single effect evaporators. The use of multiple effect evaporation allows for the capture and use of waste heat vapours off the falling film evaporator process, to replace primary steam usage throughout the refinery and in particularly, in the evaporation process. This allows for the use of waste heat as an energy source instead of primary steam. This will reduce the overall steam demand of the white sugar refining process substantially and reduce the associated greenhouse gas emissions from the combustion of coal for the purpose of generation of steam.

The objective of the proposed project is to supplement the current evaporation plant with falling film evaporators that are ideal for multiple effect evaporation with the addition of cooling crystallisers to successfully decouple evaporation and crystallisation. This will also lead to a large reduction in steam demand of 64% within the white sugar refinery plant, whilst diverting waste heat streams to processes to replace boiler supplied steam. This reduction in steam demand, based on a reduction in the specific steam consumption ratio (SSCR) of tonnes of steam to tonnes of white sugar product, will result in a direct reduction of coal consumption by the boilers. The proposed project scenario is shown at a high level in the figure below.




It is anticipated that the following GHG emission reductions will be achieved:
Annual GHG Emission Reductions: 147,719 $tCO2_e$
Total GHG Emission over crediting Period 1,477,190 $tCO2_e$

**Contribution towards sustainable development in South Africa**

The following assessment of the contribution of the proposed project towards sustainable development in South Africa is analysed in accordance with South Africa's Designated National Authority's (DNA's) published **Sustainable Development Criteria for Approval of Clean Development Mechanism Projects by the Designated National Authority of the CDM.**

Economic

The proposed project will result in short term jobs for the implementation of the new design over the two year construction period. The quantity isestimated to be 25 during the fabrication and construction phases of the project. Additionally Tongaat Hulett Sugar South Africa Limited is a Level 2 Broad Based Black Economic Empowerment contributor and preference will be given to local suppliers who conform to Tongaat Hulett Sugar South Africa Limited's procurement policy with regards to B-BBEE and technical competence It is expected that a significant portion of the projects local fabrication, manufacture and installation will benefit Historically Disadvantaged South Africans through preferential procurement and skills development.

The project has been designed locally by the Tongaat Hulett Sugar Limited's engineering team, managed by Dr Craig Jensen and Dr David Love. The project is a first of its kind technology internationally that could be repeated in other central refineries around the world promoting future export revenue and potential future local job creation whilst significantly reducing greenhouse gas emissions. The refinery operators will be up-skilled significantly as the refinery will be more complex in terms of instrumentation and control. This will add to the operators' skills levels and enhance their income earning potential in the long term.

Social

The project will result in no job losses from the refinery and will result in the creation of temporary jobs during the fabrication and construction phase of the new technology as described above.

The project will impact social heritage as it will be a world first project developed in the area that the country could be proud of as it has the potential to significantly reduce environmental impacts of the sugar refining process throughout the world.

The project is not expected to impact on social structures within the community, nor on the social amenities where the project is to be situated. As the project is a retrofit project, the surrounding community will not be developed any further, but the environmental benefits to the community will be significant.

Environmental

The reduction in the combustion of coal in the boilers at the refinery as a result of the proposed project (expected to be 56%) will result in reduced air pollution, particulate matter and greenhouse gas emissions, thereby increasing air quality in the region. The reduced coal consumption will also result in fewer emissions from the transport of coal to the refinery. By reducing the steam consumption in the facility, water usage is also reduced in the local community.

The project will result in the reduction of coal usage, a non renewable natural resource in South Africa, whilst producing the equivalent amount of refined white sugar.

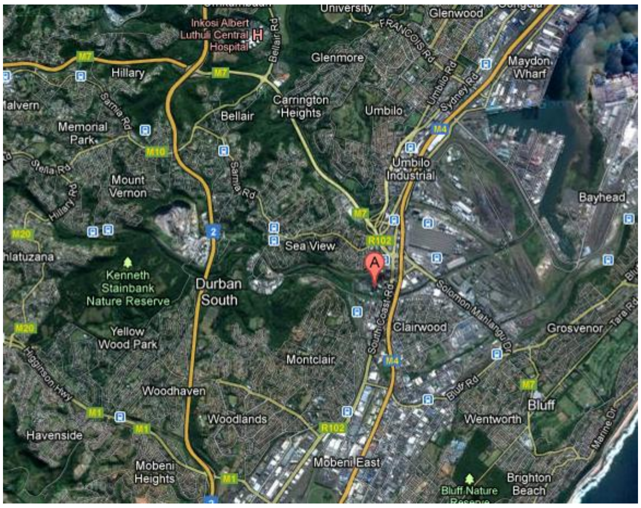
**A.2. Location of project activity**

**A.2.1. Host Party(ies)**
>>
South Africa

**A.2.2. Region/State/Province etc.**
>>
Kwazulu-Natal

**A.2.3. City/Town/Community etc.**
>>
Rossburgh, Durban

**A.2.4. Physical/Geographical location**
>>
Tongaat Hulett Sugar Refinery
444 South Coast Road
Rossburgh, Durban
Kwazulu Natal, South Africa
GPS Coordinates: 29°54’28” S 30°.58’37”E




Maps from Google Maps

**A.3. Technologies and/or measures**

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The baseline and project scenarios both occur at the same facility as described and uniquely identified in section A.2. This is the Tongaat Hulett Sugar South Africa Limited Sugar Refinery (termed “the refinery”). The refinery is a central refinery for South Africa and is owned and operated by Tongaat Hulett Sugar South Africa Limited. Tongaat Hulett Sugar South Africa Limited only owns a single refinery in South Africa and this facility is a key component of their business.

The following is a high level description of the processes involved in the entire sugar production process with specific referencing to refining of white sugar summarised from Peter Rein’s book, Cane Sugar Engineering (2007). Each step will be described in detail below.

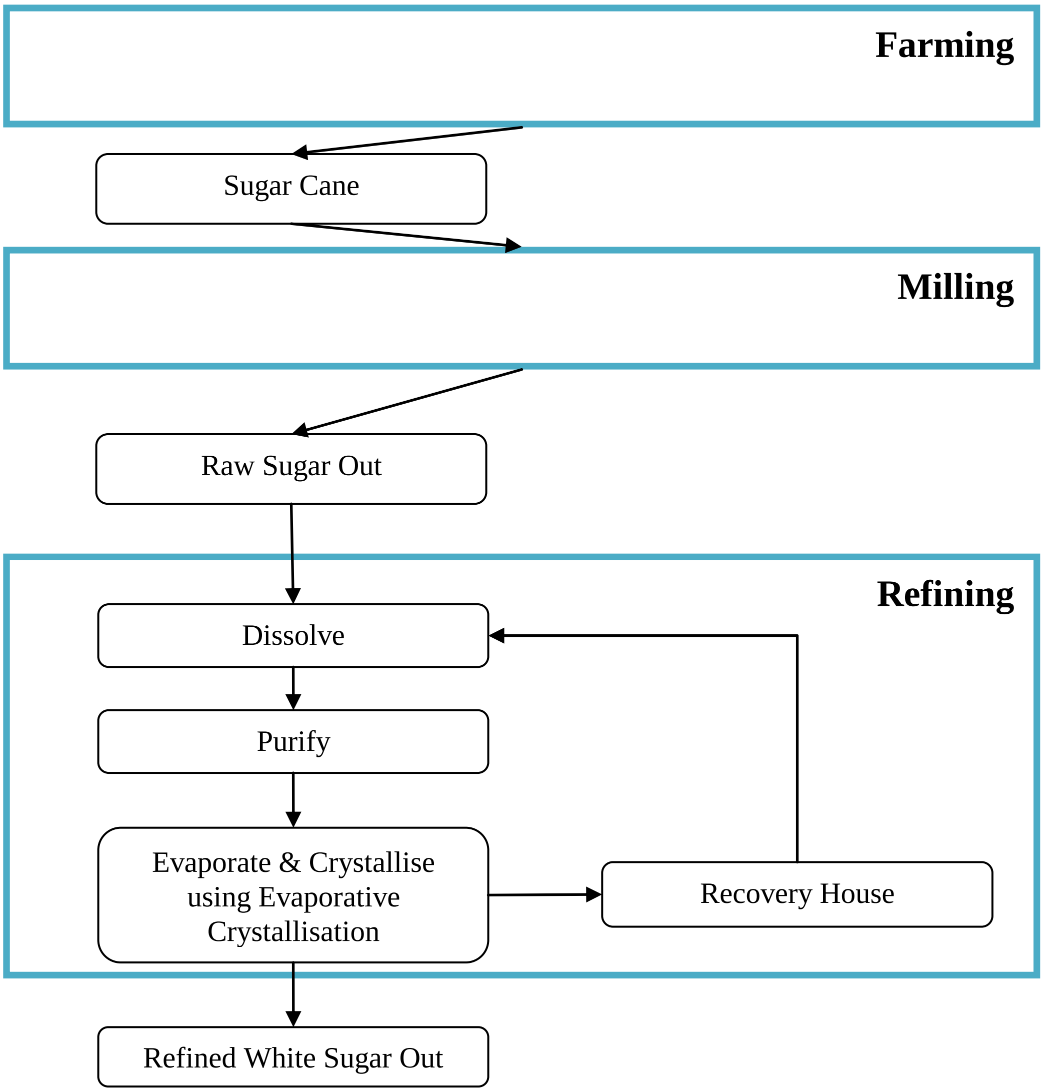


**Figure 1: White Sugar Refining Process Flow**

**Situation Existing Prior to the Project Activity & Baseline Scenario**

The situation existing prior to the implementation of the proposed project activity is the baseline scenario as demonstrated in Section B.4.

1. <u>List of technologies, systems and equipment</u>
   The table below summarises the major equipment in the baseline scenario that will be supplemented and or supplied with an alternative energy source during the project activity.

<table>
<tr><th>Process</th><th>Major Equipment</th><th>Energy Source</th><th>Equipment Lifespan</th></tr>
<tr><td>Dissolve (110 tonnes of refined white sugar per hour nameplate)</td><td>• Melter</td><td>• Heat from primary steam<br>• Some waste heat from evaporative crystallisers<br>• Electricity from turbines and grid</td><td>No concerns over equipment life. Will continue to operate during the project activity.</td></tr>
<tr><td>Purify (90 tonnes of refined white sugar per hour nameplate)</td><td>• Clarifier<br>• Filters<br>• Decolourisation</td><td>• Heat from primary steam<br>• Some waste heat from evaporative crystallisers<br>• Electricity from turbines and grid</td><td>No concerns over equipment life. Will continue to operate during the project activity.</td></tr>
<tr><td>Evaporation (92 tonnes of refined white sugar per hour nameplate)</td><td>• Single Effect Evaporator Station</td><td>• Heat from primary steam<br>• Electricity from turbines and grid</td><td rowspan="3">All pressure vessels have up-to-date inspection certificates as required by South African Law. These certificates are issued every three years and the vessels are found to be in good working order. There are no lifespan concerns around the boilers and none are due to be replaced. The boiler test certificates are attached as supporting documentation to this PDD. Regular maintenance is conducted on all equipment as per manufacturer's specifications.</td></tr>
<tr><td>White sugar crystallisation (91 tonnes of refined white sugar per hour nameplate)</td><td>• Single effect evaporative crystallisers<br>• Centrifuges<br>• Dryers<br>• Thermocompressor</td><td>• Heat from primary steam<br>• Electricity from turbines and grid</td></tr>
<tr><td>Recovery House (95 tonnes of refined white sugar per hour nameplate)</td><td>• Single effect evaporators</td><td>• Heat from primary steam<br>• Electricity from turbines and grid</td></tr>
<tr><td>Heat Energy Sources</td><td>• Coal fired boilers – efficiency of 86.56%. This is the highest efficiency measured for the</td><td>• N/A</td><td>All boilers have up-to-date inspection certificates as required by South African Law. These certificates are</td></tr>
</table>

| | | | |
|---|---|---|---|
| | high-pressure boilers by an external third party, Karbon Services. Supporting documentation is included with this PDD. | | issued every three years and the boilers are found to be in good working order. There are no lifespan concerns around the boilers and none are due to be replaced. The boiler test certificates are attached as supporting documentation to this PDD. Regular maintenance is conducted on all equipment as per manufacturer's specifications. |
| Electrical Energy Sources | • Backpressure turbines<br>• Pass out turbine<br>• South African Electrical Grid | • Steam from coal fired boilers | No concerns over lifespan. Regular maintenance is conducted on all equipment as per manufacturer's specifications. |

As shown by the above table, steam is used in the white sugar refinery process in multiple areas. The largest steam user is the evaporative crystallisation process (shown as the pans and evaporators in the baseline energy flow figure below). The evaporative crystallisation process is highly energy intensive, requiring single effect evaporators that do not allow for waste heat to be used as an energy source in subsequent evaporation steps due to the specific temperature control requirements within the evaporative crystallisers. This is common practise throughout the sugar industry in South Africa. Tongaat Hulett Sugar South Africa Limited has implemented many energy efficiency projects within the refinery, with the latest being the implementation of pinch technology1.

In addition, the above table shows that there is no concern over the life of this equipment and it is expected that it will continue to operate well after the 10 year crediting period has expired.

The following are monitored currently, in addition to the steam monitoring points shown in the figure below.

- MWh of electricity generated by turbines at the boiler control room
- MWh of electricity supplied to fructose plant at the fructose substation
- MWh of electricity purchased from the South African grid at the boiler control room
- Tonnes of coal combusted at the boiler house
- Production figures, in tonnes of refined white sugar per shift at the two white sugar scales
- Boiler feed water temperature, pressure and enthalpy at the boiler control room
- Steam temperature, pressure and enthalpy at the boiler control room of the high and low pressure boilers

1 RG Hoekstra & DJ Tayfield, (1998) *Energy efficiency improvements to Huletts sugar refinery*, Proc S AJi. Sug Technol Ass (1998)

2. Energy and mass flow balances

The figure below shows the energy flows (in tonnes of steam per hour) through the white sugar refinery and fructose plants during the baseline scenario. The figure shows the current location of installed steam monitoring equipment.

The steam that will be reduced is generated by the current coal fired boiler system at two temperature and pressure ranges, known as High Pressure 1 (HP1 at 32 bar pressure, 380°C) and High Pressure 2 (HP2 at 14 bar pressure 290°C). The steam is either fed through back pressure turbines, a pass-out turbine or the boiler feed-water pump turbine to produce electricity or through a combination of thermo-compressors and let down valves to be used as process steam. The exhaust steam of the backpressure turbines is also used as process steam. The process steam has two main ranges, known as the Intermediate Pressure (IP at 4 bar pressure 144°C) range and the exhaust range (at 1.8 bar pressure 117°C). This is currently an inefficient method of supplying steam to the refinery when compared with the proposed project activity; however it must be noted that Tongaat Hulett Sugar South Africa Limited have implemented many energy efficiency projects over the years to improve the efficiency of the current system as far as possible. A small fraction of the process steam generated by the boilers is sold to the separate Fructose Plant in addition to the refined white sugar and electricity that the plant requires. This steam and electricity is continuously metered in addition to the steam generated by the boilers.

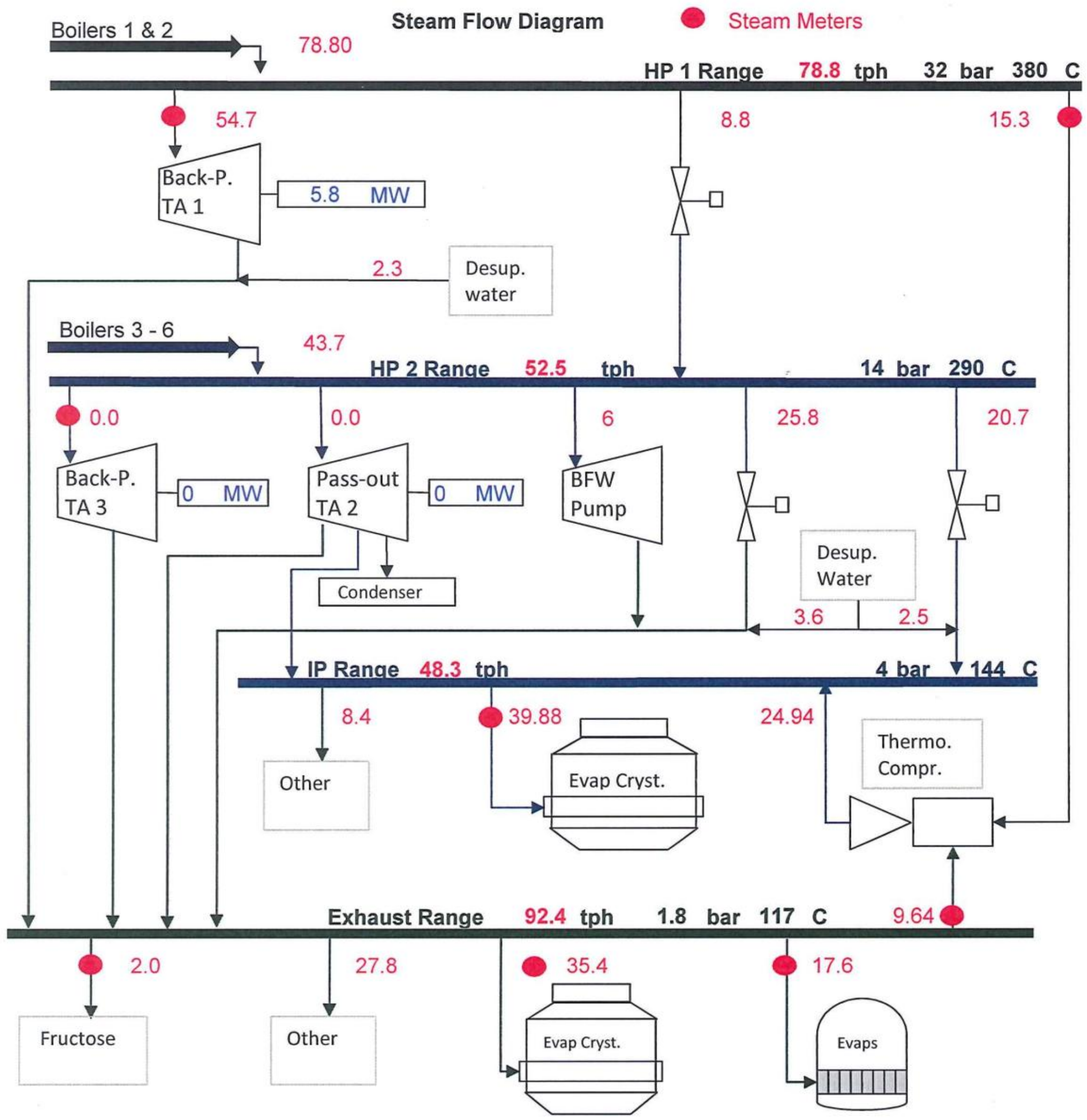


Figure 2: Baseline Energy Flows

3. Types and levels of services (products) provided
   The refinery produces refined white sugar as per the required national product specifications attached as supporting documents to this PDD. The refinery nameplate capacity is 90 tons per hour of melt (raw sugar input) (Rein, 1987) at an efficiency of 96.4% (Rein, 1987). This equates to a production nameplate capacity of 86.8 tons per hour of refined white sugar.

**Project Activity Description**

1. List of technologies, systems and equipment

The proposed project is to use Cooling Crystallisation as a supplement to the evaporative crystallisation process to grow the sugar crystals. This technology is termed GREEN Refining Technology and currently holds the status of patent pending. This is a first of its kind technology use for the sugar industry internationally. The use of cooling crystallisation allows for the decoupling of the crystallisation and evaporation steps. The decoupling then allows for the use of highly efficient multiple effect evaporators that have significant waste heat recovery opportunities associated with them off the outlet vapour of the evaporators. The waste heat recovery opportunities presented by the multiple effect evaporators allows for the energy source change from primary steam to waste heat for many steam users within the refinery, including the evaporation stages that currently only utilise primary steam as a heat energy source. This constitutes a first-of-its-kind technology as it has not been implemented successfully before. The table below summarises equipment additions to the refining process as well as energy source changes associated with the project activity.

| **Process** | **Major Equipment** | **Energy Source** |
|---|---|---|
| Dissolve (110 tonnes of refined white sugar per hour nameplate) | • Melter | • Waste heat vapour from the multiple effect evaporator station<br>• Some Heat from primary steam<br>• Electricity from turbines and grid |
| Purify (90 tonnes of refined white sugar per hour nameplate) | • Clarifier<br>• Filters<br>• Decolourisation<br>• 2nd stage decolourisation to be implemented in phase 2 to reduce energy consumption further | • Waste heat vapour from the multiple effect evaporator station<br>• Some Heat from primary steam<br>• Electricity from turbines and grid |
| Evaporation (92 tonnes of refined white sugar per hour nameplate) | • Multiple effect evaporator station using falling film evaporators<br>• Pumps | • **Waste heat vapour from the multiple effect evaporator station**<br>• Some Heat from primary steam<br>• Electricity from turbines and grid |
| White sugar crystallisation (91 tonnes of refined white sugar per hour nameplate) | • Cooling crystallisers<br>• Vertical cooling crystallisers<br>• Evaporative crystallisers<br>• Centrifuges<br>• Dryers | • **Waste heat vapour from the multiple effect evaporator station**<br>• Some Heat from primary steam<br>• Electricity from turbines and grid |
| Recovery House (95 tonnes of refined white sugar per hour nameplate) | • Single effect evaporators | • Waste heat vapour from the multiple effect evaporator station<br>• Some Heat from primary steam<br>• Electricity from turbines and grid |
| Heat Energy Sources | • Coal fired boilers – efficiency of 86.56%. This is the highest efficiency measured for the high-pressure boilers by an external third party, Karbon Services. Supporting | • N/A |

| | | |
|---|---|---|
| | documentation is included with this PDD. | |
| Electrical Energy Sources | • Backpressure turbines<br>• Pass out turbine<br>• South African Electrical Grid | • Steam from coal fired boilers |

The use of the waste heat to replace steam usage throughout the sugar refining process as a result of the use of Multiple Effect Evaporation using Falling Film Evaporators and Cooling Crystallisers significantly reduces steam consumption in the white sugar refinery and the associated anthropogenic greenhouse gas emissions as a result of the combustion of coal in the boilers.

The thermocompressor used in the baseline scenario will not be used in the project scenario.

The proposed project is shown in the flow sheet below, with the new equipment areas shown as red blocks.

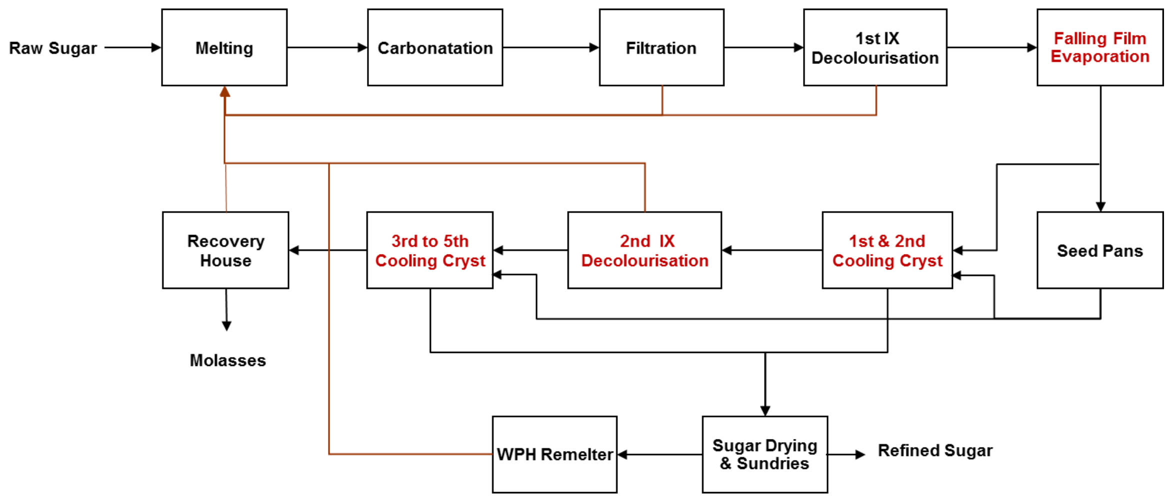


**Figure 3: White Sugar Refining Process After Project Implementation**

Phase 1 will be the implementation of cooling crystallisation and multiple effect evaporation, allowing for the decoupling. The use of this technology also allows for a further liquid decolourisation stage to be added in phase 2. This will reduce the amount of reject sugar in the refinery that is reprocessed, resulting in further energy reductions.

The project will be implemented in three phases if approved. This is shown in the table below:

| **Project Milestone** | **Completion** | **Description** |
|---|---|---|
| Proposal made to the board for a demonstration plant. | 25 Sept 2012 | Board not willing to approve project due to concerns regarding risk of applying a world-first refining technology. |
| Budget approval for demonstration plant (expected) | November 2012 | Assuming that the technical risk concerns have been adequately addressed. |
| Demonstration plant commissioning | June 2013 | |
| Approval for phase 1 (Cooling Crystallisation) | October 2013 | |
| Phase 1 commissioning | October 2014 | |
| Approval for phase 2 (2$^{nd}$ Stage Decolourisation) | July 2015 | |

| | | |
|---|---|---|
| Phase 2 commissioning | July 2016 | |

2. Energy and mass flow balances

The figure below shows the energy flows (in tonnes of steam per hour) through the white sugar refinery and fructose plants during the project scenario. The figure also shows the location of installed steam monitoring equipment.

Steam is either generated by boilers 1 and 2 (high pressure boilers at 32 bar pressure and 380°C) or boilers 3 to 6 (low pressure boilers at14 bar pressure and 290°C). This steam is sent entirely through backpressure turbines or the boiler feed-water pump turbine before being used as process steam at the exhaust range (at 1.8 bar pressure and 116°C). The total primary steam generation is significantly reduced in the project scenario as a result of the implementation of GREEN refining technology. The decoupling of the crystallisation and evaporation steps in the process that allows for multiple effect falling film evaporation technology to be used allows waste heat to be used as an energy source in both the evaporation steps as well as in other areas throughout the white sugar refinery, replacing the need for primary steam and therefore reducing the primary steam generation from the boilers. This is far simpler and more energy efficient than the baseline scenario.

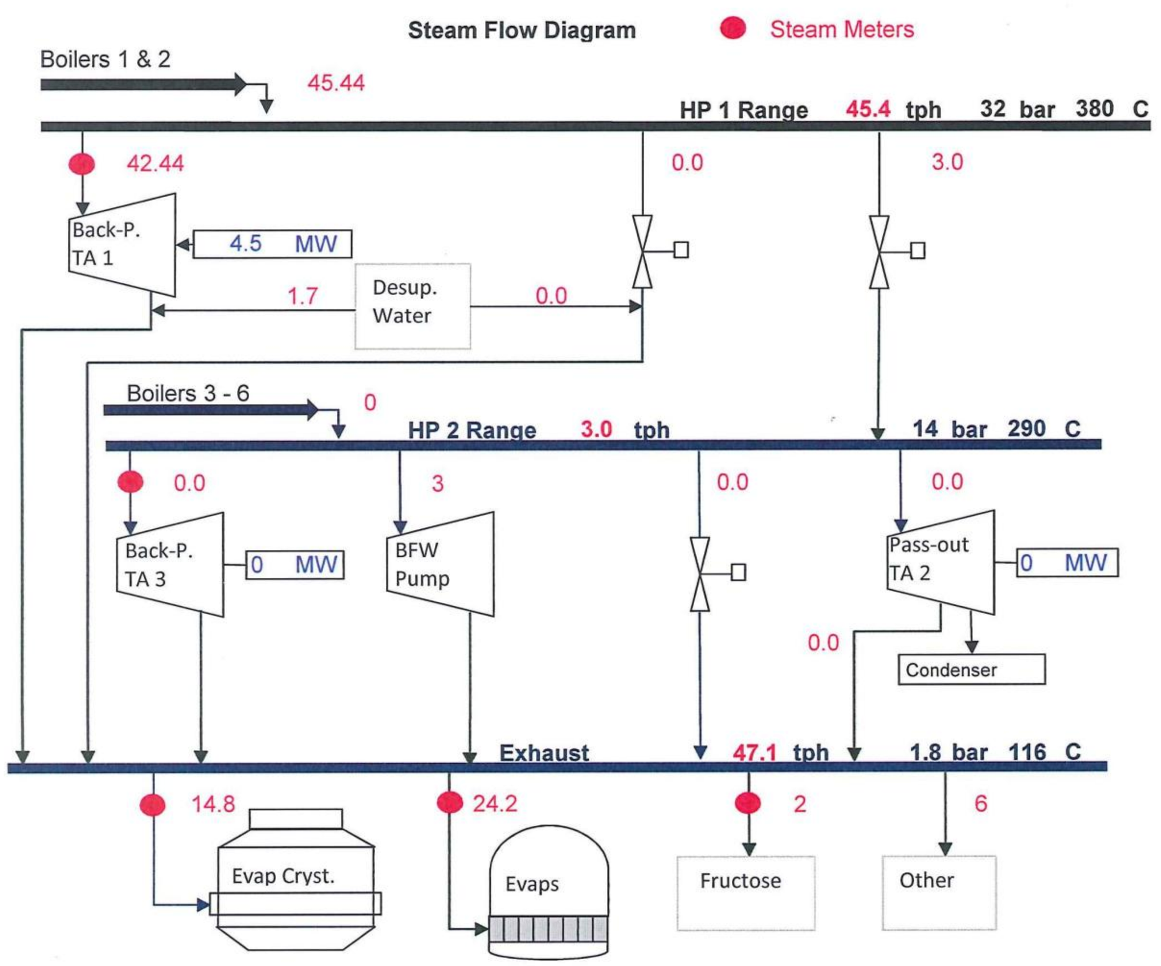


Figure 4: Project Activity Energy Flows

3. Types and levels of services (products) provided

The white sugar refinery will continue to operate at its nameplate capacity of 86.8 tons of refined white sugar per hour. This refined white sugar will continue to meet the national product specifications attached as supporting documents to this PDD.

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Technology Transfer to the Host Country

No technology transfer will occur to the host country as the technology has been designed and developed in the host country.

**A.4. Parties and project participants**

| Party involved (host) indicates a host Party | Private and/or public entity(ies) project participants (as applicable) | Indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| South Africa (host) | Tongaat Hulett Sugar South Africa Limited | No |

**A.5. Public funding of project activity**

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No public funding from Annex 1 countries is to be used in the project.

**SECTION B. Application of selected approved baseline and monitoring methodology**

**B.1. Reference of methodology**

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The following approved methodology is selected for the proposed project:

**AM0018 "Baseline methodology for steam optimization systems" version 03.0.0 valid from 02 March 2012 onwards**

The above methodology makes reference to the following tools that are used in completing this project design document:

- Tool to calculate baseline, project and/or leakage emissions from electricity consumption Version 01;
- Tool to determine the remaining lifetime of equipment Version 01;
- Combined tool to identify the baseline scenario and to demonstrate additionality Version 04.0.0

- Tool to calculate the emission factor for an electricity system. Version 02.2.1
- Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion Version 2

**B.2. Applicability of methodology**

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With reference to AM0018 "Baseline methodology for steam optimization systems" version 03.0.0 from www.unfccc.int the following are the applicability criteria of the selected methodology.

| **Methodology Requirements** | **Demonstration that Criteria is Met** |
|---|---|
| This methodology applies to project activities that optimize the use of steam in a production process. | The proposed project activity is the optimisation and reduction of steam usage in a white sugar refinery as demonstrated by the project description in A.3. The project therefore meets this criterion. |
| The methodology is only applicable where the baseline selection demonstrates that the baseline scenario is that the plant continues to operate in the current fashion, i.e. without implementation of steam optimization project. | As demonstrated in Section B.5, the baseline scenario is the continuation of the current scenario within the refinery that requires investment in maintenance and operation of the facility. |
| The process unit(s) where steam is optimized produces a homogeneous output | The steam optimisation project is proposed to take place throughout the entire white sugar refinery, with the application of GREEN refining technology in the crystallisation process. The refinery produces refined white sugar, a homogenous output.<br><br>The project meets this criterion. |
| The production volume in the process unit(s) where steam is optimised is reasonably constant under steady state conditions | The white sugar refinery output (the process) is reasonably constant at a rate of between 630 and 720 tons of sugar per 8 hour shift. The design value of the refinery (86.8 tonnes of refined white sugar per hour). The refinery currently operates below nameplate capacity.<br><br>The project therefore meets this criterion. |
| Steam consumption is monitored continuously | Steam generation of the six boilers as well as steam consumption of the two plants, the white sugar refinery and the fructose plant, is monitored continuously. The steam consumption of the white sugar refinery is measured as a difference between the steam generated and the fructose plant usage. This information is stored on a DCS system.<br><br>The project therefore meets this criterion. |
| If the steam is produced in a cogeneration system under the project activity, it should be demonstrated that the steam generated at boiler end is reduced by the quantity of steam saved by the project activity | Steam consumed by the white sugar refinery is calculated based on the steam generated by the boilers; therefore the steam generation will be reduced by the equivalent amount of steam saved in the white sugar refinery.<br><br>The project therefore meets this criterion. |

| Methodology Requirements | Demonstration that Criteria is Met |
|---|---|
| It has to be demonstrated that if the steam saved in the project activity is used, it does not lead to an increase in GHG emissions. | Steam consumed by the white sugar refinery is calculated based on the steam generated by the boilers; therefore the steam generation will be reduced by the equivalent amount of steam saved in the white sugar refinery. There is not current intention to use the steam that is saved.<br>The project therefore meets this criterion. |
| The emission reductions can be claimed for the minimum period between the crediting period and the expected lifetime of the equipment. | The remaining life of the equipment that will be replaced is expected to be over 10 years. The crediting period is 10 years, which is less than the remaining lifetime of the current equipment. |
| **In the case where the steam supplied to the process is the output of a steam turbine producing electricity** | |
| The steam equivalent to the amount of saved steam is vented to atmosphere – **then the methodology is not applicable** | The steam saved will not be vented to the atmosphere in normal conditions as the only occasions when steam is vented to the atmosphere at the refinery are during emergency conditions as the steam reduction in the refinery will result in less steam being generated by the boiler.<br><br>The project therefore meets this criterion. |
| The steam saved is directed to another application where, in the baseline, this application had an energy requirement met by a fossil fuel source only **- then the methodology is not applicable** | The steam saved will not be directed to another application. The only other current application for steam is the Fructose plant that currently receives steam from the boilers. The steam saved will not be directed to other applications where the application had an energy source met by a fossil fuel source only. .<br><br>The project therefore meets this criterion. |
| **Applicability criteria from referenced tools** | |
| Tool to calculate baseline, project and/or leakage emissions from electricity consumption Version 01;<br><br>The tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption:<br><br>Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only. Either no captive power plant is installed at the site of electricity consumption or, if any on-site captive power plant exits, it is not operating or it can physically not provide electricity to the source of electricity consumption.<br><br>Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at | Electricity consumption to the refinery is provided both by captive power plants powered by coal and by grid electricity. The project therefore meets this criterion. |

| Methodology Requirements | Demonstration that Criteria is Met |
|---|---|
| the site of the electricity consumption source and supply the source with electricity. The captive power plant(s) is/are not connected to the electricity grid.<br><br>Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumption source. The captive power plant(s) can provide electricity to the electricity consumption source. The captive power plant(s) is/are also connected to the electricity grid. | |
| Tool to calculate the emission factor for an electricity system. Version 02.2.1<br><br>In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country. | All of the electricity consumption of the refinery is located in a Non-Annex 1 country, South Africa. |

Based on the above, the methodology, AM0018 version 03.0.0 is clearly applicable to the proposed project.

**B.3. Project boundary**

As per AM0018 page 2, the following is the project boundary definition.

The spatial extent of the project boundary includes:

- The steam generating unit(s);
- Backpressure or extraction turbines in cogeneration projects should be included in the project boundary in cases where medium or low-pressure steam at the outlet of the turbine is optimized;
- In cases where electricity consumption increases as a result of the project activity, the electricity source should be included;
- Process unit(s)/system where the specific steam consumption is expected to be reduced.

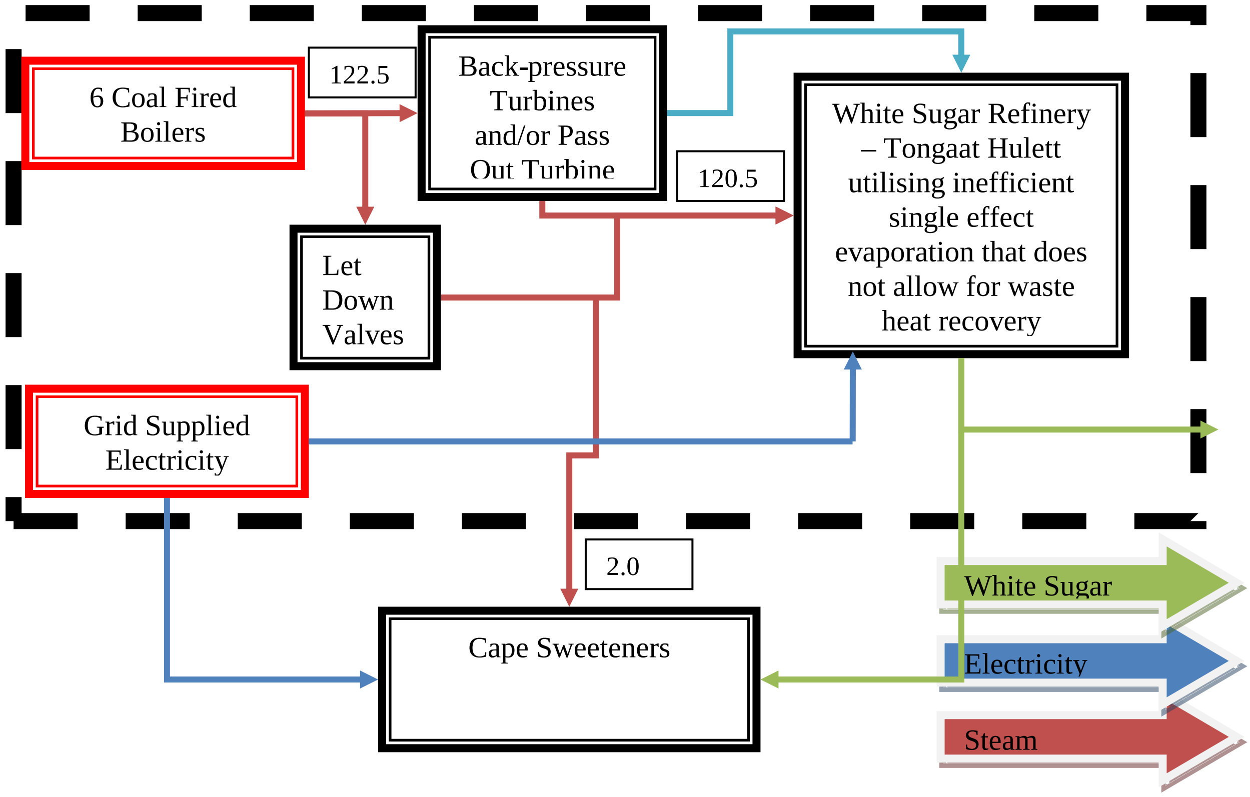
The following will be included in the project boundary:

1. The white sugar refinery and all the associated equipment and processes described in A.3 where the steam optimisation project will take place
2. The coal fired boilers providing steam to the white sugar refinery
3. The backpressure turbines providing electricity to the white sugar refinery
4. The grid supplied electricity to the white sugar refinery

| Source | | GHGs | Included? | Justification/Explanation |
|---|---|---|---|---|
| Baseline scenario | Fossil fuel combustion in steam generator | $CO_2$ | Yes | Main source of emission |
| | | $CH_4$ | No | Excluded for simplification. This is conservative |
| | | $N_2O$ | No | Excluded for simplification. This is conservative |
| | Electricity used in electrical equipment | $CO_2$ | Yes | It can be a significant source. |
| | | $CH_4$ | No | Excluded for simplification. This is conservative |
| | | $N_2O$ | No | Excluded for simplification. This is conservative |
| Project scenario | Fossil fuel combustion in steam generator | $CO_2$ | Yes | Main source of emission |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small |
| | Electricity consumptio n due to project activity | $CO_2$ | Yes | It can be a significant source as grid supplied electricity might increase during the project activity. |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small |
| | Additional fossil fuel consumptio n in any other equipment due to project activity | $CO_2$ | No | No additional fossil fuel will be consumed. |
| | | $CH_4$ | No | No additional fossil fuel will be consumed. |
| | | $N_2O$ | No | No additional fossil fuel will be consumed. |

The project boundary is shown in the figure below as the dotted black line along the Flow sheet below.

- GHG emission sources are shown in red blocks – all $CO_2$ emission sources
- Steam flows are shown in black outline blocks




The GREEN Refining Technology will be implemented throughout the plant with the central technological step change being the implementation of cooling crystallisation and multiple effect evaporation allowing for waste heat recovery to replace currently utilised primary steam.

### B.4. Establishment and description of baseline scenario

>>
This baseline was determined using the latest methodological tool, "Combined tool to identify the baseline scenario and demonstrate additionality, version 04.0.0" as well as the approved methodology AM0018. The tool and methodology require the identification of all plausible and credible alternative scenarios and is only applicable if the baseline scenario is the scenario where the plant continues to operate in the current fashion.

The identified alternatives are as follows:

1. The proposed project activity is undertaken without being registered as a CDM project activity
2. The continuation of the current situation (using evaporative crystallisation with no waste heat recovery) that requires investment in maintenance and operation of the facility
3. Part of the project activity is implemented without CDM
4. Other steam optimisation projects, including common practise in the sugar industry, are implemented at the process end within the Tongaat Hulett Sugar South Africa Limited Central Sugar refinery that are not taken up as part of the CDM Project The identified scenarios should be technically feasible alternatives that provide the same steam or fuel efficiencies/reductions throughout the crediting period.
    a. Installing **mechanical vapour recompression** to upgrade the waste heat off the evaporative crystallisers. Currently the waste vapour off the evaporative crystallisers is not usable within the facility as the pressure is too low. The use of mechanical vapour recompression is an option to increase the pressure.

  b. Reinstatement of the **double effect evaporator** at the refinery evaporator station. This would provide a small energy efficiency increase to the overall steam consumption of the facility.
  c. Utilising continuous pan or double effect pan boiling.
5. Other steam optimisation projects are implemented on the generation side within the Tongaat Hulett Sugar South Africa Limited Central Sugar refinery
  a. Installation of higher efficiency boilers.
  b. Installing gas boilers to replace coal boilers
6. Where applicable, no investment is undertaken by the project participants but third party(ies) undertake(s) investments or actions which provide the same output to users of the project activity.
7. Where applicable, the continuation of the current situation, not requiring any investment or expenses to maintain the current situation

Based on the barrier analysis conducted in Section B.5, the baseline scenario is the continuation of the current scenario as described below:

1. Steam is generated and metered in a combination of six boilers (2 high pressure and 4 low pressure) using A grade Sub bituminous coal as the fuel source for the boilers
2. The steam is either used to generate electricity through turbines or the pressure is reduced and mixed with the exhaust steam of the turbines to form the process steam within the refinery.
3. A portion of the process steam is sold to the Fructose plant. This portion of the steam is excluded from the baseline specific steam consumption ratio as it is a separate business unit. The remaining steam (calculated as the difference between the steam generated and the steam supplied to Fructose Plant) is the baseline steam consumption of the white sugar refinery.
4. Steam is used throughout the refinery at various temperatures and pressures (described in A.3) for many processes, of which the predominant steam users are evaporation and evaporative crystallisation.
5. The evaporative crystallisation process is highly energy intensive, requiring single effect evaporators that do not allow for waste heat to be used as an energy source in subsequent evaporation steps due to the specific temperature control requirements within the evaporative crystallisers.

**B.5. Demonstration of additionality**

>>
The following additionality assessment was conducted using the latest approved methodological tool – “Combined tool to indentify the baseline scenario and demonstrate additionality” version 04.0.0.
The current common practise for the process of crystallisation of refined sugar throughout the South African geographical area at central sugar refineries is the use of energy intensive evaporative crystallisers. The use of cooling crystallisation in the refinery process of sugar is not used globally and is considered a new technology for the process. This common practise is identified, as Tongaat Hulett Sugar South Africa Limited operates the only central sugar refinery in South Africa as per the South African Sugar Association2. Other sugar refineries in South Africa are not central sugar refineries, but rather “white end’ mills that produce refined sugar at the sugar mill and have a distinctly different energy make up.

**<u>Step 0: Assessment of First of its Kind Technology</u>**

2 http://www.sasa.org.za/sugar_industry/SugarMillingandRefining.aspx

Requirements as per Guidance:

As per the approved **Guidelines on Additionality of First-Of-Its-Kind Project Activities version 02.0 from 13 September 2012** the following are the requirements for demonstration that a project is a first-of-its-kind.
A proposed project activity is the first of its kind in the applicable geographical area if:

(a) The project is the first in the applicable geographical area that applies a technology that is different from technologies that are implemented by any other project, which are able to deliver the same output and have started commercial operation in the applicable geographical area before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of the proposed project activity, whichever is earlier;
(b) The project implements one or more of the measures;
(c) The project participants selected a crediting period for the project activity that is "a maximum of 10 years with no option of renewal".

With the following definitions:

1. The applicable host country should be at very minimum the entire host country.
2. The following are defined as **the measures**
    a) Fuel and feedstock switch (example: switch from naphtha to natural gas for energy generation, or switch from limestone to gypsum in cement clinker production);
    b) Switch of technology with or without change of energy source including energy efficiency improvement as well as use of renewable energies (example: energy efficiency improvements, power generation based on renewable energy);
    c) Methane destruction (example: landfill gas flaring);
    d) Methane formation avoidance (example: use of biomass that would have been left to decay in a solid waste disposal site resulting in the formation and emission of methane, for energy generation).
3. **Output** is goods/services produced by the project activity including, among other things, heat, steam, electricity, methane, and biogas unless otherwise specified in the applied methodology.
4. **Different technologies** are technologies that deliver the same output and differ by at least one of the following (as appropriate in the context of the measure applied in the proposed clean development mechanism (CDM) project activity and applicable geographical area):
    a. Energy source/fuel (example: energy generation by different energy sources such as wind and hydro and different types of fuels such as biomass and natural gas);
    b. Feed stock (example: production of fuel ethanol from different feed stocks such as sugar cane and starch, production of cement with varying percentage of alternative fuels or less carbon-intensive fuels);
    c. Size of installation (power capacity)/energy savings:
        i. Micro (as defined in paragraph 24 of decision 2/CMP.5 and paragraph 39 of decision 3/CMP.6);
        ii. Small (as defined in paragraph 28 of decision 1/CMP.2);
        iii. Large.

First-of-its-Kind Technology Analysis

The applicable geographical area is South Africa, however as there is only one central sugar refinery in South Africa, the first-of-its-kind assessment is conducted globally and compared to literature and central sugar refineries around the world. This meets criteria a) of the first-of-its-kind technology requirement.

The measure that will be implemented is measure 2 b), an energy efficiency improvement, meeting criteria b) of the first-of-its-kind technology requirement.

The output of the process is refined white sugar. The nameplate capacity of the Tongaat Hulett White Sugar Refinery will remain 90 tonnes of sugar per hour. This is the same as the baseline nameplate capacity and the GREEN Refining Technology therefore the meets the criteria of delivering the same output as the current operating refinery.

The project owner has selected a crediting period of ten years, therefore meeting criteria c) of the criteria.

The only criterion remaining is criteria a), the **different technology** criteria. The proposed project is a first-of-its-kind technology based on criteria 4 a) of the definition for different technologies in terms of the energy source that will be used for the evaporation as well as the crystallisation of the white sugar.

The baseline scenario is the use of single effect evaporation for the evaporative crystallisation process, where the only energy source is primary steam generated by the onsite coal fired boilers. Evaporative crystallisation does not allow for the use of multiple effect evaporation due to the complex temperature requirements in the crystallisation process. By implementing cooling crystallisation (the proposed project) the evaporation and crystallisation steps can be decoupled. This allows for the use of multiple effect evaporation to be implemented. Multiple effect evaporation essentially captures the waste heat, or vapours, off the evaporation process and re-uses it in the following evaporation step or in other areas of the refinery. The capturing and utilisation of waste heat streams displaces the current primary steam requirements in many areas of the refinery, thereby changing the energy source for many areas of the refinery from primary steam generated by coal fired boilers to waste heat stream from the multiple effect evaporators.

In addition, the energy source for the crystallisation process is no longer heat from the steam but rather from a close cooling water circuit that exchanges heat with ambient environment, also constituting an energy source change.

The above two analysis clearly demonstrate that the project meets criteria a) of the first-of-its-kind technology requirement.

As this process for reining white sugar has not been implemented anywhere globally, the project is therefore **clearly a first-of-its-kind technology** and as such is additional as per paragraph 6 of the **Guidelines on Additionality of First-Of-Its-Kind Project Activities version 02.0 from 13 September 2012**

**<u>Step 1: Identification of Alternative Scenarios</u>**

The first step in determining project additionality is to identify all alternative scenarios to the proposed CDM project that could be the baseline scenario.

***Step 1a – Define Alternative Scenarios***

The identified alternatives are as follows:

1. The proposed project activity is undertaken without being registered as a CDM project activity
2. The continuation of the current situation (using evaporative crystallisation with no waste heat recovery) that requires investment in maintenance and operation of the facility
3. Part of the project activity is implemented without CDM
4. Other steam optimisation projects, including common practise in the sugar industry, are implemented at the process end within the Tongaat Hulett Sugar South Africa Limited Central Sugar refinery that are not taken up as part of the CDM Project The identified scenarios should be technically feasible alternatives that provide the same steam or fuel efficiencies/reductions throughout the crediting period.

a. Installing mechanical vapour recompression to upgrade the waste heat off the evaporative crystallisers. Currently the waste vapour off the evaporative crystallisers is not usable within the facility as the pressure is too low. The use of mechanical vapour recompression is an option to increase the pressure.
b. Reinstatement of the double effect evaporator at the refinery evaporator station. This would provide a small energy efficiency increase to the overall steam consumption of the facility.
c. Utilising continuous pan and/or double effect pan boiling

5. Other steam optimisation projects are implemented on the generation side within the Tongaat Hulett Sugar South Africa Limited Central Sugar refinery
   a. Installation of higher efficiency boilers.
   b. Installing gas boilers to replace coal boilers
6. Where applicable, no investment is undertaken by the project participants but third party(ies) undertake(s) investments or actions which provide the same output to users of the project activity.
7. Where applicable, the continuation of the current situation, not requiring any investment or expenses to maintain the current situation

**Identification of Baseline Scenario**

| **Scenario Number** | **Description** | **Baseline Scenario Comments and Analysis** |
|---|---|---|
| 1 | Project activity implemented without CDM | The project is a first-of-its-kind technology with significant risks associated to it as it is utilising a different energy source for the white sugar crystallisation process. These risks have been highlighted by the board and as such the project requires CDM revenue to be implemented. Based on the first-of-its-kind technology assessment presented above, this is not a plausible alternative baseline scenario. |
| 2 | Continuation of current situation | The refinery has been operating under the current situation for many years and the continuation of current practise is the most plausible baseline scenario. Alternative technologies (double effect evaporation) have been implemented but have failed for mechanical reasons and are therefore discounted. The project therefore meets the criteria of methodology that the baseline scenario is the continuation of the current situation. |
| 3 | Partial implementation without CDM | The project is currently designed for implementation in two phases. Phase 2 requires that phase 1 is fully implemented and commissioned before it can begin. Phase 2 is designed as integration into Phase 1 to achieve maximum steam optimisation as a result of implementing the decoupled evaporation and cooling crystallisation steps that allow for waste heat recovery and the use of this alternative energy source to replace primary steam usage.<br><br>The project therefore cannot be implemented in parts as it is a fully integrated project. |
| 4 a | Mechanical Vapour | Mechanical vapour recompression has been |

| | | |
|---|---|---|
| | Recompression | investigated by Tongaat Hulett Sugar South Africa Limited (Peacock 2002) to upgrade the waste heat streams off the evaporative crystallisers to a usable waste heat stream. The following conclusions were drawn by the Tongaat Hulett Sugar South Africa Limited engineering team:<br>• **The technology is known to be problematic and prone to mechanical failures. A competitor of Tongaat Hulett Sugar South Africa Limited in South Africa have tested mechanical vapour recompression and subsequently decommissioned the technology due to maintenance failures.**<br>• **The current design of batch evaporative crystallisers at Refinery is not suitable for mechanical vapour recompression due to the high compression ratio required and the variable steam demand.**<br>• **The implementation of this technology would therefore also require replacing all the evaporative crystallisers with a highly specialised continuous evaporative crystallisers (the BMA VKT design).**<br>Due to the mechanical failure risks and the prohibitive capital cost this is not a plausible baseline scenario and would not be implemented by Tongaat Hulett Sugar South Africa Limited. |
| 4 b | Double Effect Evaporation | Following the pinch technology study the single effect evaporator was converted to a double effect by the addition of plate evaporators. Plate evaporators were selected based on the limited space constraints on the Refinery evaporator station. (Falling film and Roberts evaporators could not be accommodated in the existing building.)<br><br>The plate evaporator system has failed mechanically on two occasions (Hulett's Refinery Energy Audit Report, 2010, Page 16). The first failure was stress cracking corrosion and was overcome by replacing the stainless steel plates with Titanium at large cost to Tongaat Hulett Sugar South Africa Limited. The second failure was the embrittlement and leaking of the gaskets. This technical problem has not been resolved despite multiple visits from the supplier. The refinery therefore reverted to single effect evaporation. (The plate evaporators are still in place but have been disconnected.) |

| | | |
|---|---|---|
| | | Tongaat Hulett has quantified the impact of bypassing the plate evaporators (Scharma 2008, Internal Memorandum). Reinstating the equipment would give approximately 4 tonnes of steam per hour with a financial saving of R2.3 million. It is noted that this is very small compared to the proposed project savings that would be in excess of 65 tonnes of steam per hour.<br><br>Falling film evaporation has been recognised as a more suitable technology for the Refinery. (This technology will also be used in the proposed project). However, the implementation of double effect falling film evaporation requires the construction of a new evaporation station and dedicated buildings and long runs of large bore vapour piping. The estimated cost of this installation was in excess of R19 million, which is prohibitive considering the small steam savings that would be achieved. Therefore Tongaat Hulett decided to continue to focus its energy saving activities on the evaporative crystallisers where the potential for significant energy savings lay.<br><br>In conclusion the implementation of double effect evaporation in isolation at the Refinery is not commercially attractive and therefore has been eliminated as a plausible baseline option. |
| 4 c | Utilising continuous pans and/or double effect pan boiling. | Tongaat Hulett Sugar South Africa Limited pioneered the development of continuous pan (evaporative crystalliser) technology in the cane sugar industry. (See marketing brochure). Despite the huge success of this technology in raw sugar applications, there has been little uptake by refineries.<br><br>Continuous evaporative crystallisation coupled with double effect pan boiling is a technique that if viable could yield significant steam efficiency improvements for the Refinery (Peacock, Schorn 2009). This would also be a first-of-its kind technology and there are significant technical barriers to entry.<br><br>A recent feasibility study to install a continuous pan at Refinery to be R41.6 million was carried out (A Authar, 2012). Based on the high capital cost and risks associated with this technology, this approach has been abandoned. |

| | | |
|---|---|---|
| | | Therefore continuous pans and double effect pan boiling have been eliminated as plausible alternative baselines. |
| 5 a | Higher Efficiency Boilers | The boilers are currently is good working order, with the large high pressure boilers operating in excess of 86% efficiency. Any further efficiency gains would be negligible for the capital cost associated with the installation of higher efficiency boilers and as such this is not a plausible baseline scenario as it would not be implemented by Tongaat Hulett Sugar South Africa Limited. This is also not practised by the sugar industry in South Africa. |
| 5 b | Gas boilers to replace coal boilers | This option has been investigated by Tongaat Hulett Sugar South Africa Limited with the conclusion that the gas supply is still too far away (over 5km) and the cost of installing both gas fired boilers and the associated gas supply line would be prohibitive from a cost basis. The fact that the current coal boilers are also in good working order, makes this a non plausible baseline scenario as it would not be implemented by Tongaat Hulett Sugar South Africa Limited. This is also not practised by the sugar industry in South Africa. |
| 6 | Investment by a third party | This is not applicable to Tongaat Hulett Sugar South Africa Limited as they currently produce refined white sugar. It is not feasible for a third party to produce the same output.<br><br>This is therefore not a plausible baseline scenario. |
| 7 | Continuation of current practise without maintenance | This is not applicable as it is a working refinery that requires ongoing maintenance due to the mechanical nature of the installation.<br><br>This is not a feasible baseline scenario. |

It is clear that Refinery has exhausted all the avenues for improving its energy efficiency through detailed investigation and implementations. This is shown through the project history timeline shown below. It must be noted that the refinery itself is an old installation (built 1950's) with equipment design and spatial constraints that adversely affect the ability to implement incremental energy efficiency improvements. This is common practise in process plants around the world, where modern plants become more efficient than the older ones, not only because of technology, but also because of layout and the physical spatial ability to install new technology. (A User Guide on Process Integration for the Efficient Use of Energy by Linnhoff et al., and published by The British Institution of Chemical Engineers)

| **Project Milestone** | **Completion** | **Description** |
|---|---|---|
| Initial Energy Audit reviewed Progress | 2010 | Improvements noted, but Panhouse recognised as primary obstacle for further improvements (page 17). |
| Project GNU, to investigate the | March 2012 | |

| | | |
|---|---|---|
| application of cooling crystallisation at Refinery commenced. | | |
| Terra Firma Solutions engaged to investigate the potential for carbon revenue streams | 12 June 2012 | |
| GREEN Refining Technology Patent Application | August 2012 | Jensen and Love, Aug 2012. |
| Proposal made to the board for a demonstration plant. | 25 Sept 2012 | Board not willing to approve project due to concerns regarding risk of applying a world-first refining technology. |
| Budget approval for demonstration plant (expected) | November 2012 | Assuming that the technical risk concerns have been adequately addressed. |
| Demonstration plant commissioning | June 2013 | |
| Approval for phase 1 | October 2013 | |
| Phase 1 commissioning | October 2014 | |
| Approval for phase 2 | July 2015 | |
| Phase 2 commissioning | July 2016 | |

It is noted in the Hulett's Refinery Energy Audit Report of 2010 on page 17 that

"For a number of years it has been recognised that a primary obstacle to the improvement of energy efficiency at HR is the behaviour of the white pan house and its interaction with the boiler station. Most of the steam demand at the refinery is used in the five white house pans."

It is clear that the only remaining opportunity for energy efficiency is the first-of-its-kind project proposed, but due to the first-of-its-kind project definition and inherent risks the Tongaat Hulett Sugar South Africa Limited Board is reluctant to proceed, making the baseline scenario the continuation of the current situation.

***Step 1b – Consistency with mandatory applicable laws and regulations***

This step is used to analyse each alternative scenario and to ensure that it complies with all mandatory applicable laws and regulations in the region.

All of the above indentified alternatives scenarios are in full compliance with all mandatory and applicable legal requirements in South Africa.

The applicable laws and regulations are as follows:

- Occupational Health and Safety Act (Act 85 of 1993)3
- Scheduled trade permit from EThekwini Health governing emissions from the refinery
- Site permit to discharge trade effluent delivered by road haulage to an approved municipality facility from EThekwini Water and Sanitation
- Site permit to discharge trade effluent into the municipal sewer from EThekwini Water and Sanitation
- Site permit to extract river water

3 https://www.labour.gov.za/legislation/acts/occupational-health-and-safety/occupational-health-and-safety-act-and-amendments

- National Environmental Management Act (Act 107 of 1997)4, including
  - Air Quality
  - Waste
- SARS Income Tax Rebates for energy efficiency[5]
- Department of Trade and Industry Rebates for Manufacturing Competitive Enhancement [6]

Tongaat Hulett Sugar Limited is currently within all the required levels for emissions, effluent and water extraction. There are currently no local legally binding policies that prohibit any of the alternative scenarios or the identified baseline scenario.

The rebates offered through both SARS and the DTI are not significant (approximately R15 million for tax incentives) when compared to the capital requirements (approximately R300 million) and can only be claimed should the project be implemented. These rebates do not force the project owner to implement the project.

***Step 2: Barrier Analysis***

This step serves to identify barriers and to assess which alternative scenarios are prevented by these barriers. The latest approved version of the guidelines for objective demonstration and assessment of barriers was used in this analysis.

| Alternative Scenario | Identified Barriers |
|---|---|
| Proposed Project is undertaken without being registered as a CDM project activity | **First-of-Its-Kind Barrier**<br>As per the assessment above the proposed project is a first-of-its-kind technology and the first-of-its-kind barrier is therefore applied. |
| The continuation of the current scenario of evaporative crystallization | The refinery has been operating under these conditions for over 60 years and as such no barriers are indentified that prevent the current practise of the refinery from continuing. |

As the only remaining alternative as a result of the significant business risks associated with implementing a first of its kind technology at a crucial business installation is the continuation of current practise and the baseline scenario. The project is clearly a first of its kind and as such the project is clearly additional and as such no further analysis of additionality is required.

**B.6. Emission reductions**

**B.6.1. Explanation of methodological choices**
>>

**Baseline Emissions as per AM0018**

4 http://www.acts.co.za/ntl_enviro_man/index.htm
[5] http://www.cmvpsa.org.za/ee_incentives.aspx
[6] http://www.thedti.gov.za/financial_assistance/financial_incentive.jsp?id=53&subthemeid=25

The baseline Specific Steam Consumption Ratio (SSCR) is determined using the following 3 Steps:

Step 1: Determine the baseline production output benchmark;

Step 2: Determine the baseline steam consumption benchmark;

Step 3: Determine the baseline Process Specific Steam Consumption Ratio (SSCR).

The SSCR is calculated for a normal production range; that is production that falls within +-5% of nameplate production. Any steam consumption or production values that fall outside of this range are removed from the calculation of the baseline SSCR as required by the approved appropriate methodology.

The baseline SSCR was calculated based on a period of one year's production and steam consumption. (October 2011 to September 2012). The baseline is developed based on the following key assumptions and rationales:

- The rated nameplate output capacity of the refinery is 86.8 tonnes of refined white sugar per hour.
- The refinery runs three 8 hour shifts per day and operates continuously. There is no batch production of refined white sugar.

**Step 1: Determine the baseline production output benchmark**

A representative daily production figure ($P_{rep,BL,d}$) is calculated based on historical production data for each shift ($P_{1,BL,s}$, $P_{2,BL,s}$, $P_{3,BL,s}$).

The production figures of $P_{1,BL,s}$, $P_{2,BL,s}$, $P_{3,BL,s}$ given in Equation (1) below should be selected based on the normal production range of rated plant capacity.

$$P_{rep,BL,d} = \frac{P_{1,BL,s} + P_{2,BL,s} + P_{3,BL,s}}{n_d} \times A \qquad (1)$$

Where:

| | | | |
|---|---|---|---|
| $P_{rep,BL,d}$ | = | Representative historical average production for a day *d* (Mass unit of tonnes of refined white sugar produced) | Calculated |
| $P_{1,BL,s}$, $P_{2,BL,,s}$….$P_{n,BL,s}$ | = | Baseline production output per shift of refined white sugar (Measured in tonnes of refined white sugar) | Taken from October 2011 to September 2012 values |
| A | = | Maximum number of shifts/day or in the baseline | A = 3 |
| $n_d$ | = | Number of shifts in operation for each day | $n_d$ =3 from plant data. If plant is closed for part of a day then partial shifts are excluded. |

Production data points that fall outside the normal production range (outside of ± 5% of the nameplate capacity of the refinery) will be excluded from the calculation as per page 4 of AM0018 Version 03.0.0

**Step 2: Determine the baseline steam consumption benchmark**

The specific steam consumption for the baseline is determined from historical steam consumption data that correspond to the representative production figures determined in Step 1. Production data points that fall outside the normal production range (outside of ± 5% of the nameplate capacity of the refinery) will be excluded from the calculation as per page 4 of AM0018 Version 03.0.0

$$S_{rep,BL,d} = \frac{S_{1,BL,s} + S_{3,BL,s} + S_{1,BL,s}}{n_d} \times A \qquad (2)$$

Where:

| | | | |
|---|---|---|---|
| $S_{rep,BL,d}$ | = | Representative steam consumption for a day that correspond to $P_{rep,BL,d}$ (Mass unit of tonnes steam consumed) | Calculated |
| $S_{1,BL,s}$ $S_{2,BL,s}$….$S_{n,BLs}$ | = | Historical steam consumption figures per shift for the steam generated for the white sugar refinery only, that correspond to $P_{1,BL,s}$, $P_{2,BL,s}$ ….$P_{n,BL,s}$ (Mass unit of tonnes of steam consumed) | Taken from October 2011 to September 2012 values |
| A | = | Maximum number of shifts/day for the operation for the historical period | A = 3 |
| $n_d$ | = | Number of shifts in operation for each day | $n_d$ =3 from plant data. If plant is closed for part of a day then partial shifts are excluded. |

**Step 3: Determine the baseline Process Specific Steam Consumption Ratio (SSCR)**

The SSCR is determined by the ratio of above two parameters.

$$SSCR_{BL,d} = \frac{S_{rep,BL,d}}{P_{rep,BL,d}} \quad (3)$$

Where:

| | | |
|---|---|---|
| $SSCR_{BL,d}$ | = | Daily -wise specific steam consumption ratio of the day in the baseline (tonnes of steam/tonne of refined white sugar of production) |
| $S_{rep,BL,d}$ | = | Representative steam consumption for the day *d* in the baseline (tonnes) supplied to the white sugar refinery only. |
| $P_{rep,BL,d}$ | = | Representative production for the day *d* in the baseline (tonnes of refined white sugar) |

The daily values for SSCR estimated using data for a month (except in cases where seasonal variations exist, then data for a full year is used) are averaged to arrive at baseline SSCR. There are seasonal variations in production of refined white sugar, energy usage or equipment performance at the white sugar refinery and as such a year's values was used a representative sample.

The table in appendix 4 shows the production values and SSCR used in the baseline calculation.

$$SSCR_{avg,BL} = \frac{\sum_{d=1}^{d=D_w} SSCR_{BL,d}}{D_w} \quad (4)$$

Where:

| | | | |
|---|---|---|---|
| $SSCR_{avg,BL}$ | = | Average daily specific steam consumption ratio in the baseline (tonnes of steam/tonne of refined white sugar of production) | |
| $SSCR_{BL,d}$ | = | Daily/batch-wise specific steam consumption ratio of the day in the baseline (tonnes of steam/tonne of refined white sugar of production) | |
| $D_w$ | = | Number of days in month or year, based on applicable historical data used for establishing the specific steam consumption ratio | = total days in period |

**Procedure to determine the baseline SSCR ($SSCR_{BL}$) for days when the production falls outside the normal production range (i.e. above or below 5% of verifiable nameplate capacity)**

As per the methodology AM0018, the number of days for which the historical production falls outside the normal production range, must not exceed 10% of the plant operating days in the year or period chosen for the baseline SSCR determination.

If the number of days for which the historical production falls outside the range are more than 10%, the following procedure should be used for allocating SSCR for the days when the historical baseline production falls outside the +/-5% production range. The number of days in August 2012 was 45%; therefore the following procedure was used.

Where a month's data is used, the lowest SSCR figure calculated for the month should be allocated to each day for the month where production falls outside the normal production range;

The average of the daily SSCR figures for the month for the baseline was calculated after allocating the SSCR for the days when production fell outside the normal range. The table in Annex 4 describes the calculation of the baseline SSCR. The column label adjusted SSCR shows the daily value used when production falls outside of the normal range. ,

Project Emissions as per AM0018

The project SSCR value is estimated using the following Steps:

Step 5: Determine representative production output;

Step 6: Monitor steam consumption;

Step 7: Determine average steam consumption;

Step 8: Determine the Specific Steam Consumption Ratio for the day;

Step 9: Estimate $CO_2$ emissions due to additional electricity consumption in project scenario;

Step 10: Estimate $CO_2$ emissions due to additional steam/ fuel consumption in project scenario.

Actual output ($P_{act,PR}$) will be monitored for each shift during the crediting period. For the purposes of the ex ante emissions reduction estimation calculations, the representative production output used, is a three year historical average.

***Step 5: Determine representative production output***

The representative production output for the day or batch ($P_{rep,\,PR,d}$) is determined by selecting and averaging the representative production figures (i.e. within the normal production range, as described in the baseline section above).

$$P_{rep,PR,d} = \frac{P_{1,PR,s} + P_{2,PR,s} + P_{3,PR,s}}{m_d} \times A \quad (5)$$

Where:

| | | | |
|---|---|---|---|
| $P_{rep,PR,d}$ | = | Representative production output for the day (tonnes of refined white sugar produced) | Calculated based on three year historical values and a 47 week operational year |
| $P_{1,PR,s}$, $P_{2,PR,s}$….$P_{m,PR,s}$ | = | Shift production output figures for project scenario (Mass or volume unit) | Monitored throughout the crediting period |
| A | = | Maximum number of shifts/day or during crediting period | 3 |
| $m_d$ | = | Number of shifts in operation for each day | Monitored throughout the crediting period |

***Step 6: Monitor steam consumption***

Steam consumption is monitored continuously using temperature and pressure meters that are connected to the DCS system. The Daily Refinery Performance Report will include shift steam generation and consumption (of both fructose by measurement and white sugar refinery by difference)

***Step 7: Determine average steam consumption***

Average shift steam consumption rate for the day ($S_{rep,PR,d}$) is determined by selecting and averaging the steam consumption rate figures that correspond to the representative production output. The following equation will be used to determine average steam consumption.

$$S_{rep,PR,d} = \frac{\left(S_{1,PR,s} + S_{2,PR,s} \ldots\ldots + S_{m,PR,s}\right)}{m_d} \times A \quad (6)$$

Where:

| | | | |
|---|---|---|---|
| $S_{rep,PR,d}$ | = | Representative steam consumption of the white sugar refinery for a day that correspond to $P_{rep,PR,d}$ (in tonnes of steam) | Calculated based on three year historical values and a 47 week operational year and the energy saving from technical feasibility study |
| $S_{1,PR,s}$ $S_{2,PR,s}$….$S_{m,PRs}$ | = | Historical steam consumption figures of the white sugar refinery per shift that correspond to $P_{1,PR,s/b}$, $P_{2,PR,s}$ ….$P_{m,PR,s}$ (in tonnes of steam) | Monitored throughout the crediting period |
| A | = | Maximum number of shifts/day or batches/day for the operation for the historical period | A = 3 |
| $m_d$ | = | Number of shifts in operation for each day | Monitored throughout the crediting period |

The steam consumption of the white sugar refinery will be calculated as a difference sum between the steam generated and the steam sold to the fructose plant. The following formula will be used:

$$S_{m,PR,s} = SG_{m,PR,s} - SF_{m,PR,s} \quad (6.1)$$

Where

| | | |
|---|---|---|
| $S_{m,PR,s}$ | Historical steam consumption figures of the white sugar refinery per shift **in tonnes of steam** | **Continuously calculated during the crediting period** |
| $SG_{m,PR,s}$ | Historical steam generation figures of the boilers per shift in tonnes of steam | Continuously monitored during the crediting period |
| $SF_{m,PR,s}$ | Historical steam consumption figures of the fructose per shift in tonnes of steam | Continuously monitored during the crediting period |

***Step 8: Determine the Specific Steam Consumption Ratio for the day***

The Specific Steam Consumption Ratio is determined by the ratio of the two parameters calculated above.

$$SSCR_{PR,d,y} = \frac{S_{rep,PR,d}}{P_{rep,PR,d}} \quad (7)$$

Where:

| | | |
|---|---|---|
| $SSCR_{PR,d,y}$ | = | Specific Steam Consumption Ratio for the project activity for day *d* in year *y* |
| $S_{rep,PR,d}$ | = | Representative steam consumption for the day, corresponding to $P_{rep,PR,d}$ (tonnes of steam) |
| $P_{rep,PR,d}$ | = | Representative production output for the day (tonnes of refined white sugar) |

**Procedure to determine $SSCR_{PR,d,y}$ for days where the production falls outside normal production range (i.e. the production rate is above or below 5% of verifiable nameplate capacity)**

Tongaat Hulett Sugar South Africa Limited currently has no plans to modify the design of the refinery in order to permanently increase nameplate production capacity, but should the production fall outside of the nameplate capacity range; the following procedure will be adhered to.

**Option 1**

If the daily production output intermittently falls outside the normal production range for less than 10% of the operating days in the year and design modifications are not required in the plant or process to meet the extra production capacity. The following procedure should be used for allocating SSCR ($SSCR_{PR,d,y}$) under project activity for the days when the production falls outside the range.

(1) Maximum SSCR figure for the month will be allocated to each day of the particular month when the production falls outside the normal range;

(2) When the SSCR falls outside the range for every day of the month, the maximum SSCR figure for the year should be allocated to every day/batch of that particular month.

Note that the maximum number of days where the production can fall outside the range under this Option is 36 days (10% of the days in a year). Should this case occur, then option 2 of the methodology will be used.

**Option 2**

If the daily plant production rate falls outside of the +-5% of verifiable nameplate capacity, the following procedure will be used:

If the daily production figure falls outside the normal production range for more than 10% of the operating days in the year and design modifications are not required in the plant or process to meet the extra production capacity.

(1) For a plant that consistently operates at rates higher than the normal production range rates, the nameplate capacity will be re-verified. Based on the re-verified nameplate capacity, the normal production range (higher and lower limits of +/-5%) will be defined. The SSCR figure for the crediting period will be estimated based on the new nameplate production capacity by applying the procedure described in this methodology;

(2) If the plant consistently operates at rates lower than the normal production range, the SSCR figure for the crediting period should be determined as per Option-1. As per the baseline

production figures used, this is the anticipated scenario as production only fell below the nameplate capacity during the baseline period.

(3) Where feasible, estimate the SSCR by drawing the characteristic curve for SSCR vs. production output in the baseline and extrapolating the curve to derive the SSCR figure for the new production rate in the project scenario. This Step can be implemented by project proponents in one of the following ways:

- Before implementation of the project i.e. in baseline, if it is envisaged that production will increase above or decrease below the normal range during the crediting period; or
- During the crediting period after removing the modifications installed under CDM project activity and operating the plant with expanded production quantities.

If available, the most relevant and updated manufacturer's specifications for the unit/ system can be used to determine the SSCR for the new production rates achieved.

(4) The baseline SSCR for increased or decreased production is determined from the SSCR vs. production characteristic curve or the most relevant up to date manufacturer's specifications;

(5) If a plant re-verified its higher production capacity and subsequently operates at lower production range (which is below the normal range of the new (re-verified) capacity), the procedure under Option-1 should be followed to allocate the SSCR figures for the days/batches when production was outside the normal range.

**Option-3:** If the production capacity is expanded permanently by implementing modifications to the process plant or design to meet the additional production capacity.

For the scenario where the plant production capacity is modified without affecting the CDM project activity, the following Steps must be considered:

(1) Re-verification of nameplate capacity should be done and the new normal production range of +/-5% should be defined. The SSCR figure for the crediting period can be estimated based on the new nameplate production capacity by applying the procedure described in the methodology;

(2) If possible and where it is practical to disconnect the modifications installed under the CDM project activity, the plant should be operated within the normal range of the new production capacity at least for one month to collect the data of steam consumption and baseline SSCR;

(3) The average SSCR figure for the baseline should be determined from the new production run as described in Step 2.

***Step 9: Estimate $CO_2$ emissions due to additional electricity consumption in project scenario***

It is expected that there will be a small decrease in the electricity generated by the backpressure turbines in the facility with the average generation reducing from 5.8MW to 4.7MW, however there is also expected to be a net reduction in electricity consumed by the white sugar refinery. The electricity generated prior to the implementation of the project activity as well as the electricity imported from the grid has been measured and the baseline specific grid electricity consumption has been calculated and documented in Appendix 4. It is not expected that there will be any increase in specific electricity generation and as such for the estimated project emissions used in the ex ante calculation of emission reductions is 0.

The grid electricity imported during the project activity will be measured for year y and

**If** $$\frac{EG_{tur,BL} + EC_{grid,BL} - EC_{fructose,BL}}{P_{act,BL}} < \frac{EG_{tur,PR,y} + EC_{grid,PR,y} - EC_{fructose,PR,y}}{P_{act,PR,y}}$$

Then the project emissions will be estimated using the below referenced tool for the additional electricity which is estimated as follows:

$$EC_{PJ,y} = \left(\frac{EG_{tur,PR,y} + EC_{grid,PR,y} - EC_{fructose,PR,y}}{P_{act,PR,y}} - \frac{EG_{tur,BL} + EC_{grid,BL} - EC_{fructose,BL}}{P_{act,BL}}\right) \times P_{act,PR,y} \quad (8)$$

$\frac{EG_{tur,BL} + EC_{grid,BL} - EC_{fructose,BL}}{P_{act,BL}}$ will be calculated ex ante and fixed for the crediting period unless the nameplate capacity of the refinery increases. In such a case, the specific electricity consumption, or $SE_{avg,BL,}$ will be recalculated.

The project emissions from the electricity consumption will be calculated using with the **"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"**, the emission factor used will be calculated emission factor that is fixed ex-ante as per the methodology and the latest Tool to calculate the emission factor for an electricity system" version 02.2.1.

$$PE_{EC,y} = EC_{PJ,y} \times EF_{grid,CM,y} \quad (8.1)$$

Where:

| | | |
|---|---|---|
| $EC_{PJ,y}$ | = | Quantity of additional electricity consumed by the project activity in year *y* (MWh/yr) |
| $EG_{Tur,PR,y}$ | = | Anticipated quantity of electricity generated by the turbines in year *y* (MWh/yr) |
| $EC_{grid,PR,y}$ | = | Anticipated quantity of grid connected electricity consumed during the year immediately preceding the implementation of project activity (MWh/yr) |
| $EC_{fructose,PR,y}$ | | Anticipated quantity of electricity consumed during the year immediately preceding the implementation of project activity by the fructose plant (MWh/yr) |
| $P_{act,BL}$ | = | The relevant annual production output from the process unit or system where |

| | | |
|---|---|---|
| | | steam is optimised that was produced during the year immediately preceding the implementation of project activity for the same production stream which is used for estimation of baseline SSCR (tonnes of refined white sugar) |
| $P_{act,PR,y}$ | = | The relevant annual production output from the white sugar refinery or system where steam is optimised in year *y* (tonnes of refined white sugar) |
| $EF_{grid,CM,y}$ | = | Grid emission factor as calculated using the **Tool to calculate the emission factor for an electricity system. Version 02** and fixed ex ante at 0.94t$CO_2$e per MWh. Details in Annex 4. |
| $PE_{EC,y}$ | = | Project emissions from the additional consumption of grid connected electricity that is due to the project |

***Step 10: Estimate $CO_2$ emissions due to additional steam/ fuel consumption in project scenario***

No additional steam/fuel consumption is expected in the project scenario.

The equipment to be installed during the project activity will be new equipment specially fabricated for the project and as such no leakage emissions will occur.

No existing equipment will be scrapped or sold as a result of the project and as such no leakage emissions occur.

No additional fuel will be required for the project activity and as such there will be no additional transportation requirements and associated leakage emissions.

**Emission Reductions**

Emission reduction value is estimated using the following Steps:

Step 11: Estimate the difference in SSCR for the baseline and project scenarios;

Step 12: Estimate net daily reduction in steam consumption;

Step 13: Estimate net daily reduction in energy due to reduction in steam consumption;

Step 14: Estimate daily reduction in input energy to the boiler;

Step 15: Estimate $CO_2$ emission reductions in the boiler per day;

Step 16: Estimate the net $CO_2$ emission reductions due to project.

**Step 11: Estimate the difference in SSCR for the baseline and project scenarios**

$$SSCR_{diff,d,y} = SSCR_{avg,BL} - SSCR_{PR,d,y} \quad (9)$$

**Where:**

| | | |
|---|---|---|
| $SSCR_{diff,d,y}$ | = | Daily difference in SSCR for the baseline and project scenarios (Tonnes of steam/Tonnes of refined white sugar) |
| $SSCR_{avg,BL}$ | = | Annual average Specific Steam Consumption Ratio in the baseline (Tonnes of steam/Tonnes of refined white sugar) |
| $SSCR_{PR,d,y}$ | = | Daily Specific Steam Consumption Ratio for the project activity (Tonnes of steam/Tonnes of refined white sugar) |

**Step 12: Estimate net daily reduction in steam consumption**

$$S_{net,d,y} = SSCR_{(diff,d,y)} \times P_{act,PR,d} \tag{10}$$

Where:

| | | |
|---|---|---|
| $S_{net,d,y}$ | = | Net reduction in steam consumption during the day *d* (tonnes of steam per day) |
| $SSCR_{diff,d,y}$ | = | Difference in SSCR for baseline and project scenarios (Tonnes of steam/Tonnes of refined white sugar) |
| $P_{act,PR,d}$ | = | Actual production figure from the process unit or system where steam is optimised during the day d (tonnes of refined white sugar) |

If the actual production for the plant is above the normal production range use the following equation:

**If** $P_{act,PR,d} > P_{nameplate}$

**Then** $P_{act,PR,d} = P_{nameplate}$ (11)

Where:

| | | |
|---|---|---|
| $P_{act,PR,d}$ | = | Actual production figure from the process unit or system where steam is optimised during the day d (Mass of refined white sugar in tonnes) |
| $P_{nameplate}$ | = | Baseline nameplate daily (per shift) production capacity of the process |

**Step 13: Estimate the net daily reduction in energy due to reduction in steam consumption**

$$E_{net,d} = S_{net,d} \times \sum_{n} \frac{S_{n,d}}{S_{tot}} E_{n,s,d} \tag{12}$$

Where:

| | | |
|---|---|---|
| $E_{net,d}$ | = | Net reduction in steam energy consumption per day (kJ) |
| $S_{net,d}$ | = | Net reduction in steam consumption per day (tonnes of steam) apportioned to the low and high pressure boilers according to the steam generation percentages of each |
| $E_{n,s,d}$ | = | Net enthalpy of steam at the boiler n outlet (or kJ/kg of steam) |
| $S_n$ | = | Total steam generated in day d by boiler n |
| $S_{tot}$ | = | Total steam generated in day d by all boilers |

$$E_{n,s,d} = E_{n,tot,d} - E_{n,fw,d} \tag{13}$$

Where:

| | | |
|---|---|---|
| $E_{n,s,d}$ | = | Net enthalpy of steam at the boiler n outlet (kJ/kg of steam) |
| $E_{n,tot,d}$ | = | Total enthalpy of steam at the boiler n outlet (kJ/ kg of steam) |
| $E_{n,fw,d}$ | = | Enthalpy of feed water to boiler n (kJ/kg of water) |

**Step 14: Estimate daily reduction in input energy to the boiler**

$$E_{in,d} = \left(\frac{E_{net,d}}{\eta_b}\right) \quad (14)$$

Where:

| | | |
|---|---|---|
| $E_{in,d}$ | = | Energy input in boiler (kJ) |
| $E_{net,d}$ | = | Net reduction in steam energy consumption per day (kJ) |
| $\eta_b$ | = | Efficiency of boiler, to be monitored periodically by direct method. The higher of the baseline and monitored boiler efficiency will be used. |

**Step 15: Estimate $CO_2$ emission reductions ($ER_D$) in the boiler per day**

$$ER_D = E_{in,d} \times CEF_{fuel} \times H_{fuel,d} \quad (15)$$

Where:

| | | | |
|---|---|---|---|
| $ER_D$ | = | $CO_2$ emission reductions in the boiler per day (t $CO_2$) | |
| $E_{in,d}$ | = | Energy input into boiler (kJ) | |
| $CEF_{fuel}$ | = | Carbon emission factor for fuel (t $CO_2$/kJ) | Will be measured continuously throughout the year using coal supply records that show carbon content of fuel |
| $H_{fuel,d}$ | = | Share of energy supplied by each type of fuel consumed per day (%) | Only coal will be used, therefore 100% |

**Step 16: Estimate the net $CO_2$ emission reductions due to project**

$$ER_y = \sum ER_D - PE_{EC,y} \quad (16)$$

Where:

| | | | |
|---|---|---|---|
| $ER_y$ | = | Emission reductions due to the project activity in the year *y* (t $CO_2$ ) | |
| $ER_D$ | = | $CO_2$ emission reductions in the boiler per day (t $CO_2$/day) | |
| $PE_{EC,y}$ | = | Project emissions due to additional electricity consumption as a result of project activity (t $CO_2$) | |
| *D* | = | Day in the project year, for which project data is collected and emission reduction is estimated | |

### B.6.2. Data and parameters fixed ex ante

| Data / Parameter | $P_{1,BL,s}$, $P_{2,BL,s}$,….$P_{n,BL,s}$ |
|---|---|
| Unit | Mass unit of tonnes of refined white sugar |
| Description | Baseline production output per shift that will be measured in the year immediately preceding the project implementation |
| Source of data | Daily Refinery Performance Report |
| Value(s) applied | October 2011 to September 2012 |
| Choice of data or Measurement methods and procedures | The production in the refinery is seasonal and a year's production data was chosen as a representative sample. The period Oct 2011 to Sept 2012 was chosen as it is was the most recent at time of calculation.<br>The production figures are measured by two white sugar scales that are found at the end of the white sugar production process. |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | The procedure for removing production output values that are outside of the norm (based on +/-5% of nameplate capacity) was applied to the representative figures. Should the baseline be re-estimated based on new production and steam consumption values for increased production scenarios, the required procedure as per the methodology will be used. |

| Data / Parameter | A |
|---|---|
| Unit | - |
| Description | Maximum number of shifts/day in the baseline |
| Source of data | Plant data from Daily Refinery Performance Report |
| Value(s) applied | 3 |
| Choice of data or Measurement methods and procedures | The refinery runs a maximum of three 8 hour shifts per day as per historical records and plant operating procedures. |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | |

| Data / Parameter | $n_d$ |
|---|---|
| Unit | |
| Description | Number of shifts in operation for each day "d" |
| Source of data | Plant data from Daily Refinery Performance Report |
| Value(s) applied | 3 |
| Choice of data or Measurement methods and procedures | The refinery runs a maximum of three 8 hour shifts per day as per historical records and plant operating procedures. |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | |

| | |
|---|---|
| **Data / Parameter** | $S_{1,BL,s}$, $S_{2,BL,s}$,….$S_{n,BL,s}$ |
| **Unit** | Mass unit of steam in tonnes being used by the white sugar refinery |
| **Description** | Historical steam consumption figures per shift that correspond to $P_{1,BL,s}$, $P_{2,BL,s}$ ….$P_{n,BL,s}$ |
| **Source of data** | Plant data based on the difference between daily steam generation and steam consumption of the fructose plant as shown on the Daily Refinery Performance and Daily Fructose Performance Reports |
| **Value(s) applied** | October 2011 to September 2012 – Table in Appendix 4 |
| **Choice of data or Measurement methods and procedures** | The steam consumption of the refinery for the period, measured by difference between the output of the boiler system and supply to fructose using temperature and pressure meters connected to the DCS system. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $SG_{1,BL,s}$, $SG_{2,BL,s}$,….$SG_{n,BL,b}$ |
| **Unit** | Mass unit of tonnes steam being generated by the boilers in the baseline period |
| **Description** | Historical steam generation figures per shift that correspond to $P_{1,BL,s}$, $P_{2,BL,s}$ ….$P_{n,BL,s}$ |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | October 2011 to September 2012 Table in Appendix 4 |
| **Choice of data or Measurement methods and procedures** | The steam generation of the refinery for the period, measured at the output of the boilers using temperature and pressure gauges that are connected to the DCS system and recorded on Daily Refinery Performance Report. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | This figure will be compared to the steam generated by the boilers during the project activity to ensure that the steam reduced by the optimisation results in a equal steam reduction at the boiler generation side |

| | |
|---|---|
| **Data / Parameter** | $SF_{1,BL,s}$, $SF_{2,BL,s}$,….$SF_{n,BL,b}$ |
| **Unit** | Mass unit of tonnes steam being consumed by the fructose plant in the baseline period |
| **Description** | Historical steam generation figures per shift that correspond to $P_{1,BL,s}$, $P_{2,BL,s}$ ….$P_{n,BL,s}$ |
| **Source of data** | Plant data from Daily Fructose Performance Report |
| **Value(s) applied** | October 2011 to September 2012 Table in Appendix 4 |
| **Choice of data or Measurement methods and procedures** | The steam consumption of the fructose plant for the period, measured at the input of the fructose plant using temperature and pressure gauges that are connected to the DCS system and recorded on the Daily Fructose Performance Report. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $D_w$ |
| **Unit** | - |
| **Description** | Number of days in year, based on applicable historical data used for establishing the specific steam consumption ratio |
| **Source of data** | Plant data |
| **Value(s) applied** | 366 |
| **Choice of data or Measurement methods and procedures** | Days in baseline period where production took place. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $P_{nameplate}$ |
| **Unit** | Mass in tonnes of refined white sugar per shift |
| **Description** | Baseline nameplate daily (per shift) production capacity of the white sugar refinery |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 694.4 tonnes of sugar per shift |
| **Choice of data or Measurement methods and procedures** | The refinery has a designed capacity of 86.8 tonnes of sugars output per hour and an 8 hour shift, totalling the above nameplate production mass. This is shown in the internal report by Rein in 1986 |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $P_{act,BL}$ |
| **Unit** | Mass of refined white sugar in tonnes |
| **Description** | The relevant annual production output from the process unit or system where steam is optimised that was produced during the year immediately preceding the implementation of project activity for the same production stream which is used for estimation of baseline SSCR |
| **Source of data** | Plant data from the Daily Refinery Performance Report |
| **Value(s) applied** | October 2011 to September 2012 - 548635 tonnes |
| **Choice of data or Measurement methods and procedures** | The production figures for the refinery were measured onsite using calibrated sugar scales at the output of the white sugar refinery and recorded at the refinery. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | - |

| | |
|---|---|
| **Data / Parameter** | $EC_{grid,BL}$ |
| **Unit** | MWh/yr |

| | |
|---|---|
| **Description** | Quantity of grid electricity that was consumed by the whole site during the year immediately preceding the implementation of project activity |
| **Source of data** | Plant data from the Daily Refinery Performance Report |
| **Value(s) applied** | October 2011 to September 2012 – 18263 MWh |
| **Choice of data or Measurement methods and procedures** | Measured using a calibrated electricity meter installed at the facility. The electricity measurements are recorded, reported and stored at the refinery. The meter is located in the control room, with readings taken per shift by the operator and recorded on a spreadsheet. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $EC_{fructose,BL}$ |
| **Unit** | MWh/yr |
| **Description** | Quantity of grid electricity that was consumed by the fructose plant during the year immediately preceding the implementation of project activity |
| **Source of data** | Plant data from the Monthly Fructose Electricity Bills |
| **Value(s) applied** | October 2011 to September 2012 – 336 MWh |
| **Choice of data or Measurement methods and procedures** | Measured using a calibrated electricity meter installed at the facility. The electricity measurements are recorded, reported and stored at the refinery. The meter is located in the fructose sub distribution room, with readings taken monthly by the foreman and recorded on a spreadsheet. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $EG_{tur,BL}$ |
| **Unit** | MWh/yr |
| **Description** | Quantity of grid electricity that was generated by the electricity turbines during the year immediately preceding the implementation of project activity |
| **Source of data** | Plant data from the Daily Refinery Performance Report |
| **Value(s) applied** | October 2011 to September 2012 – 29941 MWh |
| **Choice of data or Measurement methods and procedures** | Measured using a calibrated electricity meters installed at the facility. The electricity measurements are recorded, reported and stored at the refinery. The meter is located in the control room, with readings taken per shift by the operator and recorded on a spreadsheet. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $\eta_{b,BL}$ |
| **Unit** | - |
| **Description** | Baseline efficiency of boiler, derived from independent tests. Highest efficiency of all boilers used as baseline boiler efficiency |
| **Source of data** | Independent third party tests |
| **Value(s) applied** | 86.56% |
| **Measurement methods and procedures** | Measured by an external third party. |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | - |

| | |
|---|---|
| **Data / Parameter** | $SSCR_{avg,BL}$ |
| **Unit** | Ratio |
| **Description** | Baseline Specific Steam Consumption Ratio |
| **Source of data** | Calculated as per measured and reported production and steam consumption values as described above in this section. |
| **Value(s) applied** | 1.368 |
| **Choice of data or Measurement methods and procedures** | Calculated as per methodology |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | Might need to be re-calculated as per the methodology should the nameplate production capacity of the refinery be increased permanently. |

| | |
|---|---|
| **Data / Parameter** | $SE_{avg,BL}$ |
| **Unit** | Ratio |
| **Description** | Specific Grid Electricity consumed by the white sugar refinery |
| **Source of data** | Calculated as per measured and reported refined white sugar production figures ( $P_{act,BL}$ ) and electricity consumption of the white sugar refinery calculated as $EC_{grid,BL} + EG_{tur,BL} - EC_{fructose,BL}$ |
| **Value(s) applied** | 0.09 MWh/tonne refined white sugar |
| **Choice of data or Measurement methods and procedures** | Calculated as per methodology |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | Might need to be re-calculated as per the methodology should the nameplate production capacity of the refinery be increased permanently. |

| | |
|---|---|
| **Data / Parameter** | $EF_{grid,CM,y}$ |
| **Unit** | $tCO_2e$ per MWh |

| | |
|---|---|
| **Description** | Grid emission factor for the year y |
| **Source of data** | Calculated as per the Tool to calculate the emission factor for an electricity system" version 02.2.1 and fixed ex ante. |
| **Value(s) applied** | 0.94 $tCO_2e$ per MWh |
| **Choice of data or Measurement methods and procedures** | Calculated as per the Tool to calculate the emission factor for an electricity system" version 02.2.1 and fixed ex ante. Detailed calculation to be found in Annex 4. |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | - |

**B.6.3. Ex ante calculation of emission reductions**
>>
The baseline emissions, project emissions and emission reductions was calculated as per the methodology described in B.4 and choices described in B.6.1.

As per AM0018, the following was used to estimate the project emissions and emission reductions.

**B.6.4. Summary of ex ante estimates of emission reductions**

| Year | Baseline emissions (t $CO_2$e) | Project emissions (t $CO_2$e) | Leakage (t $CO_2$e) | Emission reductions (t $CO_2$e) |
|---|---|---|---|---|
| 2014 | 65,852 | 28,922 | 0 | 36,930 |
| 2015 | 263,408 | 115,689 | 0 | 147,719 |
| 2016 | 263,408 | 115,689 | 0 | 147,719 |
| 2017 | 263,408 | 115,689 | 0 | 147,719 |
| 2018 | 263,408 | 115,689 | 0 | 147,719 |
| 2019 | 263,408 | 115,689 | 0 | 147,719 |
| 2020 | 263,408 | 115,689 | 0 | 147,719 |
| 2021 | 263,408 | 115,689 | 0 | 147,719 |
| 2022 | 263,408 | 115,689 | 0 | 147,719 |
| 2023 | 263,408 | 115,689 | 0 | 147,719 |
| 2024 | 197,556 | 86,767 | 0 | 110,789 |
| **Total** | 2,568,228 | 1,127,972 | 0 | 1,440,256 |
| **Total number of crediting years** | 10 years | | | |
| **Annual average over the crediting period** | 263,408 | 115,689 | 0 | 147,719 |

**B.7. Monitoring plan**

**B.7.1. Data and parameters to be monitored**

| **Data / Parameter** | $P_{1,PR,s}$, $P_{2,PR,s}$,….$P_{m,PR,s}$ |
|---|---|
| **Unit** | Mass of refined white sugar produced per shift in tonnes of refined white sugar |
| **Description** | Shift production output figures for project scenario |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 3 year historical average is used for ex-ante calculations. Table found in Appendix 4. An average of sugar production per shift is calculated using a 47 week year and 21 shifts per week |
| **Measurement methods and procedures** | Measurement: Using two sugar scales located at the end of the refining process<br>Data Type: Measurement<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Every shift aggregated daily and monthly |
| **QA/QC procedures** | Using an annually calibrated measuring device, complying to QA/QC procedures of plant. |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | The procedures described in AM0018 will be followed for selecting the production/ output values (based on +/-5% of nameplate capacity) and if the nameplate output capacity of the refinery changes. |

| | |
|---|---|
| **Data / Parameter** | $S_{1,PR,s}$, $S_{2,PR,s}$,….$S_{m,PR,s}$ |
| **Unit** | Tonnes of steam per shift consumed by the White Sugar Refinery during the project activity measured in tonnes of steam |
| **Description** | Shift steam consumption figures for the project that correspond to $P_{1,PR,s}$, ….$P_{m,PR,s}$ measured in tonnes |
| **Source of data** | Plant data from Daily Refinery Performance Report calculated as the difference between steam generated by the boilers and steam sold to the fructose plant |
| **Value(s) applied** | 3 year historical average is used for ex-ante calculations. Table found in Appendix 4. An average of steam consumption per shift is calculated using a 47 week year and 21 shifts per week and a reduction calculated based on the technical feasibility study |
| **Measurement methods and procedures** | Measurement: Calculation<br>Data Type: calculation (total steam generated – total steam sold to fructose)<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Per shift |
| **QA/QC procedures** | Calculated |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | As this is a cogeneration system it will be demonstrated that the steam generated for the White Sugar Refinery Business unit is reduced by the amount of steam saved in the Refined White Sugar Business Unit. |

| Data / Parameter | $SG_{1,PR,s}$, $SG_{2,PR,s}$,….$SG_{m,PR,s}$ |
|---|---|
| **Unit** | Mass unit of steam generated by the boiler system, measured in tonnes of steam |
| **Description** | Shift steam generation figures for the project that correspond to $P_{1,PR,s}$, ….$P_{m,PR,s}$ |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 3 year historical average is used for ex-ante calculations. Table found in Appendix 4. An average of steam generation per shift is calculated using a 47 week year and 21 shifts per week and a reduction calculated based on the technical feasibility study |
| **Measurement methods and procedures** | Measurement: Temperature and Pressure Meters located at the outlet of each boiler and the outlet of feed water tanks<br>Data Type: Measurement<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Per shift |
| **QA/QC procedures** | temperature and pressure meters to be calibrated annually as per internal QA/QC procedures of plant |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | The steam consumption of the processes optimised will be constantly measured and compared to the baseline. The steam generation figures will be compared to the baseline to ensure that steam saved by the project activity reduces the net steam generation of the boiler to ensure applicability with this methodology. |

| Data / Parameter | $SF_{1,PR,s}$, $SF_{2,PR,s}$,….$SF_{m,PR,s}$ |
|---|---|
| **Unit** | Mass unit of steam sold to Fructose, measured in Tonnes of steam |
| **Description** | Shift steam consumption figures for the project that correspond to $P_{1,PR,s}$, ….$P_{m,PR,s}$ |
| **Source of data** | Plant data from Daily Fructose Performance Report |
| **Value(s) applied** | 3 year historical average is used for ex-ante calculations. Table found in Appendix 4. An average of steam consumption of fructose per shift is calculated using a 47 week year and 21 shifts per week. |
| **Measurement methods and procedures** | Measurement: Temperature and Pressure Meters located at the entrance to fructose plant<br>Data Type: Measurement<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Per shift |
| **QA/QC procedures** | temperature and pressure meters to be calibrated annually as per internal QA/QC procedures of plant |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | Steam that is sold to fructose is excluded from the project boundary |

| | |
|---|---|
| **Data / Parameter** | $EG_{Tur,PR,y}$ |
| **Unit** | MWh/yr |
| **Description** | Quantity of electricity generated by the turbines in year y |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 3 year historical average is used for ex-ante calculations. Table found in Appendix 4. An average of electricity generated per annum by the turbines in combination with the technical feasibility study for electricity consumption of the refinery during project period. See table in Appendix 4 |
| **Measurement methods and procedures** | Measurement: continuous electricity meter located in the control room<br>Data Type: Measurement<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Daily figures aggregated annually |
| **QA/QC procedures** | Power meters to be calibrated annually as per internal QA/QC procedures of plant |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $EC_{grid,PR,y}$ |
| **Unit** | MWh/yr |
| **Description** | Quantity of grid electricity consumed by the whole facility in year y |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 3 year historical average is used for ex-ante calculations. Table found in Appendix 4. An average of electricity generated per annum by the turbines in combination with the technical feasibility study for electricity consumption of the refinery during project period. See table in Appendix 4 |
| **Measurement methods and procedures** | Measurement: continuous electricity meter located in the control room<br>Data Type: Measurement<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Daily figures aggregated annually |
| **QA/QC procedures** | Power meters to be calibrated annually as per internal QA/QC procedures of plant |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | |

| **Data / Parameter** | $EC_{fructose,PR,y}$ |
|---|---|
| **Unit** | MWh/yr |
| **Description** | Quantity of grid electricity consumed by the fructose plant in year y |
| **Source of data** | Plant data from Daily Fructose Performance Report |
| **Value(s) applied** | 3 year historical average is used for ex-ante calculations. Table found in Appendix 4. An average of electricity generated per annum by the turbines in combination with the technical feasibility study for electricity consumption of the refinery during project period. See table in Appendix 4 |
| **Measurement methods and procedures** | Measurement: continuous electricity meter located in the fructose sub db room<br>Data Type: Measurement<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Daily figures aggregated annually |
| **QA/QC procedures** | Power meters to be calibrated annually as per internal QA/QC procedures of plant |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | |

| **Data / Parameter** | $P_{act,PR}$ |
|---|---|
| **Unit** | Tonnes of refined white sugar |
| **Description** | The relevant annual production output from the process unit or system where steam is optimised in year *y* |
| **Source of data** | Plant Data from Daily Refinery Performance Report |
| **Value(s) applied** | estimated as the average of three years historical data – 608266 tonnes of white sugar |
| **Measurement methods and procedures** | Measurement: Aggregated plant values<br>Data Type: Calculation<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Daily |
| **QA/QC procedures** | - |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | All sugars produced at the plant will be aggregated to a single mass value for the year y for the purposes of calculating the specific grid electricity consumption of the white sugar refinery. |

| | |
|---|---|
| **Data / Parameter** | $E_{tot,d}$ |
| **Unit** | kJ/kg of steam |
| **Description** | Total enthalpy of steam at the boiler outlet |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 3180 kJ/kg |
| **Measurement methods and procedures** | Measurement: Steam meter for flow measurement. Pressure gauge and Temperature indicator for pressure and temperature measurements respectively. Steam table for enthalpy determination at given pressure and temperature.<br>Data Type: Calculation<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Daily |
| **QA/QC procedures** | temperature and pressure meters to be calibrated annually as per internal QA/QC procedures of plant |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | - |
| **Data / Parameter** | $E_{fw,d}$ |
| **Unit** | kJ/kg of feed water |
| **Description** | Enthalpy of feed water |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 440 kJ/kg |
| **Measurement methods and procedures** | Measurement: temperature and pressure meters respectively. Enthalpy to be estimated by multiplying mass flow, temperature (deg C) and specific heat of water (1 kCal/kg/deg C)<br>Data Type: Calculation<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: annually |
| **Monitoring frequency** | Daily |
| **QA/QC procedures** | kJ/kg of steam |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | - |

| Data / Parameter | $\eta_b$ |
|---|---|
| Unit | - |
| Description | Efficiency of boiler, to be monitored daily by direct method |
| Source of data | Plant data from Daily Refinery Performance Report |
| Value(s) applied | 86.56% |
| Measurement methods and procedures | Measurement: The efficiency of the boiler will be calculated using the direct method. The energy content of the steam generated will be divided by the energy content of the coal combusted. The energy content information of the coal will be provided by the coal supplier.<br>Data Type: calculation<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>**Calibration Frequency: -** |
| Monitoring frequency | Daily values, aggregated to a monthly value |
| QA/QC procedures | - |
| Purpose of data | Calculation of project and baseline emissions |
| Additional comment | **Direct Boiler Efficiency Method (Input-Output Method) to determine boiler efficiency:**<br>The efficiency by direct method can be determined by dividing the monitored actual heat generation of the boiler by the heat input to the boiler. |

| Data / Parameter | $CEF_{fuel}$ |
|---|---|
| Unit | t $CO_2$/kJ |
| Description | Carbon emission factor for fuel |
| Source of data | Coal characteristics provided by coal supplier |
| Value(s) applied | 8.3E-08 t $CO_2$/kJ. Historical data used and detailed in table in Appendix 4. |
| Measurement methods and procedures | Measurement: from supplier coal quality reports<br>Data Type: calculated value<br>Archiving Policy: weekly data<br>Responsibility: Data Analyst<br>Calibration Frequency: n/a |
| Monitoring frequency | For each fuel supply and for all fuels in fuel mix – will only be coal |
| QA/QC procedures | Use standard test procedures for test of fuels |
| Purpose of data | Calculation of project and baseline emissions |
| Additional comment | - |

| | |
|---|---|
| **Data / Parameter** | $H_{fuel,d}$ |
| **Unit** | % |
| **Description** | Share of energy supplied by each type of fuel consumed per day. Will only be coal |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 100% |
| **Measurement methods and procedures** | Measurement: Using purchasing invoices<br>Data Type: calculation<br>Archiving Policy: Paper & Electronic<br>Responsibility: Data Analyst<br>Calibration Frequency: na/ |
| **Monitoring frequency** | Daily |
| **QA/QC procedures** | Use calibrated meters |
| **Purpose of data** | Calculation of project and baseline emissions |
| **Additional comment** | - |

| | |
|---|---|
| **Data / Parameter** | $m_d$ |
| **Unit** | - |
| **Description** | Number of shifts in operation for each day |
| **Source of data** | Plant data from Daily Refinery Performance Report |
| **Value(s) applied** | 3 |
| **Measurement methods and procedures** | - |
| **Monitoring frequency** | Daily |
| **QA/QC procedures** | - |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | - |

**B.7.2. Sampling plan**
>>
Not Applicable and Left Blank Intentionally

**B.7.3. Other elements of monitoring plan**
>>
Tongaat Hulett Sugar South Africa Limited will manage the monitoring and reporting of all the required data for the purposes of the proposed CDM project activity as per the monitoring organisation chart supplied in Appendix 5.

All of the monitored parameters will be consolidated and reported on a monthly basis as the values will be at daily or per shift values from the installed monitoring equipment and recorded by plant operators and foreman as shown in the monitoring organisation chart.. The monthly reports will be compiled by the Data Analyst at Tongaat Hulett Sugar South Africa Limited and archived accordingly for a period of 2 years past the crediting period. Tongaat Hulett Sugar South Africa Limited will archive the monthly reports in hard copy and electronic format.

The following will be the flow of each monitored data variable.

**Boiler Steam Generation:**

1. Temperature and pressure meters for each boiler will measure total steam production
2. Meters will be connected to the DCS system that will measure and record data
3. Shiftly generation will be captured by the statistics administrator into an Excel spreadsheet and placed onto the Daily Refinery Performance Report
4. This is checked by the Data Analyst before distribution

**Fructose Steam Consumption:**

1. Temperature and pressure meters for each boiler will measure total steam consumption of fructose
2. Meters will be connected to the DCS system that will measure and record data
3. Shiftly consumption will be captured by the statistics administrator into an Excel spreadsheet and placed onto the Daily Refinery Performance Report
4. This is checked by the Data Analyst before distribution

**Refined White Sugar Production:**

1. Two electronic refined white sugar scales (H1 and Silo Streams) will measure total white sugar production
2. Scales will be connected to the DCS system that will measure and record data
3. Shiftly production will be captured by the statistics administrator into an Excel spreadsheet and placed onto the Daily Refinery Performance Report
4. This is checked by the Data Analyst before distribution

**Feed Water and Boiler Output Enthalpy:**

1. Temperature and pressure meters for each boiler will feed water and boiler output enthalpy by calculation
2. Meters will be connected to the DCS system that will measure and record data
3. Average daily enthalpy values will be captured by the statistics administrator into an Excel spreadsheet and placed onto the Daily Refinery Performance Report
4. This is checked by the Data Analyst before distribution

**Electricity Generation:**

1. Electricity generation is metered by continuous power meters in the boiler control room
2. Power meters will be connected to the DCS system that will measure and record data
3. Daily electricity generation will be captured by the statistics administrator into an Excel spreadsheet and placed onto the Daily Refinery Performance Report
4. This is checked by the Data Analyst before distribution

**Fructose Electricity Consumption:**

1. Electricity consumption by fructose is metered by continuous power meters in the fructose sub station
2. Power meters will be connected to the DCS system that will measure and record data
3. Daily electricity consumption will be captured by the statistics administrator into an Excel spreadsheet and placed onto the Daily Fructose Performance Report
4. This is checked by the Data Analyst before distribution

**Grid Electricity Import:**

1. Electricity imported is metered by continuous power meters in the boiler control room
2. Power meters will be connected to the DCS system that will measure and record data
3. Daily electricity consumption will be captured by the statistics administrator into an Excel spreadsheet and placed onto the Daily Refinery Performance Report
4. This is checked by the Data Analyst before distribution

**Carbon and Energy Content of Coal:**

1. Carbon and Energy content of coal is provided by the supplier
2. Carbon and Energy content is captured onto a spreadsheet by the Statistics Administrator
3. Data is checked by the Data Analyst before being archived

**Coal Consumption:**

1. Coal consumption will be measured daily by calculating the volume of coal remaining in the bunkers, comparing it to coal supplied and calculating the consumption. This will be measured by the stores controller
2. Data will be placed in an excel spreadsheet and checked weekly in the coal consumption amendment report that is compiled by the Data Analyst.

**Boiler Efficiency:**

1. Boiler efficiency will be monitored daily by the direct method
2. Data Analyst will calculated the efficiency based on the coal consumed, energy content of coal, and output energy of boiler
3. Data will be placed on Daily Refinery Performance Report before distribution.

## SECTION C. Duration and crediting period

### C.1. Duration of project activity

#### C.1.1. Start date of project activity

>>

Construction of Phase 1 is expected to begin after board approval in quarter 3 of 2013 and is expected to be complete by the end of quarter 4 2014.

#### C.1.2. Expected operational lifetime of project activity

>>

In excess of 25 years

## C.2. Crediting period of project activity

### C.2.1. Type of crediting period

>>

Fixed Crediting Period

### C.2.2. Start date of crediting period

>>

The crediting period will begin once Phase 1 is fully commissioned on 1 October 2014.

### C.2.3. Length of crediting period

10 Years

## SECTION D. Environmental impacts

## D.1. Analysis of environmental impacts

>>

The only environmental impacts from the proposed project activity are the positive impacts from the reduction in coal combustion in the boilers at the refinery as a result of reduced steam consumption in the refinery. These benefits are as follows:

- Reduced GHG emissions
- Reduced Particulate matter in the ambient environment
- Reduced $SO_x$ and $NO_x$ emissions
- Reduced water consumption by the refinery as a result of reduced steam requirements
- Reduced effluent from the refinery through a reduction in fine water consumption

The project is a retrofit of the current crystallisation process with no negative impacts associated with it. No major construction is required and minimal waste will be generated during the construction process.

The following transboundary effects on GHG emissions as a result of the project;

- The refinery currently has a permit to discharge ion exchange effluent to the Southern Wastewater Facility. This facility conducts minimal treatment before discharging to the ocean. There will be no effect on the emissions associated with the downstream discharge of the refinery's effluent to the ocean as the use of resin in the process that results in the ion exchange effluent will not be effected by the project activity.
- Air emissions, including particulate matter and GHG emissions, will be reduced through the reduction in coal consumption. This will result in reduced emissions in the atmosphere that is common and shared by all countries.

## D.2. Environmental impact assessment

>>

In terms of the revised environmental regulations it is necessary to determine if this activity i.e. the proposed modification is listed and triggers an environmental assessment. In terms of the Environmental Impact Assessment Regulations, 2010, promulgated under section 24(5) of the National Environmental Management Act (Act No. 107 of 1998) (NEMA) and published in government notice no R543 of 2010, the following listed activities are *potentially* qualifying factors:

*"The expansion of existing facility for any process or activity where such exopansion will result in the need for a new, or amendment of , an existing permit or licence in terms of national or provincial*

*legislation governinig the release of emissions or pollution, excluding where the facility, process or activity is included in the list of waste magaement activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008/ (Act no. 59 of 2008) in which case that act will apply."*
Government Notice No.544 of 2010

"*The construction of facilities or infrastructure for any process or activity which requires a permit or license in terms of national or provincial legislation governining the generation or release of emission, pollution or effluent and which is not identified in Notice No.544 of 2010 or oncluded in the list of waste managment activities published in terms of section 19 o*f *National Environmental Management: Waste Act, 2008/ (Act no. 59 of 2008) in which case that act will apply."*
Government Notice No.544 of 2010

The above have been the only items identified in the schedule of listed activities that could potentially trigger an Environmental Impact Assessment (EIA) and which require further scrutiny.

It is concluded that the emissions, pollution, waste and effluent contributed by the refinery 'expansion' modification will be considerably reduced and they will not pose any changes to the existing permits. In accordance with the NEMA EIA Regulations the project is therefore not considered to be a scheduled activity that would legally require an EIA.

## SECTION E. Local stakeholder consultation

### E.1. Solicitation of comments from local stakeholders

>>
A local stakeholder consultation meeting was held on the evening of 12 September 2012 at the Tongaat Hulett Sugar Limited Refinery meeting room. The following were invited to attend:

- Representative of the DNA (Personal invitation by email)
- Local Community (an advert displayed in public places around the community – bus stops, taxi ranks and the town hall)
- Interested and Affected Parties that are normally involved in stakeholder consultation processes for the refinery (Personal invitation by email)

The proposed project as well as the CDM process was explained to all parties involved. Participation lists and evaluation forms were completed and archived in both paper and electronic format as well as comments invited during the meeting. A summary of the comments received was develop and due account of all comments was taken. All comments received were either addressed during the presentation or through a reply after the presentation.

A total of 16 stakeholders took part in the stakeholder consultation process.

The stakeholder meeting had the following presentation outline:

- Presenter Introductions
- The Kyoto Protocol and the Clean Development Mechanism (CDM)
- CDM Explanation
- Project Description
    - Project Aim
    - Project Location
    - Project Initiators and their Motivation
    - Project Phases and Timelines
    - Why CDM is a requirement for project success

  - Sustainability Benefits (Environmental, Social and Economic)
- Stakeholder Participation and Questions
- Evaluation

A full report was developed on the local stakeholder consultation process by Terra Firma Solutions and is available on request

**E.2. Summary of comments received**

>>
The majority of the comments received we positive around the following aspects of the project:

- The DNA of South Africa finds a positive contribution towards sustainable development in South Africa and the community after requesting further information on the potential job opportunities and skills development associated with the proposed project.
- Large emission reductions are a big positive from many stakeholders
- Large coal usage reduction that will lead to lower $SO_2$ and Particulate Matter being emitted by the sugar refinery are a big positive from many stakeholders after it was explained that it is not only greenhouse gases that will be reduced during the proposed project activity
- Reduction in water usage from many stakeholders
- The representative from the health department finds it a relief that companies are pursuing methods to reduce carbon emissions as it relieves the local government from many complaints received from communities surrounding facilities that emit large amounts of greenhouse gasses
- Many stakeholders found it positive that South Africa is potentially prototyping a new, world first technology that could be exported to other countries

The only negative comments received were around:

- The risks associated with a new technology. This was explained to the stakeholders that the risk is a business risk in terms of the refinery not producing the same output of product from the new process and that it is not a safety risk in terms of equipment malfunctioning and causing safety concerns. It was also explained by the Tongaat Hulett Sugar South Africa Limited Engineering team that the process will become more complex and that this will lead to an up-skilling of refinery operators to be competent on the new, world first technology. This was seen as a significant positive to the project.
- Another negative comment received was around the carbon trading mechanisms, however the benefits of such a mechanisms were then clearly explained and highlighted. The need for carbon revenue to assist in promoting the proposed project was explained and understood.
- A member of the forum requested information on how the proposed project will negatively impact the community. It was carefully explained that there are no perceived negative impacts on the local community and that the project has many benefits. The technological barrier to the project, being the first of its kind, untested technology, was explained as the downside of the project.

General questions were posed by the community on:

- The project implementation plan and phased approached – it was explained that the project does not have final board approval and the implementation plan will be discussed with the stakeholder forum at quarterly meetings once more details are known
- The proposed technology and its effect on the scheduled trade permit (this was mainly posed by the City Council) – Tongaat Hulett Sugar South Africa Limited has been in negotiations with the council surrounding this issue and will make information on the technology and new process available to the city council.

Overall, the project was seen to have many positive impacts and had the support of stakeholders going forwards.

**E.3. Report on consideration of comments received**

>>
All comments received were documented in evaluation forms and in notes from the meeting. Responses to comments were given during the meeting by Tongaat Hulett Sugar South Africa Limited Engineering Staff, Management and Terra Firma Solutions.

Further clarifications on the proposed project around the detailed implementation plan and timelines will be explained during the quarterly stakeholder forums that Tongaat Hulett Sugar South Africa Limited holds in order to keep the local stakeholders fully informed of the progress of the project and whether or not the project gets approved by the Tongaat Hulett Sugar South Africa Limited Board.

The next scheduled stakeholder engagement session is on 14 November 2012 where the project will be explained again to the stakeholder's forum.

**SECTION F. Approval and authorization**
>>
No letters of approval are available at the time of submitting this PDD to the validating DOE. A PIN has been submitted to the DNA and the PDD will be submitted concurrently with the submission to the DOE.

- - - - -

**Appendix 1: Contact information of project participants**

| | |
|---|---|
| **Organization name** | Tongaat Hulett Sugar South Africa Limited |
| **Street/P.O. Box** | Amanzimnyama Hill Road |
| **Building** | |
| **City** | Tongaat |
| **State/Region** | KwaZulu-Natal |
| **Postcode** | 4400 |
| **Country** | South Africa |
| **Telephone** | +27 32 439 4019 |
| **Fax** | +27 31 570 1055 |
| **E-mail** | info@tongaat.com |
| **Website** | www.tongaat.com |
| **Contact person** | Craig Jensen |
| **Title** | Technology Development Group Leader |
| **Salutation** | Dr. |
| **Last name** | Jensen |
| **Middle name** | Robert Carl |
| **First name** | Craig |
| **Department** | Technology and Engineering Group |
| **Mobile** | +27 (0) 83 386 8374 |
| **Direct fax** | +27 (0) 86 644 0337 |
| **Direct tel.** | +27 (0) 32 439 4337 |
| **Personal e-mail** | Craig.Jensen@tongaat.com |

**Appendix 2: Affirmation regarding public funding**

No public funding will be used in this project activity.

**Appendix 3: Applicability of selected methodology**

Detailed in Section B.2.

## Appendix 4: Further background information on ex ante calculation of emission reductions

**Baseline SSCR Calculation:**

**Project SSCR Calculation**

**Baseline Specific Electricity Consumption**

**Calculation of the South Africa Grid Emission Factor**

The South African grid emissions factor has been calculated using the methodological tool "**Tool to calculate the emission factor for an electricity system" version 02.2.1.** The section below outlines the decision process chosen based on the seven steps described within the tool.

**Step 1:** Identify the relevant electricity systems.

The project activity will be reducing electricity generation on site and may therefore require additional electricity from the grid to run some of the plants peripheral devices which will result as a project emission. The grid connected electricity system is therefore defined as all power stations that generate, transmit and distribute electricity to the South African network. The current owner and operator of all grid connected power stations within South Africa is Eskom, and all relevant data used in the following steps has been used as per Eskoms annual published data around fuel usage and electricity generation.

**STEP 2**. Choose whether to include off-grid power plants in the project electricity system (optional).

*Project participants may choose between the following two options to calculate the operating margin and build margin emission factor:*

***Option I:*** *Only grid power plants are included in the calculation.*

***Option II:*** *Both grid power plants and off-grid power plants are included in the calculation.*

When choosing whether or not to include off grid power stations or not, *Option 1* was chosen due to lack of available information around fuel use and electricity generation of off grid power plants and the small minority of existing plants if any.

**STEP 3**. Select a method to determine the operating margin (OM).

*The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods, which are described under Step 4:*

*(a) Simple OM; or*

*(b) Simple adjusted OM; or*

*(c) Dispatch data analysis OM; or*

*(d) Average OM.*

*The simple OM method (option a) can only be used if low-cost/must-run resources2 constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production.*

The simple OM calculation was chosen for this analysis. No data was available for the electricity generation on the low-cost/ must-run resources; however the installed capacity of the low-cost/ must-run resources is 9% of the total installed capacity. It is therefore possible to say that the low-cost/ must-run resources constitute less than 50% of total grid generation and therefore satisfies the criteria for choosing this specific option for calculating the operating margin.

The *ex ante* option for determining the emission factor was also chosen, thus the emission factor is determined once off at validation stage with no further monitoring and recalculation required throughout the life of the project activity.

**STEP 4**. Calculate the operating margin emission factor according to the selected method.

*The simple OM emission factor is calculated as the generation-weighted average CO2 emissions per unit net electricity generation (tCO2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.*

*The simple OM may be calculated by one of the following two options:*

***Option A**: Based on the net electricity generation and a CO2 emission factor of each power unit;3 or*

***Option B**: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.*

*Option A* was chosen to calculate the simple operating margin. The formula below outlines the calculation of the simple operating margin:

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\Sigma EG_{m,y}}$$

*Where:*

| | |
|---|---|
| $EF_{grid,\ OMsimple,y}$ : | = Simple operating margin CO2 emission factor in year y (tCO2/MWh) |
| $EG_{m,y}$ : | = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh) |
| $EF_{EL,m,y}$: | = CO2 emission factor of power unit m in year y (tCO2/MWh) |
| m : | = All power units serving the grid in year y except low-cost / must-run power units |
| y: | = The relevant year as per the data vintage chosen in Step 3 |

When determining $EF_{EL,m,y}$, *Option A.1* was chosen as data on the individual power plants for the fuel consumption and electricity generation was available from Eskoms annual report. The formula below outlines the calculation of the emission factor $EF_{EL,m,y}$:

$$EF_{EL,m,y} = \frac{\Sigma_i FC_{i,y,m} \times NCV_{i,y} \times EF_{co2,i,y}}{EG_{m,y}}$$

*Where:*

| | |
|---|---|
| $EF_{EL,m,y}$ : | =CO2 emission factor of power unit m in year y (tCO2/MWh) |
| $FC_{i,,y,m}$: | =Amount of fossil fuel type i consumed by power plant unit m in early (mass or volume unit) |
| $NCV_{i,y}$ : | =Net calorific value (energy content)of fossil fuel type i in year y (GJ/mass or volume) |
| $EF_{CO2,i,y}$: | =CO2 emission factor of fossil fuel type i in year y (tCO2/GJ) |
| $EG_{m,y}$ : | =Net electricity generated and delivered to the grid by all power unit m in year y (MWh) |
| m : | = All power units serving the grid in year y except low-cost/must-run power units |
| i : | =All fossil fuel types combusted in power sources power unit m in year y |
| y : | =The relevant year as per data vintage chosen in Step 3. |

The table below outlines the data used for the above calculations:

Table 1: Operating Margin Calculation Data

| Plant names | Fuel Type | UoM | Fuel Consumption 2010 | Fuel Consumption 2011 | Fuel Consumption 2012 | Electricity generation 2010 (MWh) | Electricity generation 2011 (MWh) | Electricity generation 2012 (MWh) | NCV of Fuel (TJ/kTfuel) | CO2 factor (tCO2/TJ) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Arnot** | Coal | Tonnes/Year | 6,794,134 | 6,525,670 | 7,035,460 | 13,227,864 | 12,194,878 | 12,229,098 | 19.9 | 89.5 |
| **Duvha** | Coal | Tonnes/Year | 11,744,606 | 10,639,393 | 9,154,172 | 22,581,228 | 20,267,508 | 17,556,459 | 19.9 | 89.5 |
| **Hendrina** | Coal | Tonnes/Year | 6,905,917 | 7,139,198 | 6,849,996 | 12,143,292 | 11,938,206 | 11,412,357 | 19.9 | 89.5 |
| **Kendal** | Coal | Tonnes/Year | 13,866,514 | 15,174,501 | 15,938,407 | 23,307,031 | 25,648,258 | 27,309,297 | 19.9 | 89.5 |
| **Kriel** | Coal | Tonnes/Year | 8,504,715 | 9,527,185 | 8,360,504 | 15,906,816 | 18,204,910 | 15,289,169 | 19.9 | 89.5 |
| **Lethabo** | Coal | Tonnes/Year | 18,170,227 | 17,774,699 | 17,293,334 | 25,522,698 | 25,500,366 | 24,274,937 | 19.9 | 89.5 |
| **Matimba** | Coal | Tonnes/Year | 14,637,481 | 14,596,842 | 14,953,397 | 27,964,141 | 28,163,040 | 27,899,475 | 19.9 | 89.5 |
| **Majuba** | Coal | Tonnes/Year | 12,261,833 | 13,020,512 | 13,529,252 | 22,340,081 | 24,632,585 | 25,325,348 | 19.9 | 89.5 |
| **Matla** | Coal | Tonnes/Year | 12,438,391 | 12,155,421 | 11,367,521 | 21,954,536 | 21,504,422 | 20,650,022 | 19.9 | 89.5 |
| **Tutuka** | Coal | Tonnes/Year | 10,602,839 | 10,191,709 | 11,368,184 | 19,847,894 | 19,067,501 | 20,504,886 | 19.9 | 89.5 |
| **Camden** | Coal | Tonnes/Year | 4,732,163 | 4,629,763 | 4,329,462 | 7,472,070 | 7,490,836 | 7,267,648 | 19.9 | 89.5 |
| **Grootvlei** | Coal | Tonnes/Year | 1,637,371 | 2,132,979 | 3,821,963 | 2,656,230 | 3,546,952 | 6,094,910 | 19.9 | 89.5 |
| **Komati** | Coal | Tonnes/Year | 664,497 | 1,271,010 | 1,390,186 | 1,016,023 | 2,060,141 | 2,398,132 | 19.9 | 89.5 |
| **Ankelig** | Gas | Liters diesel/year | 7,459,437 | 41,305,580 | 121,853,656 | 23,367 | 130,241 | 391,049 | 0.0338 | 72.6 |
| **Gourikwa** | Gas | Liters diesel/year | 6,884,155 | 19,144,089 | 96,165,992 | 22,612 | 62,233 | 314,651 | 0.0338 | 72.6 |
| **Acacia** | Gas | Liters Kerosene/Year | 1,132,973 | 444,957 | 462,819 | 2,187 | 992 | 1,163 | 0.0353 | 70.8 |
| **Port Rex** | Gas | Liters Kerosene/Year | 375,078 | 281,941 | 828,014 | 889 | 5,507 | 2,162 | 0.0353 | 70.8 |

Table 2: Summary $EF_{grid, OMsimple,y}$

| | |
|---|---|
| **Emission Factor 2010** | 1.014 |
| **Emission Factor 2011** | 1.016 |
| **Emission Factor 2012** | 1.023 |
| **3 Year Weighted Average, $EF_{grid, OMsimple,y}$** | 1.018 |

**STEP 5. Calculate the build margin (BM) emission factor**

*In terms of vintage of data, project participants can choose between one of the following two options:*

***Option 1:*** *For the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.*

***Option 2:*** *For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.*

*The option chosen should be documented in the CDM-PDD.*

Option 1 has been chosen for the project activity outlined in this PDD document.

*Capacity additions from retrofits of power plants should not be included in the calculation of the build margin emission factor. The sample group of power units m used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:*

(a) *Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5-units}$) and determine their annual electricity generation ($AEG_{SET-5-units}$, in MWh);*

(b) *Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities ($AEG_{total}$, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of $AEG_{total}$ (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET-\geq 20\%}$, in MWh);*

(c) *From $SET_{5-units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation ($SET_{sample}$); Identify the date when the power units in $SET_{sample}$ started to supply electricity to the grid. If none of the power units in $SET_{sample}$ started to supply electricity to the grid more than 10 years ago, then use $SET_{sample}$ to calculate the build margin. In this case ignore steps (d), (e) and (f).*

*Otherwise:*

*(d) Exclude from $SET_{sample}$ the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activities, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET-sample-CDM}$, in MWh); If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET-sample-CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample-CDM}$ to calculate the build margin. Ignore steps (e) and (f).*

*Otherwise:*

*(e) Include in the sample group $SET_{sample-CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);*

*(f) The sample group of power units m used to calculate the build margin is the resulting set ($SET_{sample-CDM->10yrs}$).*

After following the procedure steps outlined above, the table below represents the resultant set of five power stations ($SET_{sample-CDM->10yrs}$):

Table 3: Five most recently built power units

| Plant names | Installed Capacity (MW) | Commissioning date | Fuel Type |
|---|---|---|---|
| **Ankelig** | 1327 | 01/10/2007 | Gas |
| **Gourikwa** | 740 | 01/10/2007 | Gas |
| **Majuba** | 3843 | 01/04/1996 | Coal |
| **Kendal** | 3840 | 01/10/1988 | Coal |
| **Matimba** | 3690 | 04/12/1987 | Coal |

*The build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:*

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\Sigma EG_{m,y}}$$

*Where:*

$EF_{grid,BM,y}$ : = *Build margin CO2 emission factor in year y (tCO2/MWh)*
$EG_{m,y}$ : = *Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)*
$EF_{EL,m,y}$: = *CO2 emission factor of power unit m in year y (tCO2/MWh)*
*m* : = *Power units included in the build margin*

*y*: = *Most recent historical year for which power generation data is available*

*The CO2 emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the guidance in Step 4 (a) for the simple OM, using options A1, A2 or A3, using for y the most recent historical year for which power generation data is available, and using for m the power units included in the build margin.*

*If the power units included in the build margin m correspond to the sample group $SET_{sample\text{-}CDM\text{->}10yrs}$, then, as a conservative approach, only option A2 from guidance in Step 4 (a) can be used and the default values provided in Annex 1 shall be used to determine the parameter $\eta_{m,y}$.*

Option A2 from Step 4 (a) was therefore used to calculate the $CO_2$ emission factor of each power station due to the resultant set being $SET_{sample\text{-}CDM\text{->}10yrs}$ with the 2012 electricity generation data being used as the most recent historical year. Eskoms annual reporting financial year is from the 1 April 2011 to the 31st March 2012.

***Option A2**. If for a power unit m only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO2 emission factor of the fuel type used and the efficiency of the power unit, as follows:*

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}}$$

*Where:*

| | |
|---|---|
| $EF_{EL,m,y}$ : | *= CO2 emission factor of power unit m in year y (tCO2/MWh)* |
| $EF_{CO2,m,i,y}$ : | *= Average CO2 emission factor of fuel type i used in power unit m in year y (tCO2/GJ)* |
| $\eta_{m,y}$: | *= Average net energy conversion efficiency of power unit m in year y (ratio)* |
| *m :* | *= All power units serving the grid in year y except low-cost/must-run power units* |
| *y:* | *= Most recent historical year for which power generation data is available* |

The table below represents the data used to calculate $EF_{EL,m,y}$:

Table 4: CO2 emission factor of power unit m

| Plant names | Installed Capacity (MW) | Commissioning date | Fuel Type | Electricity generation 2012 (MWh) | CO2 factor (tCO2/GJ) | Factor | Efficiency power plant m | $EF_{EL,m,y}$ |
|---|---|---|---|---|---|---|---|---|
| **Ankelig** | 1327 | 01/10/2007 | Gas | 391,049 | 0.0726 | 3.6 | 0.3 | 0.87 |
| **Gourikwa** | 740 | 01/10/2007 | Gas | 314,651 | 0.0726 | 3.6 | 0.3 | 0.87 |
| **Majuba** | 3843 | 01/04/1996 | Coal | 25,325,348 | 0.0895 | 3.6 | 0.37 | 0.87 |
| **Kendal** | 3840 | 01/10/1988 | Coal | 27,309,297 | 0.0895 | 3.6 | 0.37 | 0.87 |
| **Matimba** | 3690 | 04/12/1987 | Coal | 27,899,475 | 0.0895 | 3.6 | 0.37 | 0.87 |

The table below represents the final calculated Build Margin emission factor for the project electricity system:

Table 5: $EF_{grid, BM,y}$ Summary

| | |
|---|---|
| **$EF_{grid, BM,,y}$ based on historical data from 2012** | 0.871 |

**STEP 6**. Calculate the combined margin (CM) emissions factor.

*The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:*

*(a) Weighted average CM; or*

*(b) Simplified CM.*

*The weighted average CM method (option A) should be used as the preferred option.*

*The simplified CM method (option b) can only be used if:*

*• The project activity is located in a Least Developed Country (LDC) or in a country with less than 10 registered CDM projects at the starting date of validation; and*

*• The data requirements for the application of step 5 above cannot be met.*

Based on the requirements listed above, the weighted average combined margin calculation was used:

*The combined margin emissions factor is calculated as follows:*

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

*Where:*

| | |
|---|---|
| $EF_{grid,BM,y}$ : | *=Build margin CO2 emission factor in year y (tCO2/MWh)* |
| $EF_{grid,OM,y}$: | *=Operating margin CO2 emission factor in year y (tCO2/MWh)* |
| $w_{OM}$ : | *=Weighting of operating margin emissions factor (%)* |
| $w_{BM}$ : | *=Weighting of build margin emissions factor (%)* |

*The following default values should be used for $w_{OM}$ and $w_{BM}$:*

*• Wind and solar power generation project activities: $w_{OM}$ = 0.75 and $w_{BM}$ = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;*

*• All other projects: $w_{OM}$ = 0.5 and $w_{BM}$ = 0.5 for the first crediting period , and $w_{OM}$ = 0.25 and $w_{BM}$ = 0.75 for the second and third crediting period,[6] unless otherwise specified in the approved methodology which refers to this tool."*

The proposed project activity does not include wind or solar power generation and therefore the combined margin emissions factor can be calculated as follows:

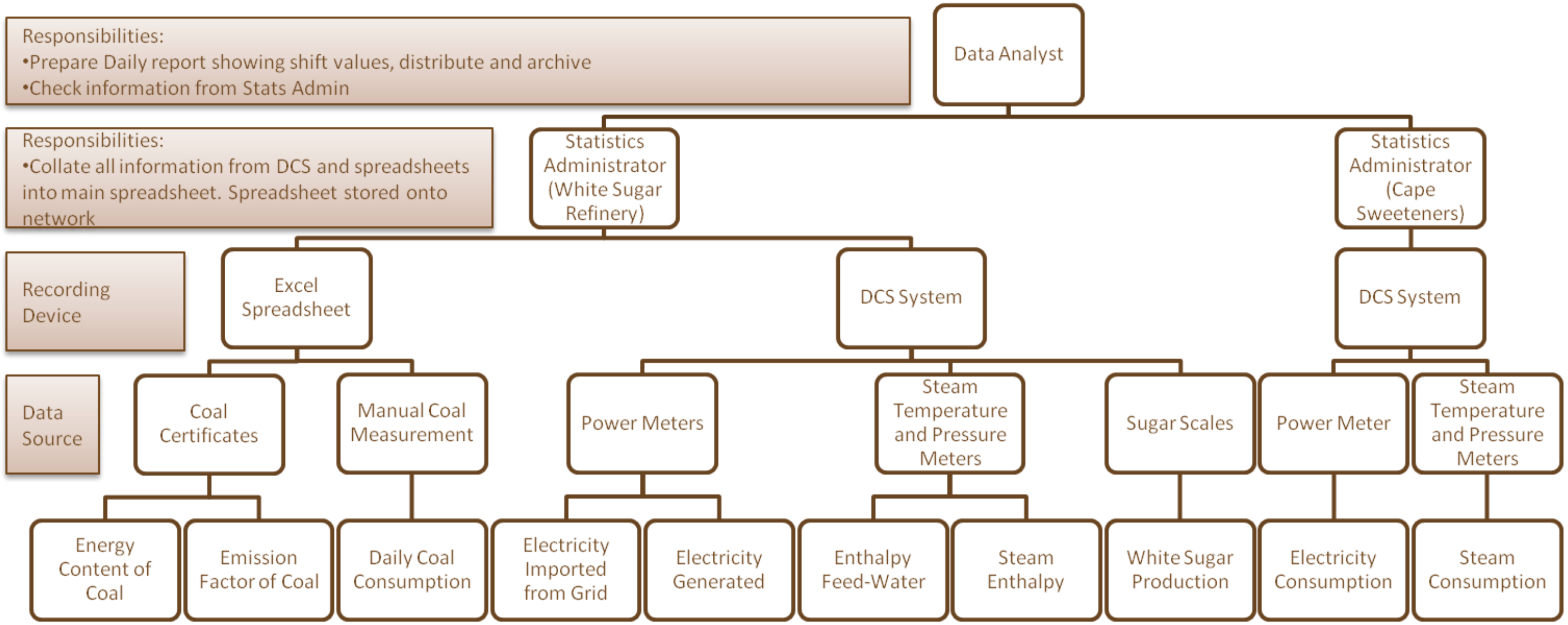
$$EF_{grid,CM,y} = EF_{grid,OM,y} \times 0.5 + EF_{grid,BM,y} \times 0.5$$

$$EF_{grid,CM,y} = 1.02 \times 0.5 + 0.87 \times 0.5$$

$$\boldsymbol{EF_{grid,CM,y} = 0.94 \frac{tCO_2}{MWH}}$$

Appendix 5: **Further background information on monitoring plan**

# Tongaat Hulett Sugar Limited Steam Optimisation Project – Monitoring Organisational Chart



## Appendix 6: Summary of post registration changes

Not applicable at this stage and none are expected

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**History of the document**

| Version | Date | Nature of revision |
|---|---|---|
| 04.1 | 11 April 2012 | Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b. |
| 04.0 | EB 66<br>13 March 2012 | Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8). |
| 03 | EB 25, Annex 15<br>26 July 2006 | |
| 02 | EB 14, Annex 06b<br>14 June 2004 | |
| 01 | EB 05, Paragraph 12<br>03 August 2002 | Initial adoption. |
| **Decision Class:** Regulatory<br>**Document Type:** Form<br>**Business Function:** Registration | | |