Proposed standardized baseline submission form
(Version 03.0)

To be used by a designated national authority (DNA) when submitting a proposed standardized baseline in accordance with the "Procedure: Development, revision, clarification and update of standardized baselines" (CDM-EB63-A28-PROC).

INFORMATION TO BE COMPLETED BY THE DNA	
Title of the proposed standardized baseline:	Emission Factor of the Electricity System of Southern Africa
Name(s) of the Party or Parties to which the proposed standardized baseline applies:	• Republic of Botswana; • Democratic Republic of Congo ; • Kingdom of Lesotho; • Republic of Mozambique; • Republic of Namibia; • Republic of South Africa; • Kingdom of Swaziland; • Republic of Zambia, and • Republic of Zimbabwe.
DNA submitting this form:	
Is the proposed standardized baseline submitted by a single Party or group of Parties? *(If the Party had 10 or fewer registered CDM project activities as of 31 December 2010, or each Party of the group of Parties had 10 or fewer registered CDM project activities as of 31 December 2010, has the Party or each Party of the group of Parties used the option to omit the assessment report more than twice in past submissions of a proposed standardized baseline?)*	☐ Single Party ☒ Group of Parties
Attachments:	
☐ Additional documentation supporting the submission (e.g. relevant data, statistics, studies, calculation tables, quality control report, etc.), where applicable ☒ Data used to establish the proposed standardized baseline in a sector-specific data template ☒ An assessment report prepared by a designated operational entity (DOE) ☐ Letters of approval of all the DNAs of the Parties to which the proposed standardized baseline applies, where the standardized baseline applies to a group of Parties	
Name of authorized officer signing for the DNA:	Emission Factor of the Electricity System of Southern Africa
Date (DD/MM/YYYY) and signature for the DNA:	12/04/2018

Contact information of the focal point(s) of the DNA: *(Names, e-mail addresses and phone contacts for procedural and technical communication on the submission)*	DNA of Botswana Mr Balisi Gopolang Department of Meteorological Services, Ministry of Environment, Natural Resources Conservation and Tourism bgopolang@gmail.com or bgopolang@gov.bw +267 361 2200/+267 361 2272
Name(s) of the proponent(s) of the proposed standardized baseline:	DNA of Botswana
Affiliation of the proponent(s): *(The definition of "admitted observer organization" can be found at https://cdm.unfccc.int/Reference/Guidclarif/glos_CDM.pdf)*	☒ Party ☐ Project Participant (PP) ☐ International Industry Organization ☐ Admitted Observer Organization
Contact information of the focal point(s) of the proponent(s): *(Names, e-mail addresses and phone contacts for procedural and technical communication on the submission. This section does not need to be completed if the DNA(s) is(are) the proponent(s) of the proposed standardized baseline.)*	GFA Consulting Group GmbH Martin Burian martin.burian@gfa-group.de +49 40 6030 6805

INFORMATION TO BE COMPLETED BY THE SECRETARIAT AND THE PROPONENT(S)
Further inputs requested from the proponent(s) on the proposed standardized baseline: ***(List of additional information and/or modifications that are required to prepare a draft standardized baseline, if applicable.)***
Response from the proponent(s): ***(If there are changes in the proposed standardized baseline form as a result of changes carried out, submit the changes in the highlighted text).***

Proposed standardized baseline submission form
CDM-PSB-FORM (Version 03.0)

Title: **Emission Factor of the Electricity System of Southern Africa**

Submission date (*dd/mm/yyyy*): 13th April 2018

Version number: 1.1

Approaches

Check below all the approaches used to develop the proposed standardized baseline and state the version and/or the reference (number, title, version) if applicable.

☐ The approach contained in the "Guidelines for the establishment of sector specific standardized baselines" (Version: ____________)

☐ A methodological approach contained in an approved, proposed new or revised baseline and monitoring methodology (reference:____________________________________)

☒ A methodological approach contained in an approved, proposed new or revised methodological tool (reference: **Tool to calculate the emission factor for an electricity system**" (Version 5.0))

☐ The approach contained in the "Guideline: Establishment of standardized baselines for afforestation and reforestation project activities under the CDM" (version: ________________)

Combination of the approaches (if applicable)

Not applicable.

New or revised methodology or methodological tool (if applicable)

Not applicable.

SECTION A: PROPOSED STANDARDIZED BASELINE DEVELOPED USING THE APPROACH CONTAINED IN THE "GUIDELINES FOR THE ESTABLISHMENT OF SECTOR SPECIFIC STANDARDIZED BASELINES"

Not applicable.

SECTION B: PROPOSED STANDARDIZED BASELINE DEVELOPED USING A METHODOLOGICAL APPROACH CONTAINED IN AN APPROVED OR PROPOSED NEW OR REVISED METHODOLOGY

Not applicable.

SECTION C: PROPOSED STANDARDIZED BASELINE DEVELOPED USING A METHODOLOGICAL APPROACH CONTAINED IN AN APPROVED OR PROPOSED NEW OR REVISED METHODOLOGICAL TOOL

Applicability of the proposed standardized baseline

The proposed standardized baseline is applicable to grid connected renewable energy and/or energy efficiency measures in the following host countries:

- Republic of Botswana;
- Democratic Republic of Congo ;
- Kingdom of Lesotho;
- Republic of Mozambique;
- Republic of Namibia;
- Republic of South Africa;
- Kingdom of Swaziland;
- Republic of Zambia, and
- Republic of Zimbabwe.

Baseline parameter standardization

List of Figures and Tables

Introduction

With financial support from the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Buildings (BMUB), the Southern African Power Pool Coordination Centre initiated a study to examine to determine the emission factor of the sub-regional grid electricity system.

These findings shall allow for updating the Approved Standardized Baseline ASB0001 which was developed by the Southern African Power Pool Coordination Centre in 2012 and which became approved by the CDM Executive Board in 2013.

The calculation of the grid emission factor is based on the most recent version of UNFCCC's "Tool to calculate the emission factor for an electricity system" (Version 5.0, hereafter referred to as the "tool"), and adopted an excel file for the calculation of the GEF which was developed by the Institute for Global Environmental Strategies (IGES).

In the course of the implementation of the study, approaches for automated additionality using the performance penetration approach (as laid out by the 'Guidelines for the establishment of sector specific standardized baselines' (CDM EB 65, Annex 23)) were considered. However, the same was not included in the final submission.

The study was implemented by GFA Consulting Group. The study team comprised Martin Burian (Team Lead), Dr. Peter Zhou (EECG, Botswana), Francis Masawi (EiL, Zimbabwe) and Prof. Dr. Francis Yamba (CEEZ, Zambia). Contact details may be found in below box.

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Many people contributed to the study outputs. The authors would like to thank Mr. Alison Chikova, Mr. Sydney Zimba, Mr. Johnson Maviya and the team of the Southern African Power Pool Coordination Centre for their strong support during the implementation of this study.

Equally we would like to thank the DNAs and the power utilities of the SAPP region for sharing and confirming the data used to estimate the emission factor for the Southern African region. Finally, we would like to extend our thanks to Mr. Randall Spalding-Fecher for valuable inputs regarding the development of the Performance Penetration Approach.

STEP 1. Identify the Relevant Electricity Systems

The SAPP covers nine operating member counties. These are the Botswana, Democratic Republic of Congo (DRC), Lesotho, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe. These member countries feature powerful transmission lines allowing for substantial electricity trades between the countries, their national power companies as well as between Independent Power Producers. Given this setup, the Project Electricity System (PES) is defined as the electricity grid shared by the nine member countries.

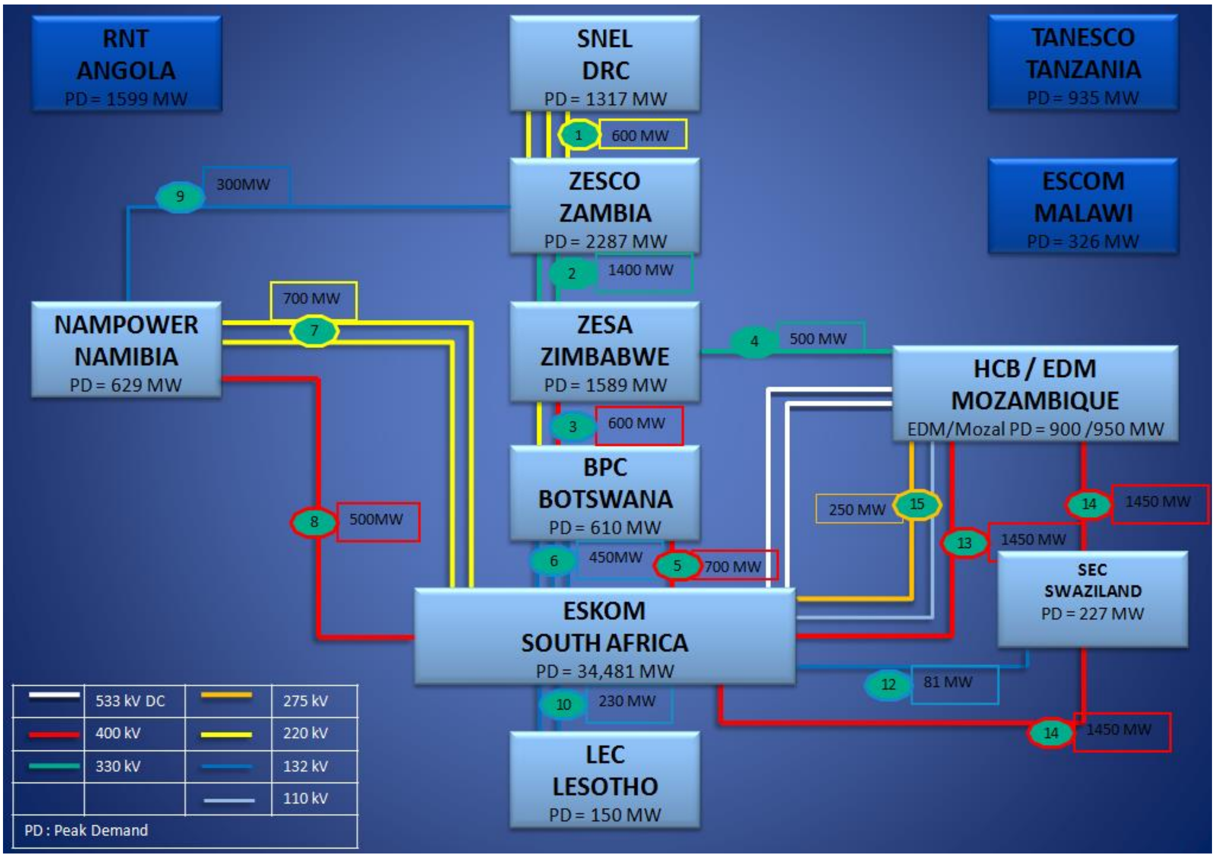
The Build Margin (BM), the Operating Margin (OM) as well as the resulting Combined Margin (CM) are determined for the joint PES. This is consistent with CDM EB 28, §14 and with the current version of the tool. In order to refer to an electricity system which covers more than one country, the tool requires demonstrating that there are no transmission constraints. The tool offers two options to evaluate the existence of transmission constraints:

- One is the investigation of price differences for electricity between countries/regions.

- The second refers to bottle necks of the operational capacity of the transmission system. Following the tool, transmission constraints exist if a transmission line is operated above 90% of its capacity for 90% of the year or more.

As it is not possible to disclose price information, we evaluated the actual bottle necks of the transmission lines. Figure 3 shows the existing transmission lines between SAPP member countries, their design capacities as well as the countries' Peak Demand (PD), both in MW.

Figure 1: Transmission Line Design Capacities in Southern Africa



Source: Information provided by the SAPP Coordination Centre

In a first step, transmission constraints were evaluated by comparing the operational capacity of tie lines with their current load factor. The Tool defines that transmission constraints do not exist if transmission line operates 90% or less of its capacity for 90% or more of the year. To make this determination, data for the operational capacity of tie lines, as well as the current electricity trades between SAPP member countries were provided by the SAPP CC.

However the SAPP CC defines operational transfer limits[1], which are not a constant factor (e.g. 90%) applicable equally to all lines, but which are line specific and defined based on the contingencies for that specific line. In a second step we evaluated whether the actual transfers exceed 90% of the operational transfer limits over 90 or more of the time of one year. Please note that operational transfer limits differ depending on the direction of the transfer. This is considered to be a thorough and conservative basis for evaluating the existence of transfer limits and operational transfer limits are presented in Annex II.

Table 1: Evaluation of Transmission Constraints in Southern Africa

No	Cross - Border Line	Voltage Level (in kV)	Transfer Capacity (in MW)	Transfer Limit N->S (in MW)	Transfer Limit S->N (in MW)	Average Energy Transfer S->N (in MWh)	Average Energy Transfer N->S (in MWh)	Transmission Constraint (YES/NO)	Normal flow direction (>90% of the time)
1	Zambia - DRC	3 x 220	600	600	483	74	0	NO	Zambia - DRC
2	Zambia - Zimbabwe	2 x 330	1400	642	642	312	0	NO	Zimbabwe - Zambia
3	Zimbabwe - Botswana	400	700	288	327	128	0	NO	Botswana - Zimbabwe
4	Mozambique - Zimbabwe	330	500	375	142	0	296	NO	Moz - Zim
5	RSA - Botswana	400	700	190	477	182	0	NO	RSA - Botswana
6	RSA - Botswana	3 x 132	450	243	354	49	68	NO	Bidirectional
7	RSA - Namibia	400	500	361	361	199	0	NO	RSA - Namibia
8	RSA - Namibia	2 x 220	700	340	530	68	0	NO	RSA - Namibia
9	Namibia - Zambia	2 x 132	300	190	190	30	0	NO	Namibia - Zambia
10	RSA - Lesotho	2 x 132	230	127	81	0	23	NO	RSA - Lesotho
11	RSA - Swaziland	400	1450	1328	146	0	462	NO	RSA - Swaziland
12	RSA - Swaziland	132	160	81	65	0	27	NO	RSA - Swaziland
13	RSA - Mozambique	400	1450	1328	146	670	0	NO	RSA - Mozambique
14	Swaziland - Mozambique	400	1450	146	1328	369	0	NO	Swaziland - Mozambique
15	RSA - Mozambique	275	250	157	105	101	0	NO	Mozambique - RSA

[1] The operational transfer limits are established each year by the SAPP CC using a methodology developed in 2006 to assist operators to maintain high reliability in cross-border electricity trading and operational support. These operation transfer limits are updated twice per year.

Table 1 above outlines the findings. The table shows the actual trades for the financial year 2015/2016 between SAPP power utilities which is based on hourly and half hourly dataset (which will be provided to the Secretariat upon request). Trades were evaluated for both directions, i.e. trade from country A to Country B and trade from Country B to Country A. This was compared with the transfer limit of the transmission lines. Dividing the actual trades by the operational capacities allows for the assessment of the transmission lines' load factor. If the load factor for both directions was below 90%, it was concluded that transmission constraints do not exist. Please note, the numbering of tie lines corresponds with the numbering of tie lines in the figure above, as well as with the figures in Annex II (illustrating the operational transfer limits). As the results indicate, there are no transmission constraints in the Southern African grid following the Tool's definition.

As can be seen from Table 1 the load factor for all transmission lines is below 90% in both directions. Following the tool's definition of transmission barriers, it is concluded that, there are no transmission constraints between the interconnected SAPP members. Hence all SAPP member countries listed in Table 1 above may form one single Project Electricity System.

As can be seen from Table 1, the Project Electricity System is not connected to the neighboring countries. Consequently, electricity imports from the Connected Electricity System were not considered for the calculation of the GEF.

STEP 2. Choose whether to Include Off-Grid Power Plants

The tool offers two options to calculate the OM and BM 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.

The project participant may choose whether to include off-grid emissions. After careful evaluation, it was decided not to consider off-grid emissions and Option I was chosen.

STEP 3. Select a Method to Determine the Operating Margin

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on the simple OM is applied. This section analyses whether the share of Low-Cost/Must-Runs (MR) is below 50%. In a first step, the share of Non-Must-Runs (NMR) in the PES is determined. For this case, NMRs are defined as steam power plants, gas turbines, combined cycle power, and diesel plants. Annex I provides a list of all power plants located in the nine countries. The far left column shows the fuel type. Using above definition allows for classifying all power plants in MR and NMR. This definition is based on the guidance of the tool.

A conservative approach for the definition of NMR would be followed, if it is ensured that NMR comprise only those fossil fueled power plants which serve the peak load of the electricity system. In exchange, fossil fueled power plants would have to be classified as MR, if the power plants (or units of the power plants) would serve the base load. Fossil fueled power plants/units generate base load only if:

- The power plant (or units of the power plants) is designed as a district heating/cooling power plant (i.e. Combined Heat and Power (CHP)). As the CHP not only generates electricity but also supplies heat, the power plant (or units of the power plant) may also serve the base load of an electricity system, and/or
- The power plant (or units of the power plant) applies supercritical coal technology. Supercritical coal (SCC) technology features high initial investments and comparably low operational expenditures. Hence this project type is usually operated to serve the base load of an electricity system.

Table 4 below provides a list of fossil fuel power plants. None of the power units covered by these power plants features a CHP design. However there is a supercritical coal power plant, Medupi, which was counted towards the MR[2].

- Based on above analysis, the standard definition was adopted as the PES. The team ensured the correctness of this definition by consultation with the SAPP Coordination Centre.
- Finally the classification was submitted to all power companies involved for revision. No objection was received.

The table below shows that the five year average total generation amounts to 278.11 TWh/yr whereas the average share of MR amounts to 59.52 TWh/yr. The share of MR amounts to 21. 04%.

Table 2: Determination of the Low-Cost/Must-Run Share

Year	04/2011-03/2012	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016
Total electricity generation	281,184,526	276,625,618	277,862,763	279,047,255	275,836,517
Average annual electricity generation in five years	278,111,336				
Generation from low-cost/must-run power units	58,114,638	55,266,294	58,249,583	63,064,299	62,908,051
Average generation from total grid generation	59,520,573				
Low-Cost/Must-Run Resource share	21.40%				
Applicability of Simple OM or Average OM	**Simple OM**				

It is concluded that as the share of MR is below 50%, the simple OM can be applied.

STEP 4. Calculate the Operating Margin Emission Factor

In a next step the simple OM was calculated. The following input data was used:

- All primary and secondary fuel consumption data, net heat rates, net calorific values was collected directly from the power companies or gathered through the SAPP Coordination Centre from the power companies. Annex I provides a list of all power plants, their fuel consumption as well as their electricity generation for the financial years 2013/14, 2014/15 and 2015/16.
- Annex III, Table 9 provides a list of NCVs used for different fuel types.
- Annex IV, Table 10 provides a list of emission factors for the various fuels used.
- For Medupi, the first supercritical coal plant in the region, ESKOM could not yet disclose the plant's key parameters, as the plant became online only in 05/2015 and the data was not yet validated. Consequently, we estimated the efficiency and electricity generation using data provided by ESKOM for Medupi after the reference period. This is conservative compared to

[2] I.e. according to data provided by ESKOM, the first unit of Medupi was commissioned on the 26th May 2015 with an installed capacity of 794 MW. However this is only one of several supercritical coal units under construction in Medupi (total planned capacity of 4,764 MW). At the same time, ESKOM is constructing Kusile supercritical coal power plant with a total installed capacity of 4,800 MW.

using IPCC default efficiency for SSC and the design load factors for SSC in southern Africa, as recently published[3].

- For some power plants, the actual fuel data could not be collected. For those plants, the A2 option for detraining plant specific emission factors was applied. These plants are listed in Table 3 below. For the determination of plants' overall emission levels, CDM EB's default efficiency factors were applied.

Below table lists those five power plants out of 117, where not fuel consumption data could be collected. The related emission levels were determined following the A2 Option outlined below.

Table 3: List of Power Plants Following the A2 Calculation Approach

No.	Power Plant Name	Option
4	IPP Dedisa Peaking power	A2
22	Eskom Medupi Unit 6	A2
115	Aggrekk	A2
116	CTRG	A2
117	Gigawatt	A2

Based on the above outlined input data, the OM emission factor was determined. Following the tool, formula (3), this allows in a subsequent step to calculate the OM emission level:

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

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO2 emission factor in year *y* (tCO2/MWh)
$EF_{CO2,i,y}$	CO2 emission factor of fossil fuel type *i* in year *y* (tCO2/GJ)
$EG_{,y}$	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year *y* (MWh)
y	Most recent historical year for which power generation data is available

For those power plants, where the fuel consumption data for the years 04/2013-03/2016 was available, we applied the A1 calculation approach (Tool, formula 4). These are all power plants listed in Annex I, Table 8, besides those listed Table 3 above).

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \ x \ NCV_{i,y} \ x \ EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

$EF_{EL,m,y}$	CO2 emission factor of power unit *m* in year *y* (tCO2/MWh)
$FC_{i,m,y}$	Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)

[3] Spalding-Fecher, R., Sentala,M., Yamba, F., Lukwesa, B., Himunzowa, G., Heaps, C., Chapman, A., Mahumane, G., Tembo, B., Nyambe, I., 2016, Electricity supply and demand scenarios for the Southern African power pool, Energy Policy, Elsevier;

$EF_{CO2,i,y}$	CO2 emission factor of fossil fuel type *i* in year *y* (tCO2/GJ)
$EG_{,m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
I	All fossil fuel types combusted in power unit *m* in year *y*
Y	Most recent historical year for which power generation data is available

For those power plants, where the fuel consumption data was not available (listed in Table 3 above), the A2 Option was applied (Tool, formula 5):

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

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

Table 4: SAPP Simple Operating Margin Data

No.	Name of Power Plant	04/2013-03/2014		04/2014-03/2015		04/2015-03/2016	
		Net Electricity Generation	CO2 Emission Factor	Net Electricity Generation	CO2 Emission Factor	Net Electricity Generation	CO2 Emission Factor
		MWh	t-CO_2/MWh	MWh	t-CO_2/MWh	MWh	t-CO_2/MWh
1	ESKOM - Acacia	56,443.0	0.9661	64,570.0	1.0422	55,960.0	0.9657
2	ESKOM - Ankerlig	2,358,259.0	0.8252	2,350,792.0	0.8421	2,503,859.5	0.8295
3	ESKOM - Port Rex	73,166.0	0.9634	67,421.0	0.9557	68,699.0	0.9551
4	IPP Dedisa Peaking power	0.0	-	0.0	-	48,875.6	0.6617
5	ESKOM - Gourikwa	1,133,246.0	0.7910	1,226,384.0	0.7929	1,307,888.1	0.8179
		-	-	-	-	-	-
7	ESKOM - Gariep	-	-	-	-	-	-
8	ESKOM - Vanderkloof	-	-	-	-	-	-
9	ESKOM - Koeberg	-	-	-	-	-	-
10	ESKOM - Arnot	10,840,753.0	0.9491	9,893,812.0	0.9619	10,099,018.0	0.9913
11	ESKOM - Camden	8,727,143.0	1.0297	8,336,111.0	1.0353	7,947,972.0	0.9795
12	ESKOM - Duvha	17,925,378.0	0.9218	13,191,464.0	0.9361	14,060,101.0	0.9226
13	ESKOM - Grootvlei	7,345,967.0	1.0652	6,144,207.0	1.0975	5,273,434.0	1.0661
14	ESKOM - Hendrina	8,861,776.0	1.0190	10,079,833.0	1.0933	8,172,225.0	1.0357
15	ESKOM - Kendal	27,012,212.0	1.0166	24,459,162.0	0.9755	25,301,535.0	0.9994

16	ESKOM - Komati	5,059,255.0	0.9989	4,066,079.0	1.0384	4,241,812.0	1.0040
17	ESKOM - Kriel	14,443,442.0	0.9568	14,803,828.4	0.9009	15,940,417.2	0.9256
18	ESKOM - Lethabo	23,092,551.0	1.1985	23,742,350.0	1.1610	20,996,410.0	1.2148
19	ESKOM - Majuba	23,801,048.0	0.9327	22,423,750.0	0.9814	21,187,846.0	0.9230
20	ESKOM - Matimba	25,895,187.0	0.9112	26,851,628.0	0.9011	24,554,035.0	0.8841
21	ESKOM - Matla	18,376,342.0	0.9301	20,221,135.0	0.9658	20,811,348.0	0.9555
22	Eskom Medupi Unit 6	0.0	-	0.0	-	3,373,734.8	0.8501
23	ESKOM - Tutuka	18,103,698.0	0.9991	20,594,572.0	0.9579	18,383,009.0	0.9702
24	ESKOM - Sere wind	-	-	-	-	-	-
25	IPP Dassiesklip wind	-	-	-	-	-	-
26	IPP van Staddens	-	-	-	-	-	-
27	IPP Hopefield	-	-	-	-	-	-
28	IPP Noblesfontein	-	-	-	-	-	-
29	IPP Kouga	-	-	-	-	-	-
30	IPP Dorper	-	-	-	-	-	-
31	IPP Jeffreys Bay	-	-	-	-	-	-
32	IPP Cookhouse	-	-	-	-	-	-
33	IPP Waainek	-	-	-	-	-	-
34	IPP Grassridge	-	-	-	-	-	-
35	IPP Gouda	-	-	-	-	-	-
36	IPP Chaba	-	-	-	-	-	-
37	IPP Khi solar one CSP	-	-	-	-	-	-
38	IPP KaXu Solar One CSP	-	-	-	-	-	-
39	IPP Bokpoort CSP	-	-	-	-	-	-
40	IPP Kalkbult CSP	-	-	-	-	-	-
41	IPP Slim Sun Swartland	-	-	-	-	-	-
42	IPP Rustmo 1	-	-	-	-	-	-
43	IPP Konkoonsies	-	-	-	-	-	-
44	IPP Aries	-	-	-	-	-	-
45	IPP Greefspan	-	-	-	-	-	-
46	IPP Herbert	-	-	-	-	-	-
47	IPP Mulilo-Prieska	-	-	-	-	-	-
48	IPP Soutpan	-	-	-	-	-	-
49	IPP Witkop	-	-	-	-	-	-
50	IPP Touwsrivier	-	-	-	-	-	-
51	IPP De Aar	-	-	-	-	-	-
52	IPP Mulilo-De Aaar	-	-	-	-	-	-

53	IPP Solar Capoital-De Aar	-	-	-	-	-	-
54	IPP Mainstream-|Droogfontein	-	-	-	-	-	-
55	IPP Letsatsi	-	-	-	-	-	-
56	IPP Lesedi	-	-	-	-	-	-
57	IPP Kathu	-	-	-	-	-	-
58	IPP Sishen	-	-	-	-	-	-
59	IPP Aurora	-	-	-	-	-	-
60	IPP Vredendal	-	-	-	-	-	-
61	IPP Linde	-	-	-	-	-	-
62	IPP Dreunberg	-	-	-	-	-	-
63	IPP Jasper	-	-	-	-	-	-
64	IPP Boshoff	-	-	-	-	-	-
65	IPP Upington	-	-	-	-	-	-
66	Zesco - Kariba North	-	-	-	-	-	-
67	Zesco - Kafue Gorge	-	-	-	-	-	-
68	Zesco - Victoria Falls	-	-	-	-	-	-
69	IPP Zambia - Mulungushi	-	-	-	-	-	-
70	Zesco - Lusiwasi	-	-	-	-	-	-
71	Zesco Kariba North Extension	-	-	-	-	-	-
72	Ndola Energy (private) - HFO	0.0	-	382,578.0	0.6643	379,945.1	0.6643
73	Zesco - Lunzua	-	-	-	-	-	-
74	Zesco - Chishimba Falls	-	-	-	-	-	-
75	Zesco - Musonda	-	-	-	-	-	-
76	BPC - Morupule A	0.0	-	0.0	-	0.0	-
77	BPC- Morupule B	1,613,253.0	1.1514	2,227,206.0	1.1341	2,267,544.0	1.0628
78	BPC - Matshelagabedi	81,175.0	0.7746	59,836.0	0.7647	62,298.1	0.7636
79	BPC-Matshelagabedi	-	-	-	-	4,185.1	0.7152
80	BPC-Orapa	81,179.0	0.7360	39,522.0	0.0075	40,056.0	0.7102
81	SEB - Ezulwini	-	-	-	-	-	-
82	SEB - Edwaleni I	-	-	-	-	-	-
83	SEB - Edwaleni II	-	-	-	-	-	-
84	SEB - Edwaleni III	-	-	-	-	-	-
85	SEB - Edwaleni IV	-	-	-	-	-	-
86	SEB - Edwaleni V	-	-	-	-	-	-
87	SEB - Mbane Hydro	-	-	-	-	-	-
88	SEB - Maguga	-	-	-	-	-	-

89	SEB - Maguduza	-	-	-	-	-	-
90	SEB - Edwaleni D6	0.0	-	0.0	-	0.0	-
91	SEB - Edwaleni D7	0.0	-	0.0	-	0.0	-
92	NAMPOWER van Eck	3,867.6	1.5928	412.3	1.5958	47,708.4	1.5960
93	NAMPOWER - Paratus	5.1	5.8022	268.1	0.8309	829.9	0.7580
94	NAMPOWER - Ruacana	-	-	-	-	-	-
95	NAMPOER Anixas	13,519.7	3.4132	17,994.6	3.4089	22,077.5	3.5396
96	IPP Namibia - Omburu PV	-	-	-	-	-	-
97	ZESA - Kariba South	-	-	-	-	-	-
98	ZESA - Harare	145,399.0	1.8871	215,659.0	1.6989	209,150.0	1.4805
99	ZESA - Munyati	189,315.0	2.0069	175,994.0	2.2314	173,280.0	2.2388
100	ZESA - Bulawayo	171,961.2	1.7872	167,482.0	2.1740	174,050.0	1.9764
101	ZESA - Hwange	3,826,850.0	1.3608	3,821,362.0	1.3650	3,720,810.0	1.2647
102	SNEL - Inga I	-	-	-	-	-	-
103	SNEL - Inga II	-	-	-	-	-	-
104	SNEL - Koni	-	-	-	-	-	-
105	SNEL - Nseke	-	-	-	-	-	-
106	SNEL - Nzilo	-	-	-	-	-	-
107	SNEL - Mwadingusha	-	-	-	-	-	-
108	SNEL - Zongo	-	-	-	-	-	-
109	SNEL - Sanga	-	-	-	-	-	-
110	LEC - Muela	-	-	-	-	-	-
111	Corumana	-	-	-	-	-	-
112	Cahora Bassa	-	-	-	-	-	-
113	Chicamba	-	-	-	-	-	-
114	Mavuzi	-	-	-	-	-	-
115	Aggreko	95,000.0	0.5213	102,000.0	0.5213	122,000.0	0.5213
116	CTRG	0.0	-	0.0	-	1,118,000.0	0.5213
117	Gigawatt	0.0	-	0.0	-	70,000.0	0.5213
Annual Electricity Generation in Total		219,327,390		215,982,956		215,119,084	

Based on above calculation, the OM was determined. The findings are presented in Table 5 below.

Table 5: Calculation of the Simple OM	
2013/14 Electricity Generation (in MWh)	219,613,180
$EF_{grid,OMsimple,\ 2013/14}$ (in tCO2)	1.0314
2014/15 Electricity Generation (in MWh)	215,982,956
$EF_{grid,\ OMsimple,\ 2014/15}$ (in tCO2)	1.0304
2015/16 Electricity Generation (in MWh)	212,928,466
$EF_{grid,\ OMsimple,\ 2015/16}$	1.0156
Operating Margin Emission Factor(t-CO_2/MWh)	**1.0259**

STEP 5. Calculate the Build Margin Emission Factor

Following the tool, Step 5, §73a-f, the sample group of power units m used to calculate the build margin consists of either:

- The set of five power units that have been built most recently; or
- The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

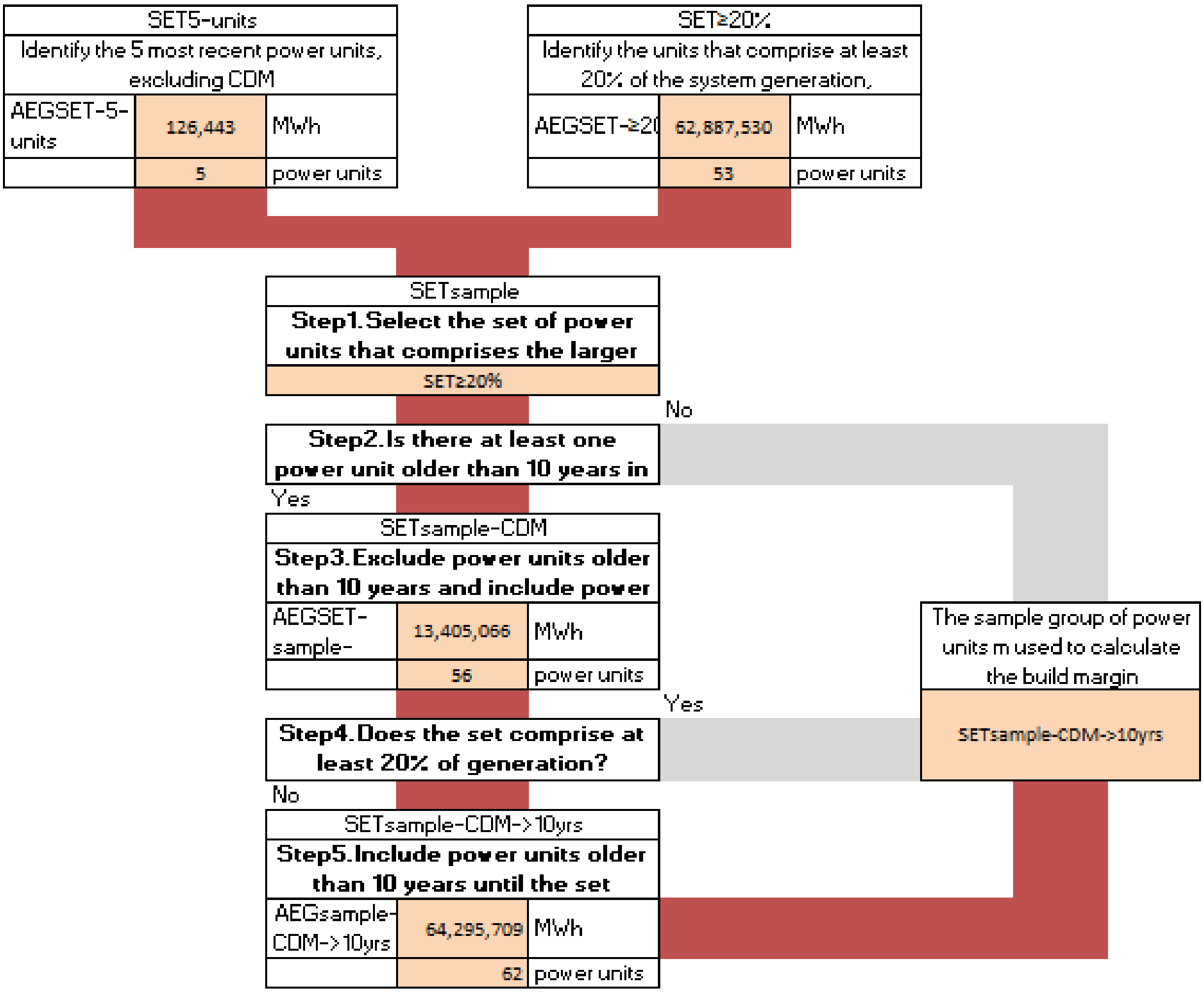
Following the guidance of the tool, this analysis was conducted for the most recent year (i.e. 04/2015-03/2016). The most recent five power plants generate 126,443 MWh (3.2% of total generation). The set which comprises the last 20% of the system generation, excluding those registered under the CDM covers 53 power plants. These plants generate 62,887,530 MWh in 2015/16 (23.12% of total generation). Therefore the latter option was applied, as it encompasses the set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

As this set comprises power plants which are older than 10 years, we excluded of power plants older than 10 years and included registered CDM plants. This results in a set of 56 plants with 13,405,055 MWh generation which falls short of the 20% generation benchmark. Hence we added plants older than 10 years and plants registered under the CDM. This procedure is illustrated by the graph below.

Following this approach results in a BM which comprises 62 facilities commissioned between 2016 and 1988. Kendal in RSA is the power plant on the margin4. Without Kendal, the BM group would cover only 14.7% of the total 2015/16 generation. Including Kendal increases the generation share to 23.7%. Following the stipulations of the Tool, Kendal has to be included. Calculating the BM emission factor results in a value of 0.8723 tCO2/MWh. Details are found in Table 6.

[4] On the margin indicates that Kendal is the power plant for which the 20% threshold is reached and bypassed.

Figure 2: Procedure for selecting BM Power Plants



According to the tool, the build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units m identified in step 5 above. To calculate the BM, the following formula was applied (Tool, formula 15):

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

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	Power units included in the build margin
y	Most recent historical year for which power generation data is available

Following this approach leads to the determination of the BM emission level for 2015/16. The results are presented in Table 6.

Table 6: Calculation of the SAPP Build Margin for 04/2015-03/2016						
Build Margin Group Option		**SETsample-CDM->10yrs**				
No.	Name of power plant	Year commissioned	Fuel Type Energy Source	Net Electricity Generation (MWh/yr)	Emission Factor tCO_2/MWh	Emissions (tCO_2)
33	IPP Waainek	2016	Wind	7,568	0.000	-
37	IPP Khi solar one CSP	2016	Solar	0	-	-
39	IPP Bokpoort CSP	2016	Solar	0	-	-
4	IPP Dedisa Peaking power	2015	Gas/Diesel Oil	48,876	0.662	32,340
22	Eskom Medupi Unit 6	2015	Other Bituminous Coal	3,373,735	0.850	2,867,932
24	ESKOM - Sere wind	2015	Wind	311,339	0.000	-
29	IPP Kouga	2015	Wind	200,522	0.000	-
34	IPP Grassridge	2015	Wind	139,275	0.000	-
35	IPP Gouda	2015	Wind	115,645	0.000	-
36	IPP Chaba	2015	Wind	20,415	0.000	-
38	IPP KaXu Solar One CSP	2015	Solar	180,845	0.000	-
41	IPP Slim Sun Swartland	2015	Solar	4,691	0.000	-
73	Zesco - Lunzua	2015	Hydro	25,936	0.000	-
79	BPC-Matshelagabedi	2015	Gas/Diesel Oil	4,185	0.715	2,993
96	IPP Namibia - Omburu PV	2015	Solar	5,865	0.000	-
116	CTRG	2015	Natural Gas	1,118,000	0.495	553,283
117	Gigawatt	2015	Natural Gas	70,000	0.495	34,642
25	IPP Dassiesklip wind	2014	5	7	0.000	27
26	IPP van Staddens	2014	Wind	72,461	0.000	-
27	IPP Hopefield	2014	Wind	167,695	0.000	-
28	IPP Noblesfontein	2014	Wind	211,865	0.000	-
30	IPP Dorper	2014	Wind	277,217	0.000	-
31	IPP Jeffreys Bay	2014	Wind	411,709	0.000	-
32	IPP Cookhouse	2014	Wind	306,220	0.000	-
40	IPP Kalkbult CSP	2014	Solar	143,788	0.000	-
43	IPP Konkoonsies	2014	Solar	20,793	0.000	-
44	IPP Aries	2014	Solar	20,256	0.000	-
45	IPP Greefspan	2014	Solar	26,879	0.000	-

46	IPP Herbert	2014	Solar	52,526	0.000	-
47	IPP Mulilo-Prieska	2014	Solar	40,420	0.000	-
48	IPP Soutpan	2014	Solar	62,947	0.000	-
49	IPP Witkop	2014	Solar	66,498	0.000	-
50	IPP Touwsrivier	2014	Solar	69,204	0.000	-
51	IPP De Aar	2014	Solar	94,097	0.000	-
52	IPP Mulilo-De Aaar	2014	Solar	19,481	0.000	-
53	IPP Solar Capoital-De Aar	2014	Solar	151,309	0.000	-
54	IPP Mainstream-|Droogfontein	2014	Solar	94,177	0.000	-
55	IPP Letsatsi	2014	Solar	145,903	0.000	-
56	IPP Lesedi	2014	Solar	148,731	0.000	-
57	IPP Kathu	2014	Solar	179,418	0.000	-
58	IPP Sishen	2014	Solar	210,116	0.000	-
59	IPP Aurora	2014	Solar	18,819	0.000	-
60	IPP Vredendal	2014	Solar	19,031	0.000	-
61	IPP Linde	2014	Solar	87,553	0.000	-
62	IPP Dreunberg	2014	Solar	157,708	0.000	-
63	IPP Jasper	2014	Solar	181,257	0.000	-
64	IPP Boshoff	2014	Solar	137,932	0.000	-
65	IPP Upington	2014	Solar	18,261	0.000	-
71	Zesco Kariba North Extension	2014	Hydro	1,178,511	0.000	-
72	Ndola Energy (private) - HFO	2014	Residual Fuel Oil	379,945	0.664	252,405
42	IPP Rustmo 1	2013	Solar	12,532	0.000	-
77	BPC- Morupule B	2012	Sub-Bituminous Coal	2,267,544	1.063	2,409,838
115	Aggreko	2012	Natural Gas	122,000	0.521	63,596
80	BPC-Orapa	2011	Gas/Diesel Oil	40,056	0.710	28,449
95	NAMPOER Anixas	2011	Residual Fuel Oil	22,077	3.540	78,144
78	BPC - Matshelagabedi	2010	Gas/Diesel Oil	62,298	0.764	47,568
2	ESKOM - Ankerlig	2007	Gas/Diesel Oil	2,503,859	0.830	2,077,028
5	ESKOM - Gourikwa	2007	Gas/Diesel Oil	1,307,888	0.818	1,069,766
88	SEB - Maguga	2006	Hydro	61,454	0.000	-
110	LEC - Muela	1999	Hydro	528,060	0.000	-
19	ESKOM - Majuba	1996	Other Bituminous Coal	21,187,846	0.957	20,277,842

15	ESKOM - Kendal	1988	Other Bituminous Coal	25,301,535	1.036	26,218,032
Total				64,216,776		56,013,885
Build Margin Emission Factor (t-CO_2/MWh)						**0.8723**

STEP 7. Calculate the Combined Margin Emissions Factor

Based on standard weighting of the BM and the OM, the SAPP region offers a GEF of 0.9126 tCO2/MWh. Details are found in Table 7. Guidance on the selection of alternative weights can be found in the tool.

Table 7: Summary of the Regional SAPP GEF			
OM Emission Factor (in t-CO_2/MWh)	1.0259		
BM Emission Factor (in t-CO_2/MWh)	0.8723		
	Weight of the OM	Weight of the BM	CM Emission Factor (in t-CO2/MWh)
Wind and solar power generation project activities for the first crediting period and for subsequent crediting periods	0.75	0.25	0.9875
All other projects for the first crediting period	0.5	0.5	0.9491
All other projects for the second and third crediting period	0.25	0.75	0.9107

Validity of the proposed standardized baseline

The proposed standardized baseline shall be valid for a period of three years. Thereafter the emission factor shall be updated based on current data of the existing and newly commissioned power plants and the delineation of the project electricity system shall be assessed considering the commissioning of currently planned tie lines such as the planned connection between Zambia and Tanzania.

Deviations from the approved methodological tool (if applicable)

Not applicable.

Annex I: Fuel Consumption and Electricity Generation Data

Table 8: SAPP Electricity Generation and Fuel Consuption

No.	Name of Power Plant	Date Installed	Installed Capacity (MW)	Net Electricity Generation (MWh)			Fuel Consumption (t/year)			Fuel Type/ Energy Source
		Year		04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	
1	ESKOM - Acacia	1976	171.0	56,443	64,570	55,960	17,267	21,308	17,111	Gas/Diesel Oil
2	ESKOM - Ankerlig	2007	1,338.0	2,358,259	2,350,792	2,503,859	627,460	638,345	669,723	Gas/Diesel Oil
3	ESKOM - Port Rex	1976	171.0	73,166	67,421	68,699	22,321	20,402	20,775	Gas/Diesel Oil
4	IPP Dedisa Peaking power	2015	335.0	0	0	48,876				Gas/Diesel Oil
5	ESKOM - Gourikwa	2007	746.0	1,133,246	1,226,384	1,307,888	289,028	313,536	344,938	Gas/Diesel Oil
6	ESKOM - Drakensberg	1981	1,000.0							
7	ESKOM - Gariep	1971	360.0	456,656	342,828	207,884				Hydro
8	ESKOM - Vanderkloof	1975	240.0	579,841	508,644	480,042				Hydro
9	ESKOM - Koeberg	1984	1,930.0	14,105,633	13,793,973	12,237,401				Nuclear
10	ESKOM - Arnot	1971	2,352.0	10,840,753	9,893,812	10,099,018	6,066,013	5,595,389	5,864,921	Sub-Bituminous Coal
11	ESKOM - Camden	1966	1,520.0	8,727,143	8,336,111	7,947,972	5,297,913	5,074,264	4,560,670	Sub-Bituminous Coal
12	ESKOM - Duvha	1980	3,600.0	17,925,378	13,191,464	14,060,101	9,741,615	7,260,002	7,599,737	Sub-Bituminous Coal
13	ESKOM - Grootvlei	1969	1,200.0	7,345,967	6,144,207	5,273,434	4,613,355	3,964,825	3,293,564	Sub-Bituminous Coal
14	ESKOM - Hendrina	1970	1,965.0	8,861,776	10,079,833	8,172,225	5,323,902	6,479,235	4,958,484	Sub-Bituminous Coal
15	ESKOM - Kendal	1988	4,116.0	27,012,212	24,459,162	25,301,535	16,190,242	14,028,640	14,813,213	Sub-Bituminous Coal
16	ESKOM - Komati	1966	940.0	5,059,255	4,066,079	4,241,812	2,979,546	2,482,388	2,494,856	Sub-Bituminous Coal
17	ESKOM - Kriel	1976	3,000.0	14,443,442	14,803,828	15,940,417	8,147,633	7,841,257	8,643,898	Sub-Bituminous Coal
18	ESKOM - Lethabo	1985	3,708.0	23,092,551	23,742,350	20,996,410	16,317,957	16,206,472	14,941,989	Sub-Bituminous Coal
19	ESKOM - Majuba	1996	4,110.0	23,801,048	22,423,750	21,187,846	13,087,805	12,938,389	11,457,000	Sub-Bituminous Coal
20	ESKOM - Matimba	1987	3,990.0	25,895,187	26,851,628	24,554,035	13,911,050	14,226,673	12,718,092	Sub-Bituminous Coal

21	ESKOM - Matla	1979	3,600.0	18,376,342	20,221,135	20,811,348	10,076,382	11,482,829	11,649,395	Sub-Bituminous Coal
22	Eskom Medupi Unit 6	2015	794.0	0	0	3,373,734.8				Sub-Bituminous Coal
23	ESKOM - Tutuka	1985	3,654.0	18,103,698	20,594,572	18,383,009	10,663,894	11,598,592	10,448,003	Sub-Bituminous Coal
24	ESKOM - Sere wind	2015	100.0			311,339				Wind
25	IPP Dassiesklip wind	2014	27.0	26	80,201	78,940				Wind
26	IPP van Staddens	2014	27.0	1,705	68,742	72,461				Wind
27	IPP Hopefield	2014	65.4	7,106	171,804	167,695				Wind
28	IPP Noblesfontein	2014	73.8	0	131,883	211,865				Wind
29	IPP Kouga	2015	77.7	0	0	200,522				Wind
30	IPP Dorper	2014	97.5	0	140,453	277,217				Wind
31	IPP Jeffreys Bay	2014	135.1	952	358,846	411,709				Wind
32	IPP Cookhouse	2014	135.8	0	104,313	306,220				Wind
33	IPP Waainek	2016	23.3	0	0	7,568				Wind
34	IPP Grassridge	2015	59.8	0	0	139,275				Wind
35	IPP Gouda	2015	135.5	0	0	115,645				Wind
36	IPP Chaba	2015	21.0	0	0	20,415				Wind
37	IPP Khi solar one CSP	2016	50.0	0	0	0				Solar
38	IPP KaXu Solar One CSP	2015	100.0	0	0	180,845				Solar
39	IPP Bokpoort CSP	2016	50.0	0	0	0				Solar
40	IPP Kalkbult CSP	2014	72.4	43,639	150,528	143,788				Solar
41	IPP Slim Sun Swartland	2015	5.0	0	0	4,691				Solar
42	IPP Rustmo 1	2013	6.9	1,463	11,808	12,532				Solar
43	IPP Konkoonsies	2014	9.7	1,759	21,209	20,793				Solar
44	IPP Aries	2014	9.7	1,590	21,050	20,256				Solar
45	IPP Greefspan	2014	9.9	0	19,012	26,879				Solar
46	IPP Herbert	2014	19.9	4,142	51,788	52,526				Solar
47	IPP Mulilo-Prieska	2014	19.1	0	15,296	40,420				Solar
48	IPP Soutpan	2014	27.9	0	31,597	62,947				Solar

49	IPP Witkop	2014	29.7	0	18,433	66,498				Solar
50	IPP Touwsrivier	2014	36.0	0	6,434	69,204				Solar
51	IPP De Aar	2014	45.6	298	83,917	94,097				Solar
52	IPP Mulilo-De Aaar	2014	10.0	0	9,620	19,481				Solar
53	IPP Solar Capoital-De Aar	2014	75.0	0	64,777	151,309				Solar
54	IPP Mainstream-|Droogfontein	2014	45.4	644	82,417	94,177				Solar
55	IPP Letsatsi	2014	64.0	0	91,786	145,903				Solar
56	IPP Lesedi	2014	64.0	0	93,317	148,731				Solar
57	IPP Kathu	2014	75.0	0	124,805	179,418				Solar
58	IPP Sishen	2014	74.0	0	24,088	210,116				Solar
59	IPP Aurora	2014	8.9	0	596	18,819				Solar
60	IPP Vredendal	2014	8.8	0	8,168	19,031				Solar
61	IPP Linde	2014	36.8	0	48,414	87,553				Solar
62	IPP Dreunberg	2014	69.6	0	49,180	157,708				Solar
63	IPP Jasper	2014	75.0	0	31,977	181,257				Solar
64	IPP Boshoff	2014	57.0	0	33,262	137,932				Solar
65	IPP Upington	2014	8.9	0	8,327	18,261				Solar
66	Zesco - Kariba North	1976	720.0	5,423,707	4,993,235	4,316,354				Hydro
67	Zesco - Kafue Gorge	1973	990.0	7,004,600	6,603,770	6,417,518				Hydro
68	Zesco - Victoria Falls	1950	108.0	780,813	808,669	784,520				Hydro
69	IPP Zambia - Mulungushi	1955	52.0	402,521	287,872	214,636				Hydro
70	Zesco - Lusiwasi	1967	12.0	55,671	58,593	63,916				Hydro SSC
71	Zesco Kariba North Extension	2014	360.0	0	1,226,674	1,178,511				Hydro
72	Ndola Energy (private) - HFO	2014	48.0	0	382,578	379,945		80,341	79,788	Residual Fuel Oil
73	Zesco - Lunzua	2015	14.8	3,163	3,466	25,936				Hydro SSC
74	Zesco - Chishimba Falls	1959	6.0	17,810	23,486	24,200				Hydro SSC
75	Zesco - Musonda	1960	5.0	25,221	20,371	6,412				Hydro SSC

76	BPC - Morupule A	1987	132.0	0	0	0				Sub-Bituminous Coal
77	BPC- Morupule B	2012	600.0	1,613,253	2,227,206	2,267,544	884,200	1,211,042	1,178,135	Sub-Bituminous Coal
78	BPC - Matshelagabedi	2010	70.0	81,175	59,836	62,298	20,106	14,632	15,196	Gas/Diesel Oil
79	BPC-Matshelagabedi	2015	35.0	-	-	4,185	-	-	963	Gas/Diesel Oil
80	BPC-Orapa	2011	90.0	81,179	39,522	40,056	19,105	95	9,088	Gas/Diesel Oil
81	SEB - Ezulwini	1985	20.0	67,252	45,148	17,931				Hydro
82	SEB - Edwaleni I	1964	2.5	14,811	10,781	4,471				Hydro SSC
83	SEB - Edwaleni II	1964	2.5	13,262	10,533	4,669				Hydro SSC
84	SEB - Edwaleni III	1964	2.5	13,993	10,428	4,433				Hydro SSC
85	SEB - Edwaleni IV	1965	2.5	12,675	9,771	3,646				Hydro SSC
86	SEB - Edwaleni V	1969	5.0	38,261	29,901	13,732				Hydro SSC
87	SEB - Mbane Hydro	1954	0.5	0	0	0				Hydro SSC
88	SEB - Maguga	2006	20.0	105,406	87,271	61,454				Hydro
89	SEB - Maguduza	1969	5.6	36,922	27,214	12,938				Hydro SSC
90	SEB - Edwaleni D6	1968	4.5	0	0	0				Gas/Diesel Oil
91	SEB - Edwaleni D7	1970	4.5	0	0	0				Gas/Diesel Oil
92	NAMPOWER van Eck	1979	120.0	3,868	412	47,708	2,575.0	275.0	31,828.0	Other Bituminous Coal
93	NAMPOWER - Paratus	1976	12.0	5	268	830	0.0	42.8	157.1	Residual Fuel Oil
94	NAMPOWER - Ruacana	1980	347.0	1,323,239	1,606,565	1,255,163				Hydro
95	NAMPOER Anixas	2011	23.0	13,520	17,995	22,077	13,241.6	17,642.4	22,528.0	Residual Fuel Oil
96	IPP Namibia - Omburu PV	2015	5.0	0	0	5,865				Solar
97	ZESA - Kariba South	1962	750.0	4,981,562	5,402,503	4,938,130				Hydro
98	ZESA - Harare	1947	135.0	145,399	215,659	209,150	100,188.0	133,776.0	113,063.0	Other Bituminous Coal
99	ZESA - Munyati	1946	120.0	189,315	175,994	173,280	141,501.1	146,263.1	144,484.9	Other Bituminous Coal
100	ZESA - Bulawayo	1947	120.0	171,961	167,482	174,050	114,460.0	135,610.0	128,116.0	Other Bituminous Coal
101	ZESA - Hwange	1987	920.0	3,826,850	3,821,362	3,720,810	2,249,520.0	2,256,141.0	2,032,645.0	Sub-Bituminous Coal
102	SNEL - Inga I	1972	351.0	1,132,000	1,627,132	1,781,855				Hydro
103	SNEL - Inga II	1982	1,424.0	4,608,000	4,246,616	4,221,751				Hydro

104	SNEL - Koni	1962	42.0	103,000	216,208	203,091				Hydro
105	SNEL - Nseke	1956	260.0	1,151,000	1,471,888	1,359,776				Hydro
106	SNEL - Nzilo	1953	108.0	475,000	535,992	516,087				Hydro
107	SNEL - Mwadingusha	1930	68.0	242,000	226,641	207,703				Hydro
108	SNEL - Zongo	1955	75.0	134,000	233,241	232,281				Hydro
109	SNEL - Sanga	1932	12.0	0	0	0				Hydro SSC
110	LEC - Muela	1999	72.0	513,030	517,380	528,060				Hydro
111	Corumana	1975	12.0	54,000	51,000	24,000				Hydro SSC
112	Cahora Bassa	1979	2,050.0	14,431,000	15,892,000	16,978,000				Hydro
113	Chicamba	1960	200.0	18,000	54,000	54,000				Hydro
114	Mavuzi	1960	60.0	148,000	178,000	24,000				Hydro
115	Aggreko	2012	130.0	95,000	102,000	122,000				Natural Gas
116	CTRG	2015	175.0	0	0	1,118,000				Natural Gas
117	Gigawatt	2015	120.0	0	0	70,000				Natural Gas

Annex II: Operational Transfer Limits

As discussed during Step 1, the SAPP defined operational transfer limits for electricity trades from North to South and South to North. The transfer limits per line were illustrated in the maps below.

Figure 3: Operational Transfer Limits North to South

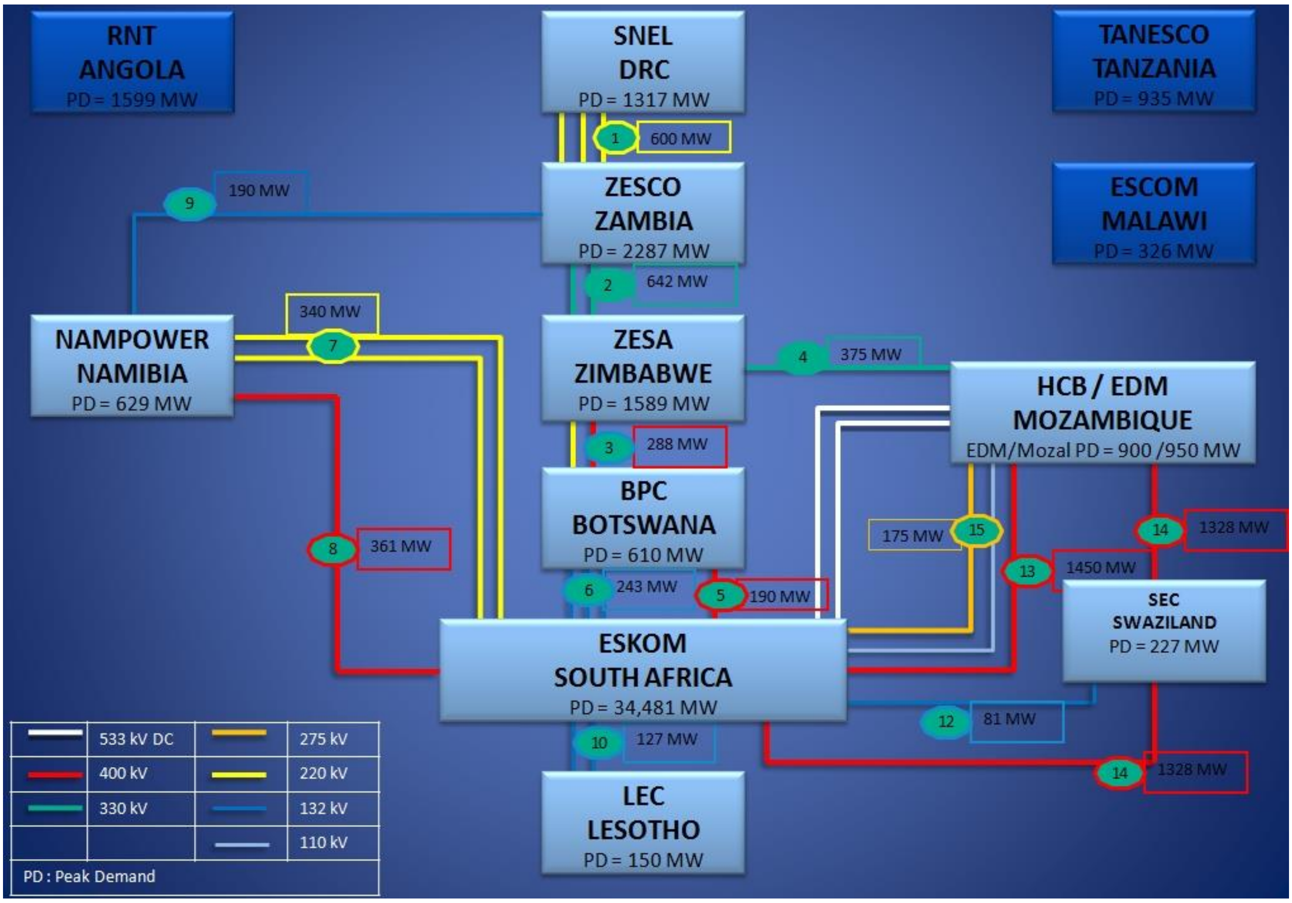
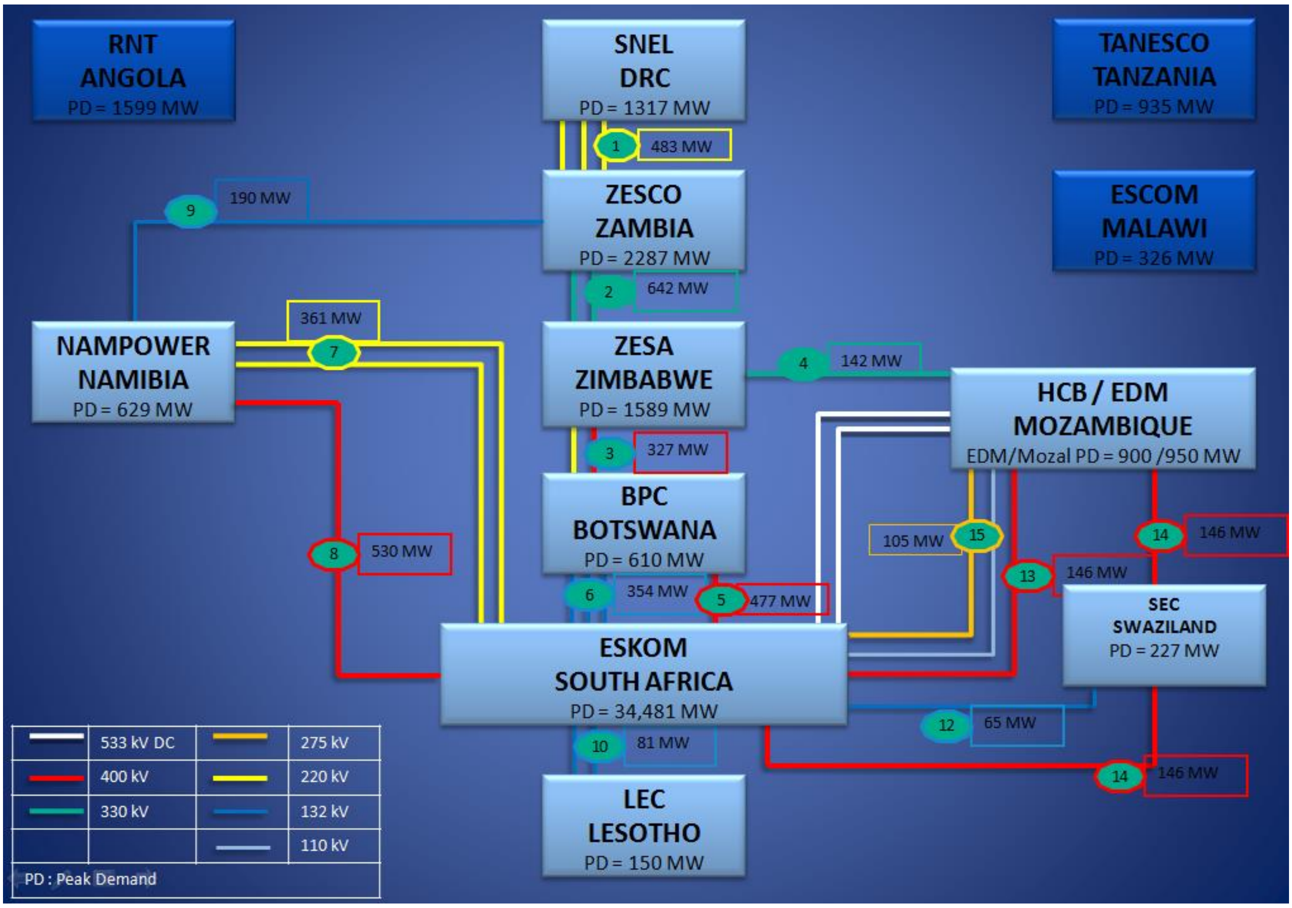


Figure 4: Operational Transfer Limits South to North



Annex III: Evaluations of Interconnections between DRC and Burundi

Stakeholders raised a question regarding the Ruizi hydroelectric plant which is located in DRC (i.e. within the boundaries of SAPP member countries) but which provides energy not only to DRC but also serves Burundi and through Burundi, Rwanda. This question aims at whether Burundi and Rwanda should be added to the SAPP PES.

We would like to clarify, that Ruizi hydroelectric plant is located at the border between DRC and Burundi and that it is correct that the plant serves both countries. However, the plant is integrated in an isolated distribution grid which is not connected to DRCs T&D system. Consequently, Burundi is not considered to be part of the SAPP PES.

The figure on the right shows a map of DRC with a close up on North Kivu. It shows that there is the plan to construct a 220 kV line (i.e. red line) which would connect the region with the reminder of the country, however this is currently not implemented.

Figure 5: Evaluation of Transmission Ties DRC - Burundi

Annex IV: Quality Assurance and Quality Control Procedures

Institutional setup: QAQC in this specific case is not done by the Designated National Authorities but merely by the SAPP CC which is the coordination body for the power sector in all nine interconnected countries.

The SAPP CC engaged in the data collection and addressed specific experts within the power utilities to provide the requested data. These experts acted under the mandate of the power utilities and within the overall framework of the SAPP.

Quality Control

- A data collection protocol was developed based on the IGES tool and prepared with the existing data for which updating was required while asking at the same time for the provision of data on newly commissioned, grid connected power plants. The data protocol was sent out to power utilities by the SAPP CC accompanied with a letter from the acting manager of the SAPP CC requesting the submission of data to the SAPP CC by the 15th of December 2016. To expedite, the team of consultants spend time in the Coordination Centre supporting the collection of a complete data set.
- The power utilities conduct their own quality control prior on the data provided.
- We assessed the transmission- and generation data provided for data integrity, correctness, and completeness.
- We avoided the double counting of electricity generated by excluding data from the pump-storage power plants.
- In cases where this lead to questions regarding the data provided, we contacted the power utilities directly seeking clarifications.
- In the event, where we found data gaps or inconsistencies we iterated with the consent of the utilities to make an agreed estimation. The estimations were provided to the utilities for validation.
- In the event where we found data gaps and /or inconsistencies related to data on the transmission system, we iterated with SAPP to make an agreed estimation.
- In cases where it was not possible to obtain specific fuel NCVs and or net heat rates, we resorted using weighted averages provided by the utilities.

Quality Assurance

- The development and the update of the SB was done by a standardized template for data collection based on an excel model developed by IGES. This assures uniformity of the collected data in term units used (e.g. MWh, kL, t coal etc) and reference periods amongst data provided by all nine utilities.
- The calculation of the SB and its updates was done by the latest version of the IGES tool and in consistency with the latest version of the Tool 07 to determine the emission factor of an electricity system. The IGES tool offers an automated approach for the calculation of the GEF and minimizes process to error while maximizing consistency.
- The sources of data for the SB were the actual power utilities who provided data with the support of the SAPP CC based on audited and / or validated data.
- When collecting the data, we put strong preference on collecting Tier 3 data (e.g. plant specific primary fuel consumption and plant specific NCVs; this was further complemented with plant specific fuel consumption and plant specific NCVs for secondary fuels).
- The SAPP CC uses PSSE modeling to determine the transfer capacities and limits of all interconnectors within the SAPP grid. We used this input to verify the actual transmission constraints in order to complement our analysis according to the Tool 07.
- The final draft calculation and underlying data was provided by SAPP CC to all power utilities for validation.

Annex V: Default NCVs, Upper and Lower Limits

Table 9: Default NCVs, Lower and Upper Limits

Fuel type Description		Net calorific value (TJ/Gg)	Lower	Upper
	Crude Oil	42.3	40.1	44.8
	Orimulsion	27.5	27.5	28.3
	Natural Gas Liquids	44.2	40.9	46.9
Gasoline	Motor Gasoline	44.3	42.5	44.8
	Aviation Gasoline	44.3	42.5	44.8
	Jet Gasoline	44.3	42.5	44.8
	Jet Kerosene	44.1	42	45
	Other Kerosene	43.8	42.4	45.2
	Shale Oil	38.1	32.1	45.2
	Gas/Diesel Oil	43	41.4	43.3
	Residual Fuel Oil	40.4	39.8	41.7
	Liquefied Petroleum Gases	47.3	44.8	52.2
	Ethane	46.4	44.9	48.8
	Naphtha	44.5	41.8	46.5
	Bitumen	40.2	33.5	41.2
	Lubricants	40.2	33.5	42.3
	Petroleum Coke	32.5	29.7	41.9
	Refinery Feedstocks	43	36.3	46.4
Other Oil	Refinery Gas	49.5	47.5	50.6
	Paraffin Waxes	40.2	33.7	48.2
	White Spirit and SBP	40.2	33.7	48.2
	Other Petroleum Products	40.2	33.7	48.2
	Anthracite	26.7	21.6	32.2
	Coking Coal	28.2	24	31
	Other Bituminous Coal	25.8	19.9	30.5
	Sub-Bituminous Coal	18.9	11.5	26
	Lignite	11.9	5.5	21.6
	Oil Shale and Tar Sands	8.9	7.1	11.1
	Brown Coal Briquettes	20.7	15.1	32
	Patent Fuel	20.7	15.1	32
Coke	Coke Oven Coke and Lignite Coke	28.2	25.1	30.2
	Gas Coke	28.2	25.1	30.2
	Coal Tar	28	14.1	55

Derived Gases	Gas Works Gas	38.7	19.6	77
	Coke Oven Gas	38.7	19.6	77
	Blast Furnace Gas	2.47	1.2	5
	Oxygen Steel Furnace Gas	7.06	3.8	15
	Natural Gas	48	46.5	50.4
	Municipal Wastes (non-biomass fraction)	10	7	18
	Industrial Wastes	NA	NA	NA
	Waste Oil	40.2	20.3	80
Solid Biofuels	Peat	9.76	7.8	12.5
	Wood/Wood Waste	15.6	7.9	31
	Sulphite lyes (black liquor)	11.8	5.9	23
	Other Primary Solid Biomass	11.6	5.9	23
	Charcoal	29.5	14.9	58
Liquid Biofuels	Biogasoline	27	13.6	54
	Biodiesels	27	13.6	54
	Other Liquid Biofuels	27.4	13.8	54
GasBiomass	Landfill Gas	50.4	25.4	100
	Sludge Gas	50.4	25.4	100
	Other Biogas	50.4	25.4	100
Other non-fossil fuels	Municipal Wastes (biomass fraction)	11.6	6.8	18

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, page 1.18
Notes: 1 The lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions, fitted to a dataset, based on national inventory reports, IEA data and available national data. A more detailed description is given in section 1.5.
2 Japanese data; uncertainty range: expert judgement
3 EFDB; uncertainty range: expert judgement
4 Coke Oven Gas; uncertainty range: expert judgement
5-7Japan and UK small number data; uncertainty range: expert judgement
8 For waste oils the values of Lubricants" are taken
9 EFDB; uncertainty range: expert judgement
10 Japanese data ; uncertainty range: expert judgement
11 Solid Biomass; uncertainty range: expert judgement
12 EFDB; uncertainty range: expert judgement
13-14Ethanol theoretical number; uncertainty range: expert judgement;
15 Liquid Biomass; uncertainty range: expert judgement
16 -18Methane theoretical number uncertainty range: expert judgement; "

Annex VI: Default CO2 Emission Factors for Combustion

Table 10: Default CO2 Emission Factors for Combustion

Fuel type English description		Default carbon content (kg/GJ)	Default carbon oxidation factor	Effective CO2 emission factor (kg/TJ) 2		
				Default value 3	95% confidence interval	
		A	B	C=A*B*44/ 12*1000	Lower	Upper
	Crude Oil	20	1	73,300	71,100	75,500
	Orimulsion	21	1	77,000	69,300	85,400
	Natural Gas Liquids	17.5	1	64,200	58,300	70,400
Gasoline	Motor Gasoline	18.9	1	69,300	67,500	73,000
	Aviation Gasoline	19.1	1	70,000	67,500	73,000
	Jet Gasoline	19.1	1	70,000	67,500	73,000
	Jet Kerosene	19.5	1	71,500	69,700	74,400
	Other Kerosene	19.6	1	71,900	70,800	73,700
	Shale Oil	20	1	73,300	67,800	79,200
	Gas/Diesel Oil	20.2	1	74,100	72,600	74,800
	Residual Fuel Oil	21.1	1	77,400	75,500	78,800
	Liquefied Petroleum Gases	17.2	1	63,100	61,600	65,600
	Ethane	16.8	1	61,600	56,500	68,600
	Naphtha	20	1	73,300	69,300	76,300
	Bitumen	22	1	80,700	73,000	89,900
	Lubricants	20	1	73,300	71,900	75,200
	Petroleum Coke	26.6	1	97,500	82,900	115,000
	Refinery Feedstocks	20	1	73,300	68,900	76,600
Other Oil	Refinery Gas	15.7	1	57,600	48,200	69,000
	Paraffin Waxes	20	1	73,300	72,200	74,400
	White Spirit & SBP	20	1	73,300	72,200	74,400
	Other Petroleum Products	20	1	73,300	72,200	74,400
	Anthracite	26.8	1	98,300	94,600	101,000
	Coking Coal	25.8	1	94,600	87,300	101,000
	Other Bituminous Coal	25.8	1	94,600	89,500	99,700
	Sub-Bituminous Coal	26.2	1	96,100	92,800	100,000
	Lignite	27.6	1	101,000	90,900	115,000
	Oil Shale and Tar Sands	29.1	1	107,000	90,200	125,000

	Brown Coal Briquettes	26.6	1	97,500	87,300	109,000
	Patent Fuel	26.6	1	97,500	87,300	109,000
Coke	Coke oven coke and lignite Coke	29.2	1	107,000	95,700	119,000
	Gas Coke	29.2	1	107,000	95,700	119,000
	Coal Tar	22	1	80,700	68,200	95,300
Derived Gases	Gas Works Gas	12.1	1	44,400	37,300	54,100
	Coke Oven Gas	12.1	1	44,400	37,300	54,100
	Blast Furnace Gas	70.8	1	260,000	219,000	308,000
	Oxygen Steel Furnace Gas	49.6	1	182,000	145,000	202,000
	Natural Gas	15.3	1	56,100	54,300	58,300
	Municipal Wastes (non-biomass fraction)	25	1	91,700	73,300	121,000
	Industrial Wastes	39	1	143,000	110,000	183,000
	Waste Oil	20	1	73,300	72,200	74,400
Solid Biofuels	Peat	28.9	1	106,000	100,000	108,000
	Wood/Wood Waste	30.5	1	112,000	95,000	132,000
	Sulphite lyes (black liquor)	26	1	95,300	80,700	110,000
	Other Primary Solid Biomass	27.3	1	100,000	84,700	117,000
	Charcoal	30.5	1	112,000	95,000	132,000
Liquid Biofuels	Biogasoline	19.3	1	70,800	59,800	84,300
	Biodiesels	19.3	1	70,800	59,800	84,300
	Other Liquid Biofuels	21.7	1	79,600	67,100	95,300
Gas biomass	Landfill Gas	14.9	1	54,600	46,200	66,000
	Sludge Gas	14.9	1	54,600	46,200	66,000
	Other Biogas	14.9	1	54,600	46,200	66,000
Other non-fossil fuels	Municipal Wastes (biomass fraction)	27.3	1	100,000	84,700	117,000

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, page 1.23
Notes: 1 The lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions, fitted to a dataset, based on national inventory reports, IEA data and available national data. A more detailed description is given in section 1.5, 2 TJ = 1000GJ
3 The emission factor values for BFG includes carbon dioxide originally contained in this gas as well as that formed due to combustion of this gas.
4 The emission factor values for OSF includes carbon dioxide originally contained in this gas as well as that formed due to combustion of this gas
5 Includes the biomass-derived CO2 emitted from the black liquor combustion unit and the biomass-derived CO2 emitted from the kraft mill lime kiln.

SECTION D: PROPOSED STANDARDIZED BASELINE DEVELOPED USING THE APPROACH CONTAINED IN THE "GUIDELINE: ESTABLISHMENT OF STANDARDIZED BASELINES FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES UNDER THE CDM"

Not applicable.

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Document information

Version	*Date*	*Description*
03.0	1 September 2015	Revision to: • Reflect updated requirements in the version 04.0 of "Procedure: Development, revision, clarification and update of standardized baselines" (CDM-EB63-A28-PROC) ; • Include editorial improvement.
02.0	1 December 2013	The document title has changed from "Proposed standardized baseline form" (F-CDM-PSB) to "Proposed standardized baseline submission form" (CDM-PSB-FORM). Revision to: • Reflect updated requirements in the "Procedure: Development, revision, clarification and update of standardized baselines" • Include editorial improvement
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