

South Africa's Grid Emission Factor

There is no general agreement on either the methodology for calculating the Grid Emission Factor (GEF) for South Africa's electricity grid, or on the actual number; and there is not a wide understanding of the difference between the country emission factor for electricity as used by the IRP electricity plan and the GEF used by Eskom.

A methodology is presented which gives a Grid Emission Factor of 0.94 t CO₂e/MWh for South Africa for calendar 2011, which is up to 10% less than the number typically reported and used.

The difference between the country and the grid emission factors is clarified.



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17th March 2013

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What is a Grid Emission Factor (GEF)?

Electricity generation usually involves the combustion of fossil fuels, which gives rise to greenhouse gas (GHG) emissions. This is certainly the case in South Africa where the major energy source for electricity is coal; according to electricity generation projections in South Africa’s Integrated Resource Plan (IRP) ¹, coal will still be the major source in 2030.

The greenhouse gas Grid Emission Factor (GEF) is the total amount of GHGs emitted per unit of electricity generated for and distributed by an electricity grid, taking in account imports and exports of electricity from the interconnection with other grids. These emissions comprise carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) ².

The GEF is typically expressed as t CO₂e/MWh. CO₂e is used to denote the inclusion of non-CO₂ gases.

Country-specific GEFs are published for some countries; for example DEFRA/DECC publish factors for the UK, and the Environmental Protection Agency publishes factors for the USA. No such factor is officially published for South Africa ³.

¹ Integrated Resource Plan for Electricity 2010-2030, Policy Adjusted Scenario, March 2011.

² A paper by Ecometrica, *Electricity-specific Emission Factors for Grid Electricity*, August 2011, gives levels of other GHGs (methane and nitrous oxide) that in total have a warming effect of 0.5% of the effect of CO₂. The uncertainty involved in the estimation of the CO₂ figures is higher than the magnitude of the non-CO₂ figures. Often non-CO₂ figures are not incorporated into the GEF although it is considered good practice to do so.

³ Although certain factors may be published for specific applications, they vary depending on the user needs, which is part of the problem.

What is South Africa's current GEF?

There is a range of interpretation of what South Africa's current GEF actually is. This is illustrated by the following numbers for calendar year 2010, roughly corresponding to Eskom's financial year ended 31st March 2011 (calendar year 2010 is the latest year for which data from all the sources considered below are available).

Source	Type	Factor t CO ₂ e/MWh	Period	Comments	Reference
IRP	Forecast (when IRP drawn up)	0.912	Calendar 2010	Included all significant producers in the country, imports and own generation sources such as electricity from waste heat recovery which is generated and consumed on the same site. It was calculated before grid transmission and distribution losses are accounted for.	4
IEA	Actual	0.927	Calendar 2010	Included emissions from fossil fuels, industrial waste and non-renewable municipal waste that were consumed for electricity generation, and electricity output excluding pumped storage. It apparently was calculated before grid transmission and distribution losses are accounted for, although this is not clearly stated. The number is based on electricity generation within South Africa, and does not take into account imports and exports of electricity ⁵ .	6
Eskom	Actual	0.99	Financial year ended 31 st March 2011	Included Eskom own generation (excluding electricity used for pumping water to pumped storage), Eskom purchased imports such as hydro from Mozambique, and Eskom purchases from Independent Power Producers (IPPs). Eskom has in some other years published two factors; in the financial year ended 31 st March 2012 these were 0.99 and 1.03 t CO ₂ e/MWh).	7
CDP		0.94 to 1.04	Largely calendar 2010	In compiling their responses to the 2011 Carbon Disclosure Project (CDP), South African companies used a range of factors.	8

The reasons for the different numbers lie in the assumptions made; in mismatches between calendar and financial years; in how the grid is defined; in what is accounted for; and, most importantly, in the interpretation of how grid transmission and distribution losses should be reported.

It is noted that the Grid Emission Factor used in Clean Development Mechanism (CDM) projects is a quite separate topic which requires its own calculation methodology.

⁴ Integrated Resource Plan for Electricity 2010-2030, March 2011, p.28.

⁵ Communication between Pedro Faria, Technical Director, CDP and Aidan Kennedy, IEA Energy Data Centre

⁶ CO₂ Emissions from Fuel Consumption – Highlights, International Energy Agency, 2012, p.112.

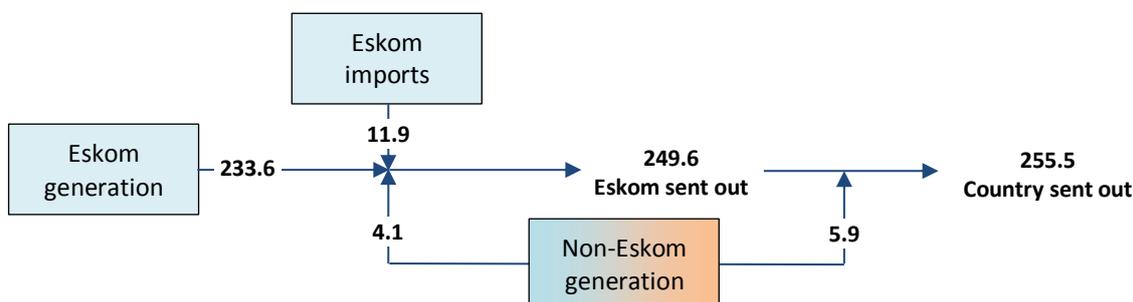
⁷ Eskom Holdings Limited Integrated Report 2011, p.327.

⁸ Authors' review of CDP responses: sample of 8 major SA companies each with more than 98% of emissions originating in SA.

The changing landscape of South African electricity generation

South Africa's electricity balance for calendar 2011 is shown below.

Source (calendar 2011)	TWh	%
Eskom net generation from own stations (= gross electricity production minus power station consumption and electricity for pumping water to pumped storage)	233.6	91.4%
Eskom imports	11.9	4.7%
Eskom purchases from Independent Power Producers (IPPs)	4.1	1.6%
Total Eskom sent out	249.6	97.7%
Non-Eskom generation not purchased by Eskom ⁹	5.9	2.3%
Total country sent out	255.5	100.0%



While Eskom generated 91% of South Africa's electricity in 2011, the proportion of electricity generated by IPPs and non-Eskom entities is expected to increase significantly in the future.

At the same time the formation of an Independent System Market Operator (ISMO) is planned; this ISMO will purchase electricity from diverse sources, including Eskom. It will provide a bundled or averaged mix of all the various sources purchased, much as Eskom does at present. The electricity distributed and the emissions from this mix will give the base country GEF.

In addition there will be:

1. Separate wheeling arrangements, wherein say Generation Company A will supply Consumer Company B with electricity with a certain emission factor, over the grid. This electricity is considered as separate from the bundled mix, even though it is handled by the grid;
2. Over-the-fence arrangements, wherein say Generation Company A will supply Consumer Company B with electricity with a certain emission factor from an adjacent site.

Thus if Consumer Company B is using electricity from both the ISMO and Generation Company A, it will have to calculate its emissions from the two sources.

Clearly a shared understanding is required by companies of the calculation methodology for the base grid GEF, and the output number, for them to be able to calculate both their attributable emissions and their mitigation potential.

⁹ StatsSA and Eskom numbers, communication from Keith Bowen, Eskom, December 2012

The country emission factor and the GEF

The IRP is concerned with the country electricity emission factor, which is not the same as the grid electricity emission factor.

The grid emission factor calculation is concerned with the bundled mix of sources that is available to general consumers over the grid; it excludes the wheeling and over-the-fence arrangements referred to earlier.

The country emission factor calculation has to include all these wheeling and over-the-fence arrangements, and also significant on-site generation such as own coal-, diesel- or gas-fired or solar PV operations.

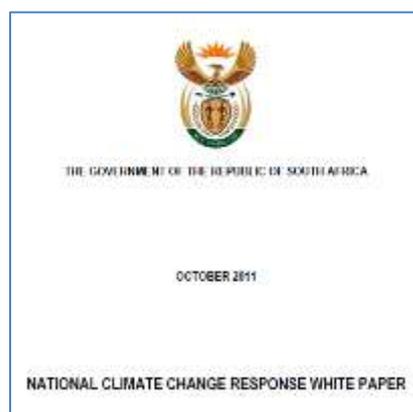
Companies reporting on and reducing their emissions

The pressure on companies to both report on and reduce their emissions is increasing.

Government issued a National Climate Change Response White Paper, which was subsequently approved by cabinet as policy in October 2011¹⁰.

It was stated in this policy that South Africa's approach to mitigation would include:

- Using a National GHG Emissions Trajectory Range, against which the collective outcome of all mitigation actions will be measured;
- Defining desired emission reduction outcomes for each significant sector and sub-sector of the economy based on an in-depth assessment of the mitigation potential, best available mitigation options, science, evidence and a full assessment of the costs and benefits;
- Requiring companies and economic sectors or sub-sectors for which desired emission reduction outcomes have been established to prepare and submit mitigation plans that set out how they intend to achieve the desired emission reduction outcomes.



Government embarked on an exercise in 2012 to establish the mitigation potential of all sectors in the economy to 2050¹¹, with a view to establishing the optimal combination of mitigation measures at the least cost to, and with the most sustainable development benefits for, the relevant sector and/or the national economy.

Again it is clear that a shared understanding is required by companies of the calculation methodology for the base grid GEF, and the outcome, for them to be able to calculate both their attributable emissions and their mitigation potential.

¹⁰ National Climate Change Response White Paper, October 2011

¹¹ South Africa's Greenhouse Gas (GHG) Mitigation Potential Analysis, Department of Environmental Affairs, October 2012.

Calculation of the GEF

Methodology currently used by Eskom

Eskom has over the years published either one or two factors with different definitions; for example for the financial year ended 31st March 2012 factors of 0.99 and 1.03 t CO₂e/MWh were published.¹²

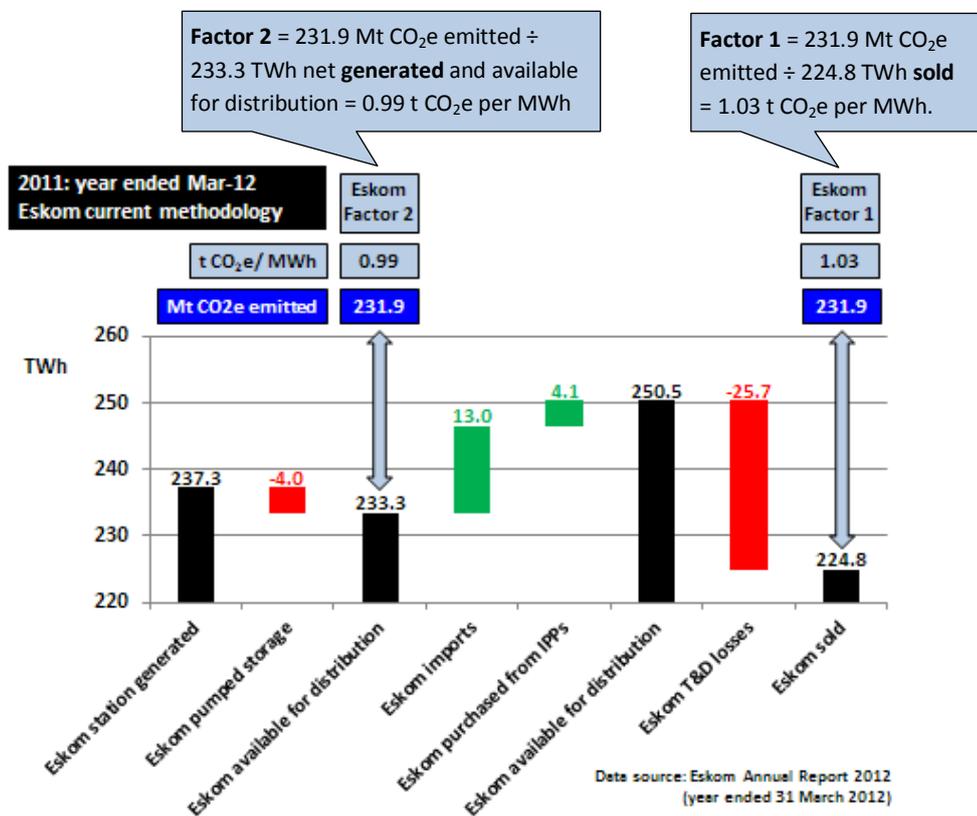
Financial year ended March	Calendar year corresponding (9 months overlap)	t CO ₂ e/MWh	
		Factor 1 Based on MWh Sold	Factor 2 Based on MWh Generated
2008	2007	1.00*	-
2009	2008	1.03*	-
2010	2009	1.03	0.98
2011	2010	-	0.99
2012	2011	1.03	0.99

*Not specified whether based on Sold or Generated, but numbers indicate based on Sold

The difference between the two numbers arises from the relationship:

$$\text{Sold} = \text{Generated} + \text{Eskom Purchases} - \text{Eskom Transmission \& Distribution losses.}$$

This was partially explained in Eskom’s Annual Report 2012; the calculation of the two factors is illustrated below.



¹² http://financialresults.co.za/2012/eskom_ar2012/fact-sheets/006.php, accessed 16th December 2012.

Before proposing an appropriate methodology for calculating the base country GEF, it is necessary to understand the categories of GHG emissions and the implications of grid transmission and distribution losses.

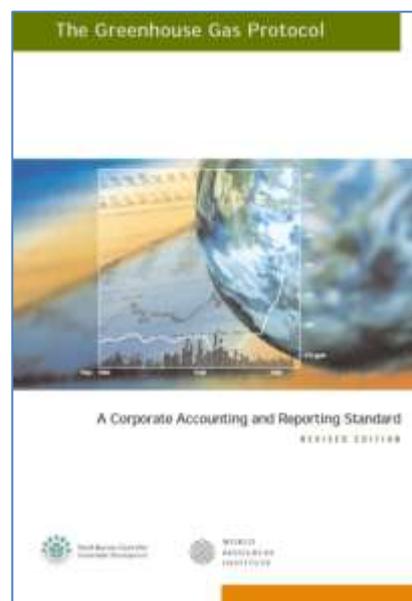
Categories of GHG emissions

Type		Source	Examples
Scope 1	Direct	Occur on-site or from company-owned assets	Consuming diesel as fuel Producing power from coal
Scope 2	Energy indirect	Created on behalf of the company in the generation of electricity or the delivery of energy via hot water or steam	Consuming electricity generated by Eskom
Scope 3	Other indirect	Result from the activities of the company, but occur from sources not owned or controlled by the company	Company's employees travelling by car on business

Transmission and distribution losses

The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard¹³ states:

- “Emissions from the generation of purchased electricity that is consumed during transmission and distribution (T&D) are reported in scope 2 by the company that owns or controls the T&D operation. End consumers of the purchased electricity do not report indirect emissions associated with T&D losses in scope 2 because they do not own or control the T&D operation where the electricity is consumed (T&D loss).”
- End consumers may, however, report their indirect emissions associated with T&D losses in scope 3 under the category “generation of electricity consumed in a T&D system.”



This is further confirmed in The Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard¹⁴, which describes the process for accounting for emissions across an electricity value chain.

These interpretations were confirmed by the World Resources Institute, which is the custodian of the Greenhouse Gas Protocol¹⁵.

¹³ Corporate Accounting and Reporting Standard, <http://www.ghgprotocol.org/standards/corporate-standard>, accessed 16th December 2012, p.27-28.

¹⁴ Corporate Value Chain (Scope 3) Accounting and Reporting Standard, <http://www.ghgprotocol.org/standards/scop3-standard>, accessed 16th December 2012, p.42-43.

¹⁵ Discussions and confirming correspondence: WRI, National Business Institute and the authors, 29th October 2012.

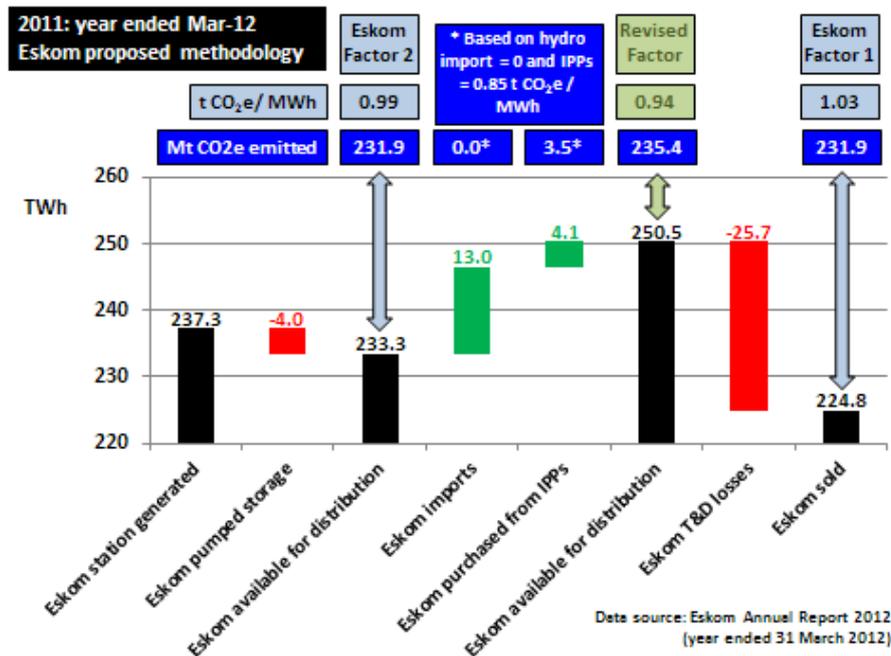
The conclusion can be drawn that companies purchasing electricity from Eskom should not report indirect emissions associated with T&D losses as scope 2, and rather as Scope 3. This falls into category 3 Scope 3 emissions (Fuel- and energy-related emissions) as defined in the GHG Protocol Scope 3 standard ¹⁶.

Proposed methodology for current Eskom and future ISMO

In keeping with the GHG Protocol standard, a revised factor for the current Eskom and the future ISMO can be calculated with the following adjustments from the Eskom published calculation for Factor 1.

For the financial year ended 31st March 2012 the calculation is:

- As denominator, use the TWh number of 250.5 TWh before T&D losses;
- As numerator, add emissions from:
 - Imports: since this is hydro from Mozambique, the emissions factor is assumed to be 0 t CO₂e/MWh;
 - Purchases from IPPs: this is a mix of sources with an estimated emissions factor of 0.85 t CO₂e/MWh ¹⁷;
 - The total numerator is hence 231.9 + 0.0 + 3.5 = 235.4 Mt CO₂e;
- The revised factor is hence 235.4 t CO₂e emitted ÷ 250.5 TWh = 0.940 t CO₂e/MWh.



¹⁶ Corporate Value Chain (Scope 3) Accounting and Reporting Standard, <http://www.ghgprotocol.org/standards/scop3-standard>, accessed 16th December 2012, p.34.

¹⁷ Communication with Keith Bowen, Eskom, October 2012

Reconciliation of IRP country emissions methodology with proposed GEF methodology

The IRP current methodology differs in three major ways from the proposed methodology for the grid - currently managed by Eskom and in future by the ISMO.

Difference	Comments and proposed reconciliation
The IRP uses calendar years, and Eskom uses financial years ending in March.	All methodologies to use calendar years.
The IRP additionally takes into account the Demand Side Management (DSM) programme, which is treated as a virtual supply with no attendant emissions. DSM achieves reductions in demand by: <ul style="list-style-type: none"> i. Increasing energy efficiency e.g. through using CFL and LED lighting; ii. Reducing demand e.g. through using solar hot water geysers. 	DSM should be excluded from all methodologies, as it represents virtual generation and complicates the picture unnecessarily.
The IRP additionally takes into account electricity that is generated by non-Eskom sources (e.g. Kelvin power station which supplies the City of Johannesburg, and other various wheeling, over-the-fence and own generation arrangements).	This is necessary to calculate the overall <u>country</u> factor, which is not the same as the <u>grid</u> emissions factor.

Custodianship of the GEF and generation of GEF numbers for use in company reporting

This role probably belongs to the Department of Energy, although the Department of Environmental Affairs may wish to play a role.

Consideration should be given to calculating the number monthly to accommodate the different financial reporting years used by companies.