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DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT

NO. 6454 **25 July 2025**

PUBLICATION OF SOUTH AFRICA'S 2023 GRID EMISSION FACTORS REPORT

I, Dion Travers George, Minister of Forestry, Fisheries, and the Environment, hereby publish the South Africa's 2023 Grid Emission Factors Report (the third GEFs Report), as set out in the Schedule hereto, for information.

This third GEFs Report shows that the grid in 2023 was less carbon intensive due to less energy generation from emissive sources coupled with increased energy generation from hydro and wind. It includes summarised information and data on electricity production and the GHG emissions associated with the electricity that was produced for the 2023 calendar year. This data was used to determine the following four grid emission factors:

i. A domestic generation grid emission factor;
ii. A national generation grid emission factor;
iii. A transmission loss grid emission factor; and
iv. A distribution loss grid emission factor.

The domestic generation GEF depicts the relationship between the amount of GHGs emitted per unit of electricity that is generated within South Africa. The national generation GEF depicts the relationship of emissions and end user electricity consumption and hence includes imported electricity along with its associated GHG emissions. The transmission losses GEF depicts the relationship between the emissions and end user electricity consumption while considering transmission losses. The distribution losses GEF depicts the relationship between the emissions and end user electricity consumption while considering distribution losses.

The 2023 GEFs Report provides information on the carbon intensity of the electricity supplied through the grid. The GEFs information is very useful for public users who intend to track their carbon footprint, including emissions associated with their electricity use. This information can equip public users to accurately track or report the change in the GHG emissions associated with mitigation measures relating to decreasing electricity usage or optimising their electricity usage. Different spheres of government can use GEFs to monitor and analyse electricity emission trends, guide climate change modelling, and inform climate change mitigation policies.

DR DION TRAVERS GEORGE
MINISTER OF FORESTRY, FISHERIES AND THE ENVIRONMENT

forestry, fisheries and the environment
Department: Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

SCHEDULE

South Africa's 2023 Grid Emission Factors Report

2025

forestry, fisheries & the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

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Contents

Abbreviations

DFFE	Department of Forestry, Fisheries and Environment
DGGEF	Domestic generation grid emission factor
DLGEF	Distribution loss grid emission factor
GEF	Grid emission factor
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
JET IP	Just Energy Transition Investment Plan
NCCRP	National Climate Change Response Policy
NERSA	National Energy Regulator South Africa
NGERs	National Greenhouse Gas Emissions Reporting Regulations
NGGEF	National generation grid emission factor
SAGERS	South African Greenhouse Gas Reporting System
TLGEF	Transmission loss grid emission factor

Executive Summary

South Africa recognises that climate change poses considerable risks and constraints to sustainable economic growth. To address this, South Africa's Just Energy Transition Plan aims to lower greenhouse gas (GHG) emissions significantly and harness investments in new energy technologies. This commitment is further confirmed in the Just Energy Transition Investment Plan (JET IP) for 2023 – 2027 that declares its aim to accelerate the decarbonisation of the electricity system. The fulfilment of these objectives will result in a less emissions intensified electricity grid overtime.

The first grid emission factor report of this kind, South Africa's 2021 Grid Emission Factor Report, was published in February 2024. Following this, South Africa's 2022 Grid Emission Factor Report was published in November 2024. This report, South Africa's 2023 Grid Emission Factor Report details South Africa's grid emission factors based on 2023 Calendar Year (CY) data. A grid emission factor (GEF) reflects the GHG emissions associated with units of electricity in the grid electricity system. As the transition towards a low carbon economy progresses, the availability of a GEF that accurately reflects the emission intensity of the national grid is increasingly important.

Carbon accounting plays a critical role for ensuring South Africa meets its international climate change commitments. South Africa's National Climate Change Response Policy (NCCRP) of 2011 cites the need for accurate, complete and up-to-date data as the foundation of an effective climate change response and positions the National GHG Inventory (of which emissions from electricity production constitute the largest component) as a critical part of national climate action. Different spheres of government can use GEFs to monitor and analyse electricity emission trends, guide climate change modelling and inform climate change mitigation policies.

At the private sector level, electricity consumers can use the GEF to determine the emissions attributed to their activities. Accurate and up to date GEFs will assist with the increasing carbon pricing (e.g., carbon tax), investor pressure and consumer expectations around climate change mitigation. Carbon pricing may not just apply domestically, but also at borders e.g., on exports to the EU. Additionally, the GEF is also a key component of carbon accounting and emission inventories.

Four location-based GEFs were developed for South Africa, namely a Domestic Generation Grid Emission Factor (DGGEF), a National Generation Grid Emission Factor (NGGEF), a Transmission Losses Grid Emission Factor (TLGEF) and a Distribution Losses Grid Emission Factor (DLGEF). These GEFs were developed for South Africa based on 2022 calendar year data.

South Africa’s 2023 GEFs are shown in Figure 1.

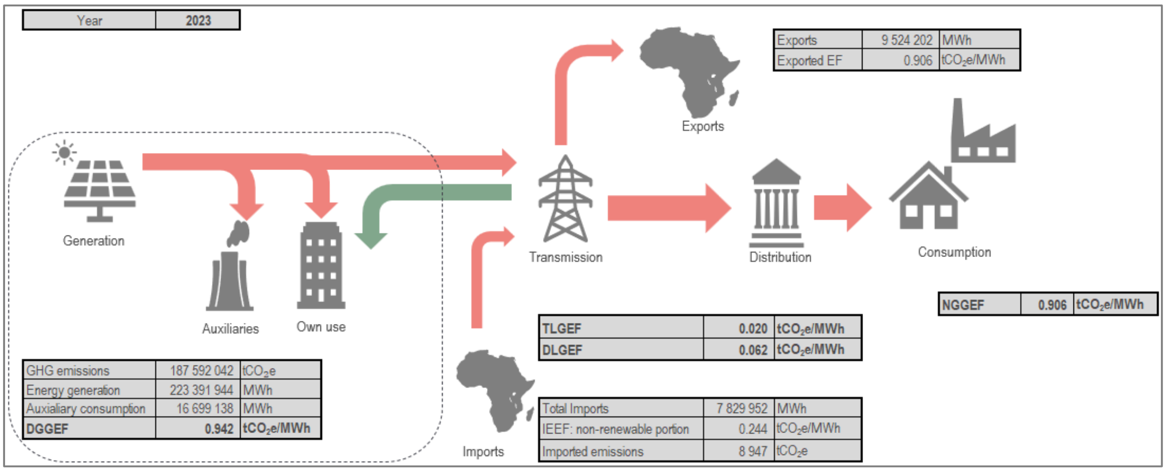

Figure 1: South Africa's Electricity Grid Information 2023

The resulting four GEFs from the above data are shown in Table 1.

Table 1: South Africa's 2023 Grid Emission Factors

GEF	Value (tCO_2e/MWh)
DGGEF	0.942
NGGEF	0.906
TLGEF	0.020
DLGEF	0.062

A high GEF (e.g., >1 kgCO2 per kWh) typically indicates that a given electricity grid is powered by carbon intensive fuel sources such as fossil fuels, while GEFs closer to zero symbolise electricity grids that are supplied by renewable energy sources. The 2023 DGGEF of 0.94 tCO_2e/MWh, is marginally lower than the 2022 DGGEF of 0.96 tCO_2e/MWh. This is due to a 4 % decrease in energy generated from emissive sources 2023 compared to 2022.

South Africa imported 7 829 952 MWh in 2023 from various sources, and the bulk of this electricity (99.5%) was produced from renewable energy, mainly from hydropower plants. The addition of this electricity to the grid is reflected in the NGGEF that is lower than the DGGEF.

1. Introduction

1.1. Background

A tool was developed to assist the Department of Forestry, Fisheries and Environment (DFFE) to periodically update South Africa's GEFs and subsequently publish them on an annual basis. A GEF represents the amount of GHG emissions related to a unit of electricity (for instance kWh). GEFs are useful for informing policy making and implementation and hence South Africa's GEFs will be updated and published annually. Furthermore, regularly updated GEFs will enhance the accuracy and integrity of emissions, related to electricity usage, that are reported by various stakeholders under different reporting mechanisms both nationally and internationally.

DFFE developed a methodology for the determination of GEFs through engagements with relevant stakeholders such as Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) and IBIS Consulting. Various methodologies from different reporting regimes and countries were investigated as part of the development of South Africa's GEFs. In the end, the following four GEFs were developed:

- Domestic Generation Grid Emission Factor
- National Generation Grid Emission Factor
- Transmission Losses Grid Emission Factor
- Distribution Losses Grid Emission Factor

The definition and intended use of these GEFs is explained in section 2.7. These GEFs are location-based GEFs.

1.2. Purpose

Four different GEFs, namely, a domestic generation grid emission factor, a national generation grid emission factor, a transmission loss grid emission factor and a distribution loss grid emission factor have been developed. The purpose of this report is to publish South Africa's 2023 GEFs and give guidance to public users on how the different GEFs should be used for reporting purposes. This report should be consulted by each stakeholder that needs to conduct reporting of emissions related to electricity consumption, to ensure that the GEFs are used accordingly.

2. Methodology

2.1. Overview

A GEF is a value that depicts the relationship between GHG emissions and electricity usage. The generic equation used to determine a GEF is shown below;

$$GEF = GHG\ Emissions\ from\ Electricity\ Production \div Amount\ of\ Electricity\ Produced$$

Depending on the boundaries incorporated, the electricity amount used could be related to electricity generated, consumed, or transmitted also taking other factors into consideration, such as the amount of electricity imported or exported. Hence, in most cases different GEFs are developed for various scenarios.

Domestic electricity generation information (emissive and non-emissive) was sourced from the National Energy Regulator South Africa NERSA. NERSA collects electricity generation information from all licensed electricity producers in the country. Eskom provided electricity import and export data, as well as distribution and transmission loss data.

2.2. GHG Emissions

2.2.1. GHG Emissions from Domestic Production

GHGs emissions data from domestic electricity production was extracted from the South Africa's GHG Emission Reporting Programme and from individual power producers in the cases where the electricity generator falls below the 10 MW threshold set by the National GHG Emissions Reporting Regulations (NGERs).

2.2.2. GHG Emissions from Imported Electricity

Data from the approved Standardised Baseline: Grid Emission Factor for the Southern African Power Pool[1] (SAPP) was used to determine an emission factor for electricity that was imported by South Africa from regional partners.

The previous imported electricity emission factor (IEEF), from the 2021 and 2022 GEF Reports, was 0.168 tCO_2e/MWh. This factor accounted for electricity generated from both emissive and non-emissive sources from the SAPP, excluding data (electricity and GHG emissions) from South Africa. This factor was hence applied to all imports, both from emissive and non-emissive sources, in the 2021 and 2022 GEF Reports.

[1] Clean Development Mechanism, ASB0040-2018_PSB0044, CDM: Standardized baselines

In 2024, DFFE received feedback on the 2021 GEF Report, that requested that the IEEF emission factor be revised to more accurately reflect electricity imported from hydropower plants. Hence the SAPP data was amended to remove data for electricity generated from Hidroelectrica de Cahora Bassa (HCB) and from Lesotho Electricity Company (LEC). The resulting IEEF, after excluding data from South Africa, HCB and LEC, is 0.244 tCO_2e/MWh. This updated IEEF is applied to the remainder of the electricity that is imported from various sources (both emissive and non-emissive) from the SAPP.

However, it should be noted that this improvement only yielded a difference of 0.6 % in the NGGEF. An example of this is based on the 2022 data. Table 2 below shows that the 2022 NGGEF changed from 0.931 tCO_2e/MWh to 0.925 tCO_2e/MWh by applying an updated IEEF to the remainder of the imports only.

Table 2: Impact of an improved IEEF

2022 Data	**IEEF (tCO_2e/MWh)**	
	Old: 0.168	Updated: 0.244
IEEF (tCO_2e/MWh)	0.168	0.244
NGGEF (tCO_2e/MWh)	0.931	0.925
Difference in NGGEF (%)	-0.6	

Further disaggregation of this factor will render the exercise more complex as it would require a more detailed breakdown of the imported sources as well as having individual emission factors for the specific exporting company or power plant. Currently, the portion of the imported electricity, not from HCB or LEC, is 0.5% of the total imports and is hence not significant. It is recommended that this IEEF of 0.244 tCO_2e/MWh be revised when the portion of electricity not imported from HCB and LEC increases to more than 20 % of total imports.

2.3. Domestic Generation Grid Emission Factor

The domestic generation grid emission factor (DGGEF) depicts the relationship between the amount of GHG emitted per unit of electricity that is generated within South Africa. The DGGEF does not consider whether the electricity is exported or consumed domestically, additionally, it excludes auxiliary consumption related to electricity generation and electricity generated for own use. Wheeling which is not intended for sale or distribution on the grid is excluded, however, private wheeling agreements are included in the GEF. Figure 2 below, shows the measurement boundary for the DGGEF.

The definition of the DGGEF makes the factor most useful for DFFE in the development of policy and international reporting purposes. This factor is also useful for other government departments such as the Department of Mineral Resources and Energy.

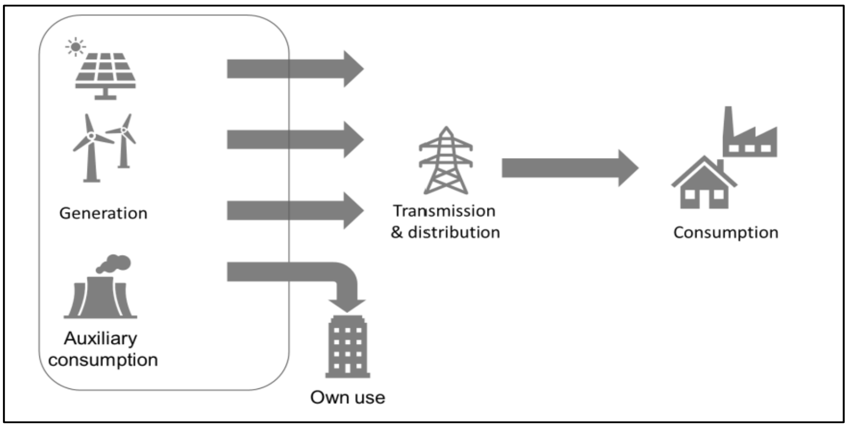

Figure 2: DGGEF Boundary

Table 3 below shows the input data that was used to determine the domestic generation GEF.

Table 3: Domestic Generation GEF Input Data

	Value	Units
Domestic Electricity Generation Emissions	187 592 042	tCO_2e
Domestic Electricity Generation[2]	199 185 848	MWh
Domestic Generation Auxiliary Consumption	16 699 138	MWh
Domestic Generation Own Consumption	7 506 959	MWh

2.4. National Generation Grid Emission Factor

The national generation grid emission factor (NGGEF) depicts the relationship of emissions and end user electricity consumption. The NGGEF does not include transmission and distribution losses because these losses are typically not suited for Scope 2 emissions reporting that only includes emissions related to electricity consumption. Transmission and distribution losses are incorporated in Scope 3 emissions reporting and are further discussed in sub-sections 2.5 and 2.6.

The NGGEF includes electricity that is imported, as a generation source, and electricity that is exported, as an end consumer. The GHG emissions associated with both imported and exported electricity are included in the calculation. Figure 3 below, shows the measurement boundary for the NGGEF.

The NGGEF will be most useful to electricity consumers, especially those that need to conduct corporate reporting of GHG emissions or those that need to report on Scope 2 emissions.

[2] This values already excludes auxiliary and own consumption.

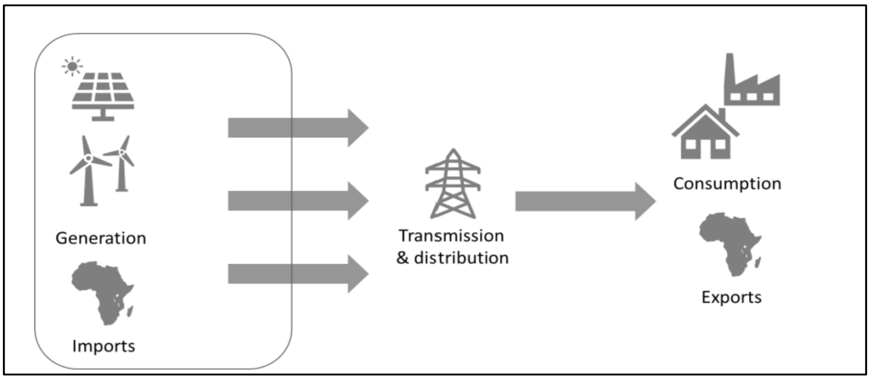

Figure 3: NGGEF Boundary

Table 4 below shows the input data that was used to determine the national generation GEF.

Table 4: National Generation GEF Input Data

	Value	Units
National Electricity Generation Emissions	187 592 042	tCO_2e
Imported Electricity Emissions	8 947	tCO_2e
National Electricity Generation[3]	199 185 848	MWh
National Generation Auxiliary Consumption	16 699 138	MWh
National Generation Own Consumption	7 506 959	MWh
Imported Electricity	7 829 952	MWh

Appendix A gives an example of how the NGGEF should be used to calculate GHG emissions for reporting.

2.5. Transmission Losses Grid Emission Factor

The transmission losses grid emission factor (TLGEF) depicts the relationship between the emissions and end user electricity consumption while considering transmission losses. This is because a unit of electricity used by an end user is not related to a unit of electricity generated due to transmission (and in some cases distribution) losses.

In some cases, transmission and distribution losses are accounted for under one GEF, however, in this case the GEFs have been developed as two separate factors. This is because some facilities are fed directly by the transmission network and hence only the TLGEF would apply to them for Scope 3 reporting. Facilities that are not fed directly by the transmission network should, therefore, use both the TLGEF and the DLGEF when reporting on Scope 3 GHG emissions.

[3] This values already excludes auxiliary and own consumption.

The TLGEF considers the inherent inefficiencies in the transmission process that result in energy being converted to non-useful sources (e.g., heat and noise) along the transmission network, as well as losses due to the voltage step-up and step-down transformers before and after the transmission network. Figure 4 below, shows the measurement boundary for the TLGEF and the DLGEF.

The TLGEF will be most useful to electricity consumers, especially those that need to conduct corporate reporting of GHG emissions or those that need to report on Scope 3 emissions. However, it should be noted that this TLGEF is not suitable for use in situations involving electricity generated for own use, since the transmission losses are considered negligible due proximity to the generator.

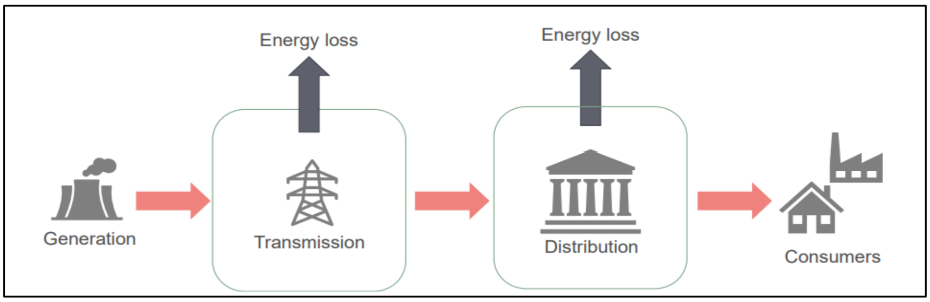

Figure 4: TLGEF and DLGEF Boundaries

Table 5 below shows the input data that was used to determine the transmission and distribution losses GEFs.

Table 5: Transmission & Distribution Losses GEFs Input Data

	Value
Transmission Losses	2.22 %
Distribution Losses (including non-technical)	9.84 %
Distribution Losses (excluding non-technical)	6.89 %

Appendix A give examples of how the TLGEF should be used to calculate GHG emissions for reporting.

2.6. Distribution Losses Grid Emission Factor

The distribution losses grid emission factor (DLGEF) depicts the relationship between the emissions and end user electricity consumption while considering distribution losses. This is because a unit of electricity used by an end user is not related to a unit of electricity generated due to distribution (and transmission) losses. The DLGEF considers technical losses and excludes non-technical losses.

The DLGEF will be most useful to electricity consumers, especially those that need to conduct corporate reporting of GHG emissions or those that need to report on Scope 3 emissions. However, it should be noted that, as with the TLGEF, the DLGEF is not suitable for use in situations involving electricity generated for own use, since the distribution losses are considered negligible due proximity to the generator.

Facilities that are not fed directly by the transmission network should use both the TLGEF and the DLGEF when reporting on Scope 3 GHG emissions.

Appendix A give examples of how the DLGEF should be used to calculate GHG emissions for reporting.

2.7. Intended Users & Uses of the Grid Emission Factors

The four different GEFs have been developed for various uses and users. Table 6 shows the intended users and uses of the four GEFs that were developed for South Africa.

Table 6: Intended Uses and Users for South Africa's Grid Emission Factors

Grid Emission Factors	Use	Intended User
Domestic generation GEF (DGGEF)	Policy development International reporting	Government
National generation GEF (NGGEF)	Corporate reporting Scope 2 emissions reporting	Consumers
Transmission losses GEF (TLGEF)	Corporate reporting Scope 3 emissions reporting	Government Consumers
Distribution losses GEF (DLGEF)	Corporate reporting Scope 3 emissions reporting	Government Consumers

3. South Africa's 2023 Grid Emission Factors

3.1. 2023 Grid Emission Factors

South Africa generated 223 391 944 MWh domestically[4], and of this amount only 200 783 447 MWh were sent to the grid. A further 7 829 952 MWh was added to the national grid from imports (see Figure 5).

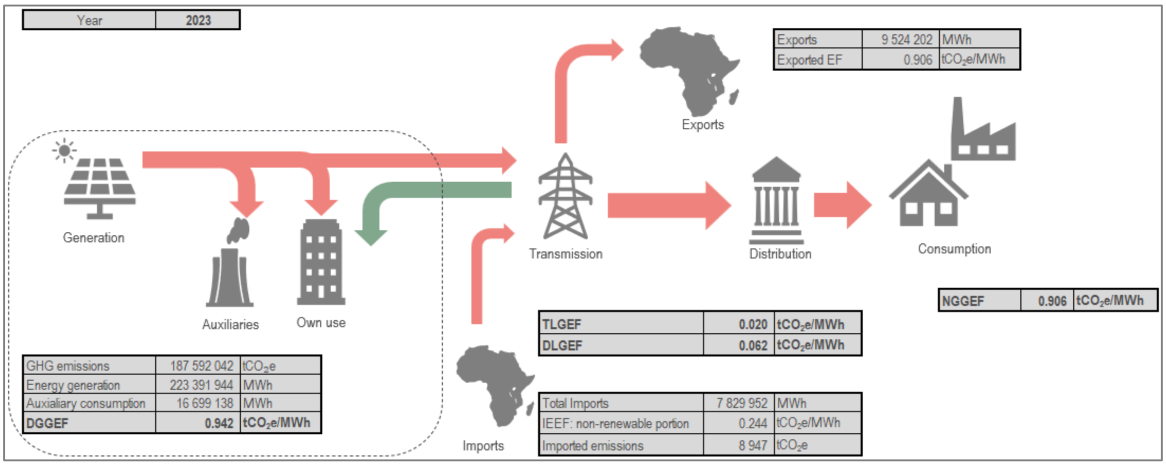

Figure 5: South Africa's Electricity Grid Information 2023

Table 7 below shows the four GEFs since 2021. A GEF value above 1 tCO_2e/MWh indicates an electricity grid that is powered by carbon intensive fuels, such as non-renewables. The 2023 DGGEF, of 0.941 tCO_2e/MWh, is lower than the 2022 DGGEF of 0.96 tCO_2e/MWh. This is due to a decrease (4.4%) in electricity from emissive sources and an increase in the contribution of electricity from non-emissive sources in 2023 in comparison to 2022. Section 3.2 shows a comparison of the GEFs since 2021.

An emission factor of 0.244 tCO_2e/MWh was used to estimate the emissions from imported electricity from sources other than HCB and LEC. This emission factor was calculated from the UNFCCC Standardised Baseline GEF for SAPP data, excluding data from South Africa, as well as from HCB and LEC which run hydro power plants.

Table 7: South Africa's previous Grid Emission Factors

GEF (tCO_2e/MWh)	2021	2022	2023
DGGEF	1.013	0.960	0.942
NGGEF	0.985	0.931	0.906
TLGEF	0.023	0.022	0.020
DLGEF	0.066	0.063	0.062

[4] This value includes auxiliary and own consumption.

3.2. Comparison of South Africa's Grid Emission Factors

Determining GEFs for each calendar year going forward will allow for accurate reporting but will also enable tracking of the carbon intensity of the grid. Figure 6 below shows the comparison of the generation GEFs for 2021 to 2023. Both the DGGEF and NGGEF have been marginally decreasing since 2021.

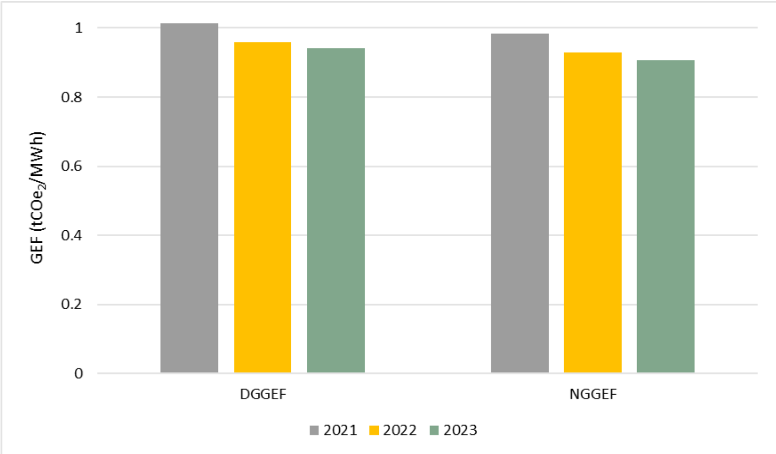

Figure 6: DGGEFs & NGGEFs for 2021 – 2023

The 2021 DGGEF was marginally over 1 tCO_2e/MWh and hence was signifying a carbon intense electricity grid. The 2022 and 2023 DGGEFs are below 1 tCO_2e/MWh, and lower than the 2021 DGGEF (5% and 7 % lower respectively) indicating that the grid was less carbon intensive in those years. The NGGEFs for the 2022 and 2023 NGGEFs are also lower than the 2021 NGGEF, showing decreases of 6 % and 8 %, respectively.

Both the DGGEFs and NGGEFs have decreased due to three main changes since 2021. Firstly, the total amount of grid electricity from emissive sources decreased by 8 % in 2023 (Figure 7). Secondly, the mix of emissive sources changed, with grid electricity from coal decreasing by 9 % in 2023 since 2021, while grid electricity from diesel increased by 61 %. Lastly, although the total amount of grid electricity from non-emissive sources decreased by 2 % in 2023 (Figure 8), the portion of total grid electricity from non-emissive sources, domestically, marginally increased in the same period (Figure 9). Noting that for the NGGEF, the amount of imported electricity from non-emissive sources increased by 8 % in 2023 since 2021.

These changes alone would not necessarily result in significantly lower GEFs, as is best illustrated in Table 8 with scenarios 1 – 3. However, together these changes do in fact result in a significantly lower GEF as shown by scenario 4.

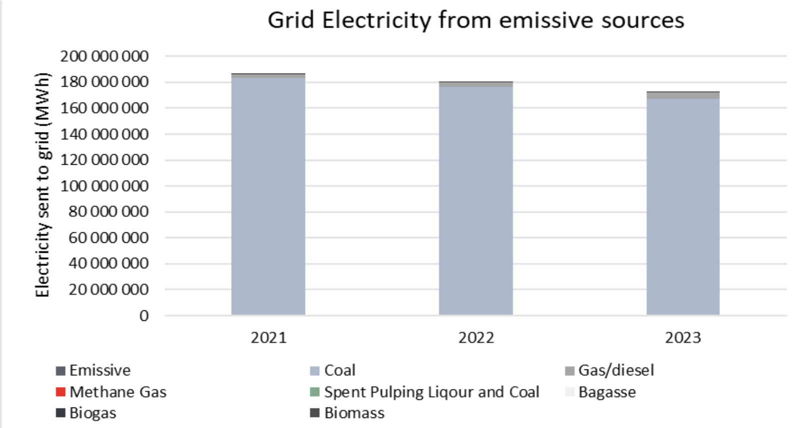

Figure 7: Grid Electricity from Emissive Sources

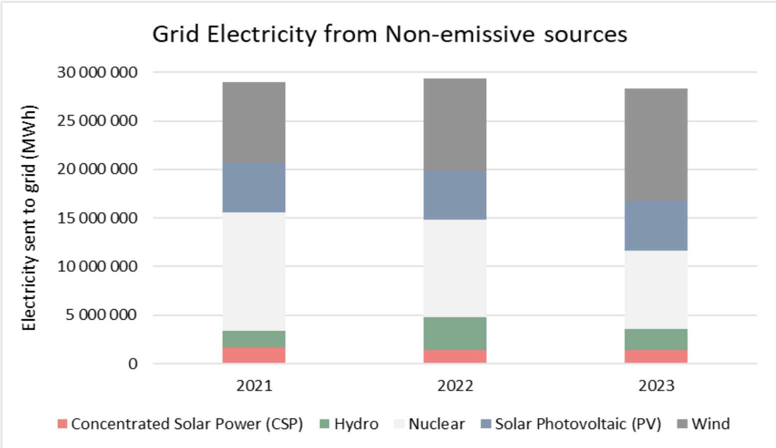

Figure 8: Grid Electricity from Non-emissive Sources

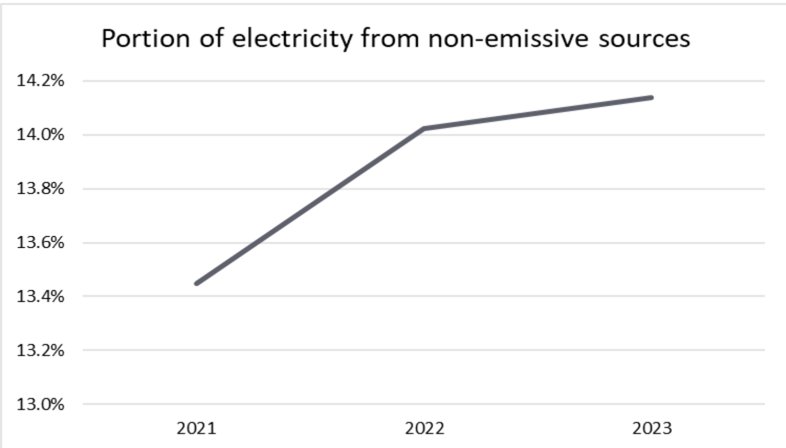

Figure 9: Portion of electricity from non-emissive sources

Table 8: Scenarios for changes in GEFs

	E_{ES}* (MWh)	GHGs (tCO_2e)	E_{NES}* (MWh)	E_{NES}* Portion	GEF (tCO_2e/MWh)	GEF change	Notes
Baseline	100	100	11	10%	0.90		Baseline
Scenario 1	80	80	11	12%	0.88	-2%	Decrease in one major emissive source
Scenario 2	80	79	11	12%	0.87	-4%	Decrease in two emissive sources
Scenario 3	100	100	12	11%	0.89	-1%	Increase in portion of E_{NES}
Scenario 4	80	79	10	11%	0.83	-8%	Combination of scenarios 1 - 3

**Where E_{ES} – electricity from emissive sources, E_{NES} – electricity from non-emissive sources*

It is also important to note that a change in the mix of emissive sources could have a significant impact on a GEF. Particularly when significant changes to the energy mix occur. For example, if we look at coal and diesel, the IPCC default CO_2 emission factors are 96 100 $kgCO_2/TJ$ and 74 100 $kgCO_2/TJ$, respectively. Hence, significantly decreasing electricity from coal while increasing electricity from diesel would result in a less carbon intense grid because of the lower carbon content of diesel.

The 2023 TLGEF is similar to the 2022 TLGEF. On the other hand, the DLGEF is marginally higher than the 2022 DLGEF, however, it is still lower than the 2021 DLGEF.

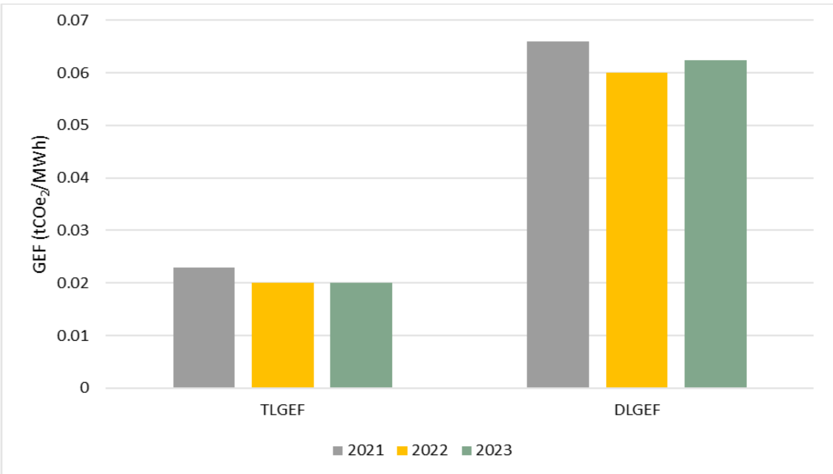

Figure 10: TLGEFs & DLGEFs for 2021 - 2023

Appendix A – Example Calculations

Below are examples showing how the NGGEF, TLGEF and DLGEF should be used. The GEFs in Figure 11 below will be used. These GEFs should be used as location-based GEFs.

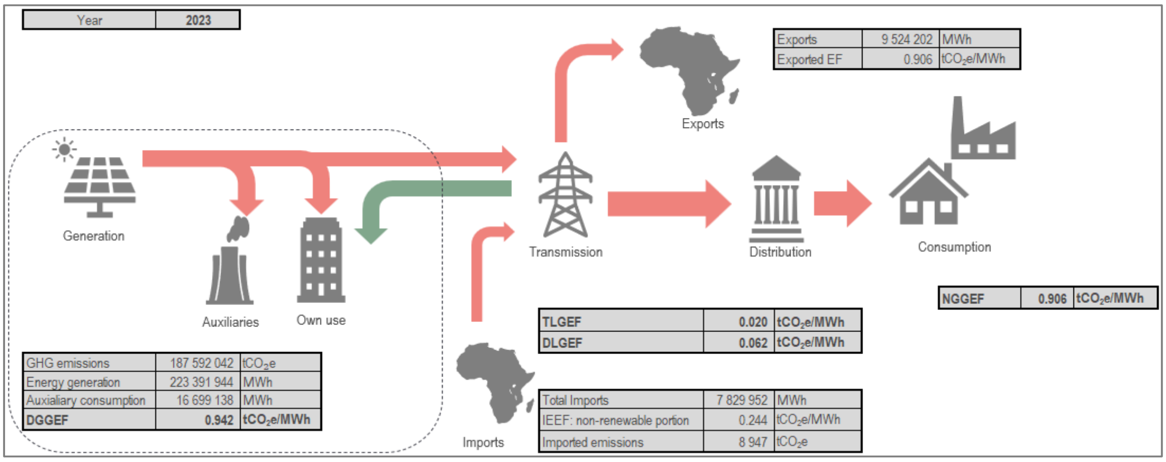

Figure 11: Example of GEFs

A.1. Calculations using the NGGEF

The NGGEF is used, for instance, for Scope 2 emissions reporting. If a consumer purchased 500 MWh during the year from the grid, the Scope 2 GHG emissions would be as follows;

Scope 2 GHG emissions = electricity purchased * NGGEF

$$= 500\ MWh * 0.906 \frac{tCO_2e}{MWh}$$

$$= \mathbf{453\ tCO_2e}$$

A.2. Calculations using the TLGEF

The TLGEF is used by consumers on the transmission network, for instance, for Scope 3 emissions reporting. If a consumer purchased 500 MWh during the year, the Scope 3 GHG emissions would be as follows;

Scope 3 GHG emissions for the transmission network = electricity purchased * TLGEF

$$= 500\ MWh * 0.022 \frac{tCO_2e}{MWh}$$

$$= \mathbf{10\ tCO_2e}$$

A:3. Calculation using the TLGEF and the DLGEF

For consumers on the distribution network, both the TLGEF and the DLGEF are applicable, for instance for Scope 3 reporting. If a consumer purchased 500 MWh during the year, the Scope 3 GHG emissions would be as follows;

Scope 3 GHG emissions for the distribution network = electricity purchased * (TLGEF + DLGEF)

$$= 500\ MWh * (0.020 + \ 0.062)\frac{tCO_2e}{MWh}$$

$$= \mathbf{41\ tCO_2e}$$

Appendix B – List of published GEF Reports

Report	Publish Date	Report Link
2021 GEF Report	2nd Feb 2024	https://www.dffe.gov.za/research-documents
2022 GEF Report	1st Nov 2024	https://www.dffe.gov.za/sites/default/files/legislations/nemaqa_gridemissionsreport2022.24_g51495gon5498.pdf
2023 GEF Report	2025	TBC