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DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT

NO. 5498 **1 November 2024**

PUBLICATION OF SOUTH AFRICA'S 2022 GRID EMISSION FACTORS REPORT

I, Dr Dion Travers George, Minister of Forestry, Fisheries, and the Environment, hereby publish the South Africa's 2022 Grid Emission Factors Report (the second GEFs Report), as set out in the Schedule hereto, for information.

This second GEFs Report shows that the grid in 2022 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 2022 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 2022 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. A copy of the South Africa's Grid GHG Emission Factor Development Report (the Methodological Report) can be accessed on the Departmental website at https://www.dffe.gov.za/legislation/gazetted_notices.

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

SCHEDULE

South Africa's 2022 Grid Emission Factors Report

2024

forestry, fisheries & the environment

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

2030 NDP

Technical Contributors: Rumbidzai Damita Mhunduru & Adele Mhangani

Reviewers: Sindisiwe Mashele & Jongikhaya Witi

All queries and questions should be addressed to:

Department of Forestry, Fisheries, and the Environment

Chief Directorate: Climate Change Mitigation & Specialist Monitoring Services

Private Bag X447

Pretoria

0001

South Africa

Email: GHGReporting@dffe.gov.za

Tel: +27 12 399 9195 / 9238 / 9161

Call Centre Tel: 086 111 2468

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Published in South Africa – 2024

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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. This report, South Africa's 2022 Grid Emission Factor Report, is the second of its kind and it details South Africa's grid emission factors based on 2022 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 2022 GEFs are shown in Figure 1.

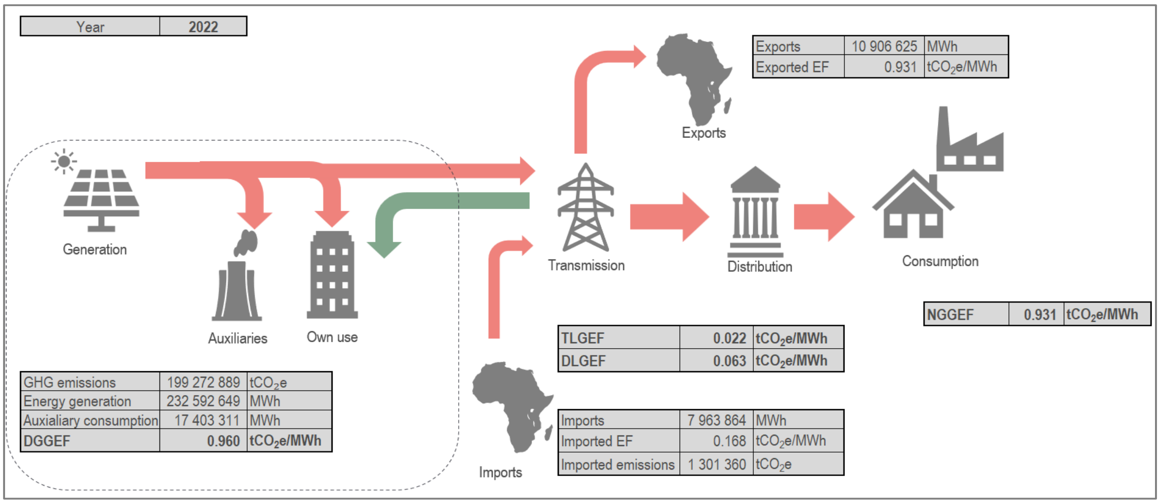

Figure 1: South Africa's Electricity Grid Information 2022

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

Table 1: South Africa's 2022 Grid Emission Factors

GEF	Value (tCO_2e/MWh)
DGGEF	0.96
NGGEF	0.931
TLGEF	0.022
DLGEF	0.063

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 2022 DGGEF, of 0.96 tCO_2e/MWh, is lower than the 2021 DGGEF of 1.013 tCO_2e/MWh. This is due to the decreased amount (3 %) of electricity produced from emissive sources as well as the increase (1 %) in electricity production from non-emissive sources in 2022 in comparison to 2021.

South Africa imported 7 963 864 MWh in 2022 from various sources and the bulk of this electricity (97%) 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 2.3. 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 2022 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. 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.

The data shown in all the tables and graphs is based on the information obtained from NERSA and Eskom and used in calculations based on the GEF Methodological Report.

2.2. Development of Grid Emission Factors

The generic equation used to determine a GEF is show below;

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

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

GHGs emissions data from domestic electricity production was extracted from the South African GHG Emission Reporting System (SAGERS) 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).

Data from the approved Standardised Baseline: Grid Emission Factor for the Southern African Power Pool[1] was used to determine an emission factor for electricity that was imported by South Africa from regional partners. The emission factor of 0.168 tonnes CO_2e/MWh was determined and it excludes electricity generated in South Africa, including the associated GHG emissions. Additionally, the emission factor is inclusive of both emissive and non-emissive electricity data from countries in the region.

2.2.1. 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

[1] Clean Development Mechanism, ASB0040-2018_PSB0044

consumption related to electricity generation, electricity generated for own use and wheeling, as well as the associated emissions. 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.

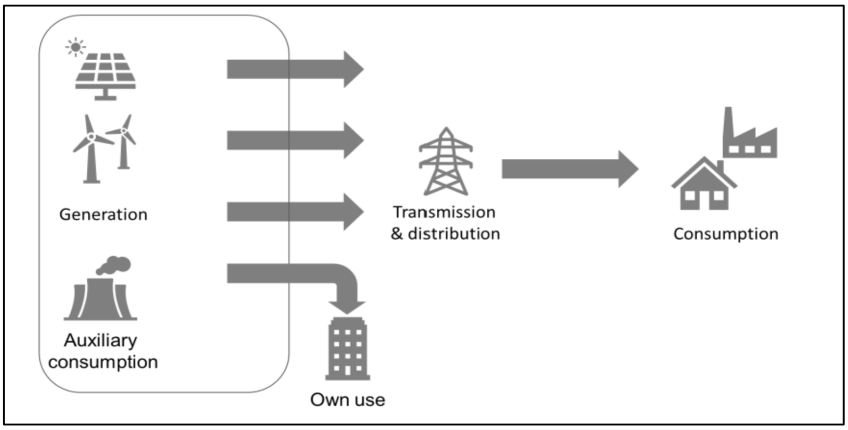

Figure 2: DGGEF Boundary

Table 2 below shows the input data that was used to determine the domestic generation GEF.

Table 2: Domestic Generation GEF Input Data

	Value	Units
Domestic Electricity Generation Emissions	199 272 889	tCO_2e
Domestic Electricity Generation[2]	207 612 127	MWh
Domestic Generation Auxiliary Consumption	17 403 311	MWh
Domestic Generation Own Consumption	7 577 211	MWh

2.2.2. 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 2.2.3 and 2.2.4.

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

The NGGEF includes electricity that is imported as a generation source, with the associated emissions, and electricity that is exported as an end consumer. 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.

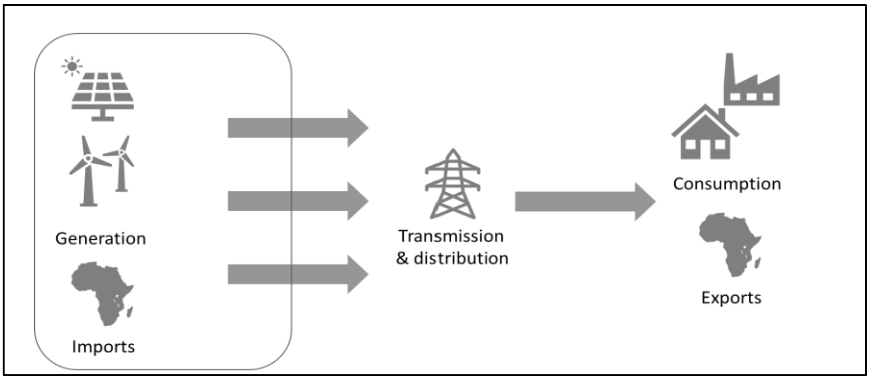

Figure 3: NGGEF Boundary

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

Table 3: National Generation GEF Input Data

	Value	Units
National Electricity Generation Emissions	199 272 889	tCO_2e
Imported Electricity Emissions	1 337 929	tCO_2e
National Electricity Generation[3]	207 612 127	MWh
National Generation Auxiliary Consumption	17 403 311	MWh
National Generation Own Consumption	7 577 211	MWh
Imported Electricity	7 963 864	MWh

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

2.2.3. 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

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

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.

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.

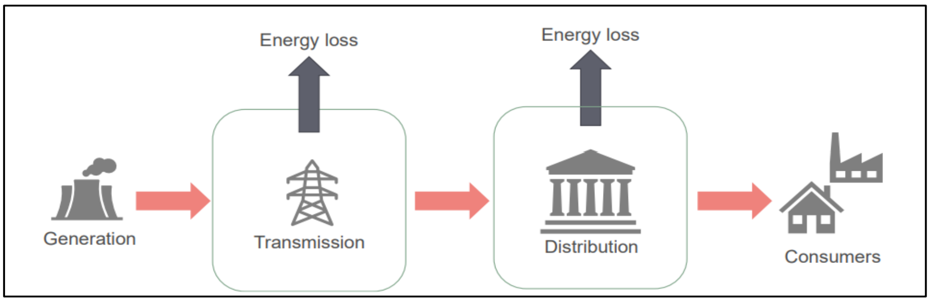

Figure 4: TLGEF and DLGEF Boundaries

Table 4 below shows the input data that was used to determine the transmission and distribution losses GEFs.

Table 4: Transmission & Distribution Losses GEFs Input Data

	Value
Transmission Losses	2.35 %
Distribution Losses (including non-technical)	9.67 %
Distribution Losses (excluding non-technical)	6.77 %

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

2.2.4. 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.

2.3. Intended Users & Uses of the Grid Emission Factors

The four different GEFs have been developed for various uses and users. Table 5 shows the intended users and uses of the four GEFs that were developed for South Africa.

Table 5: 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 2022 Grid Emission Factors

3.1. 2022 Grid Emission Factors

South Africa generated 238 998 212 MWh domestically[4], and of this amount only 215 201 825 MWh were sent to the grid. A further 7 267 995 MWh was added to the national grid from imports (see Figure 5).

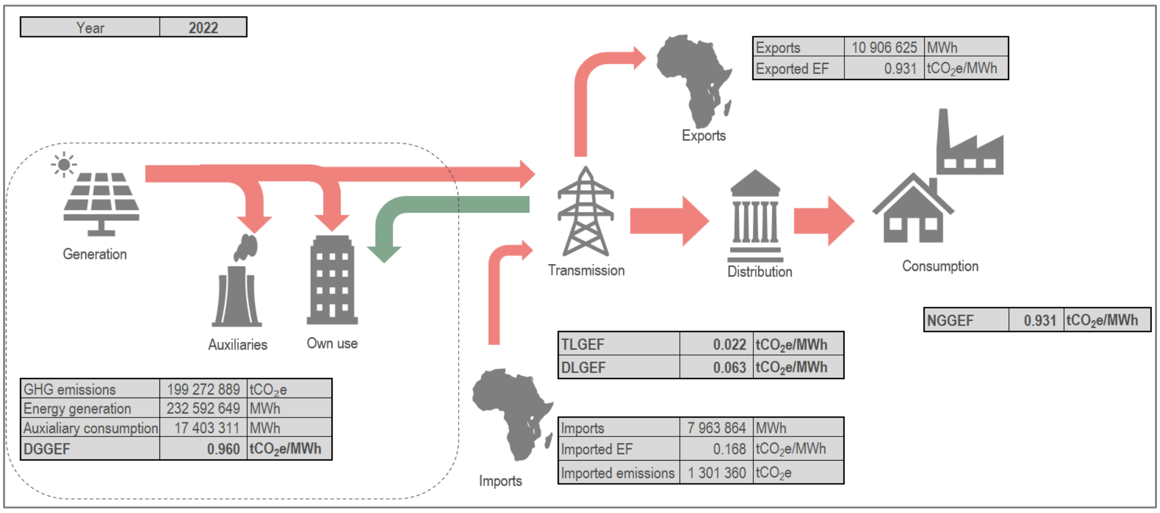

Figure 5: South Africa's Electricity Grid Information 2022

Table 6 below shows the four GEFs for 2022. A GEF value above 1 tCO_2e/MWh indicates an electricity grid that is powered by carbon intensive fuels, such as non-renewables. The 2022 DGGEF, of 0.96 tCO_2e/MWh, is lower than the 2021 DGGEF of 1.013 tCO_2e/MWh. This is due to the decreased amount (3 %) of electricity produced from emissive sources as well as the increase (1 %) in electricity production from non-emissive sources in 2022 in comparison to 2021. Section 3.2 shows a comparison of data for the 2021 and 2022 GEF data.

An emission factor of 0.168 tCO_2e/MWh was used to estimate the emissions from imported electricity. This emission factor was calculated from the UNFCCC Standardised Baseline GEF for SAPP data, excluding data from South Africa's power plants. The bulk of imported electricity (97 %) was produced from renewable energy, mainly from hydropower plants. The addition of this electricity from renewable energy is reflected in the NGGEF that is lower than the DGGEF.

[4] This value includes auxiliary consumption.

Table 6: South Africa's 2021 Grid Emission Factors

GEF	Value (tCO_2e/MWh)
DGGEF	0.960
NGGEF	0.931
TLGEF	0.022
DLGEF	0.063

3.2. Comparison of 2021 and 2022 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 and 2022. For both factors, the 2022 GEFs are lower than the 2021 GEFs.

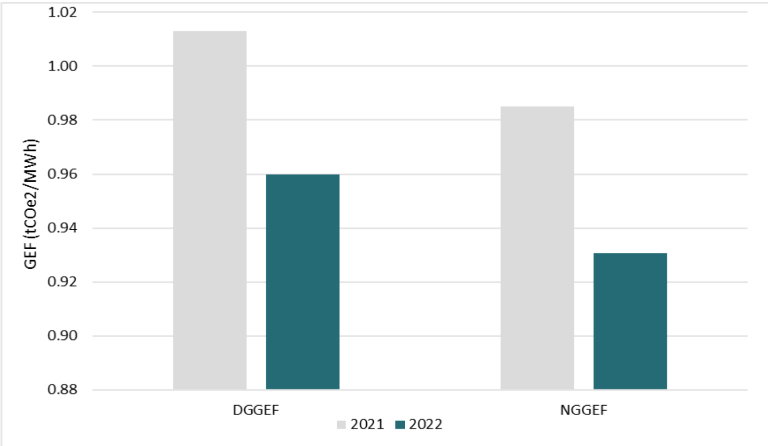

Figure 6: DGGEFs & NGGEFs for 2021 & 2022

The 2021 DGGEF was marginally over 1 tCO2e/MWh and hence was signifying a carbon intense electricity grid. For 2022 this GEF is below 1 tCO2e/MWh and hence indicates that in 2022 the grid was less carbon intensive. The decrease in the DGGEF is supported by Figure 7 which shows a decrease in grid energy from emissive sources and Figure 8 which shows a decrease in energy generated from coal.

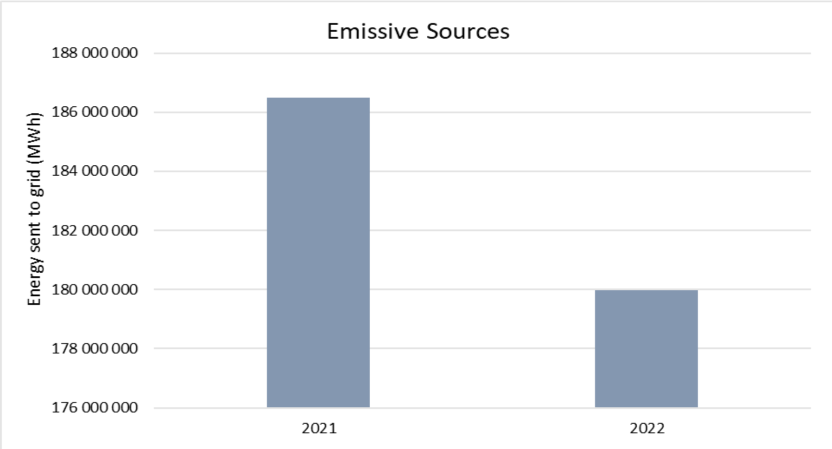

Figure 7: Grid Energy from Emissive Sources

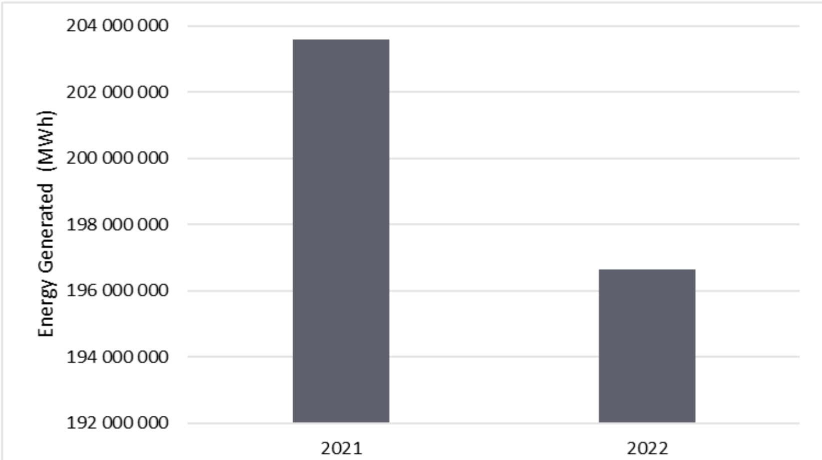

Figure 8: Energy generated from coal in 2021 & 2022

A decrease in energy from emissive sources not only decreases energy produced but also decreases the GHG emissions associated with grid energy. Hence, a decrease in grid energy from emissive sources alone would not necessarily lower the DGGEF. An increase in energy from non-emissive sources would also be required.

Therefore, in addition to the decrease in grid energy from emissive sources, 2022 also experienced an overall increase in grid energy from non-emissive sources (Figure 9) with significant increases in energy generated from hydro and wind (Figure 10).

Although Figure 9 shows an overall increase in energy from non-emissive sources, Figure 10 shows that energy generated from concentrated solar power (CSP) and solar photovoltaic (PV) decreased in 2022.

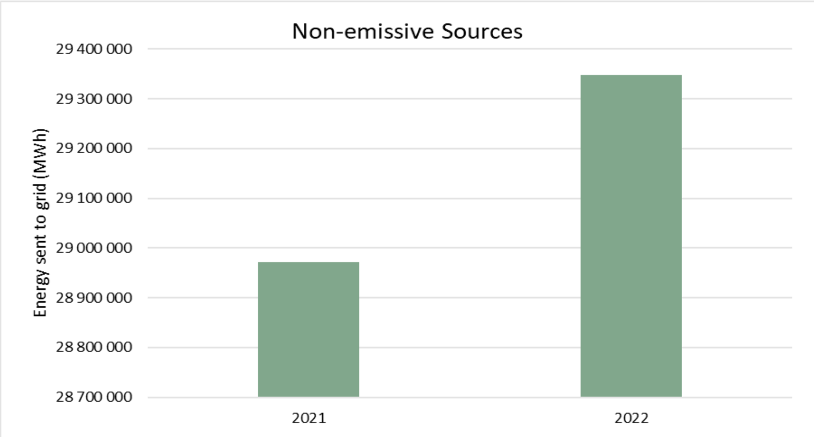

Figure 9: Grid Energy from Non-emissive Sources

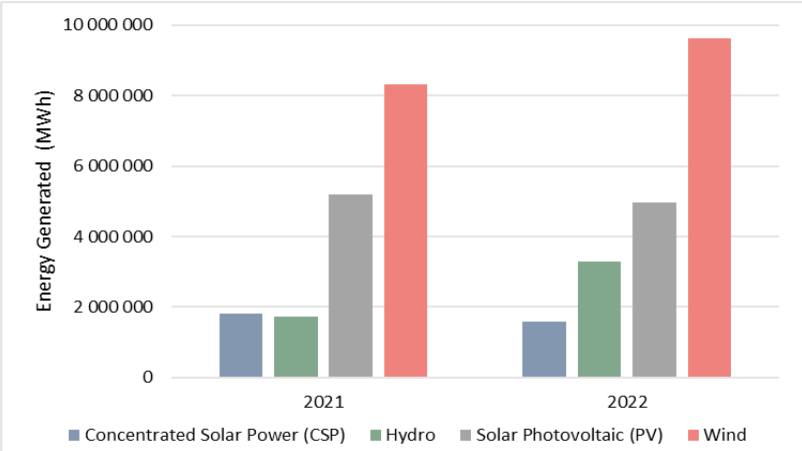

Figure 10: Energy Generated from CSP, Hydro, PV & Wind

The 2022 TLGEFs and DLGEFs are marginally lower that the 2021 GEFs, although there were slight increases in both the transmission and distribution losses.

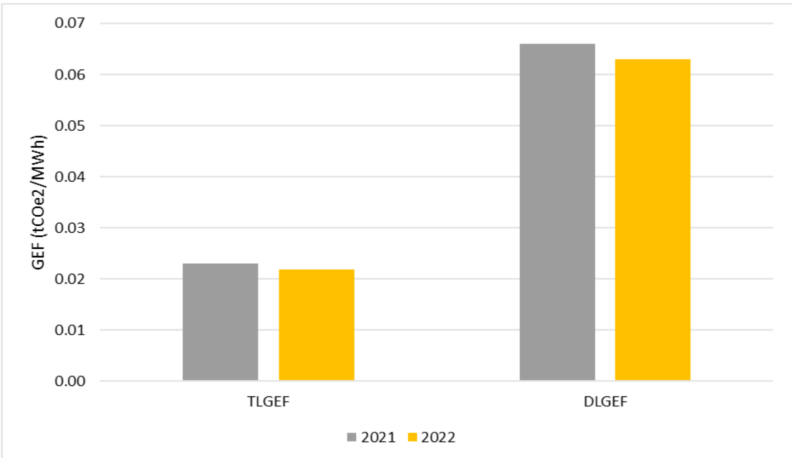

Figure 11: TLGEFs & DLGEFs for 2021 & 2022

Appendix A – Example Calculations

Below are examples showing how the NGGEF, TLGEF and DLGEF should be used. The GEFs in Figure 12 below will be used. These GEFs should be used as location-based GEFs.

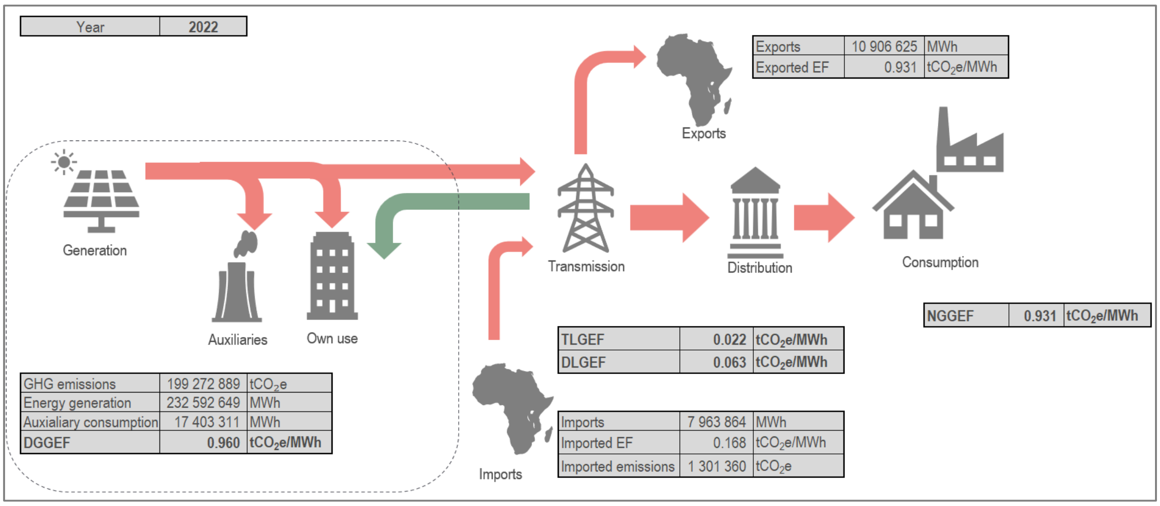

Figure 12: Example of GEFs

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

$$= 500\ MWh * 0.931 \frac{tCO_2e}{MWh}$$

$$= \mathbf{465.5\ tCO_2e}$$

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

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

$$= \mathbf{11\ tCO_2e}$$

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)

$$= 500\ MWh * (0.022 + 0.063)\frac{tCO_2e}{MWh}$$

$$= \mathbf{42.5\ tCO_2e}$$

Appendix B – List of published GEF Reports

Report	Publish Date	Report Link
2021 Grid Emission Factor Report	2nd Feb 2024	https://www.dffe.gov.za/research-documents
2022 Grid Emission Factor Report	2024	TBC

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