DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT

NO. 4317 **02 February 2024**

PUBLICATION OF SOUTH AFRICA'S 2021 GRID EMISSION FACTORS REPORT

I, Barbara Dallas Creecy, Minister of Forestry, Fisheries, and the Environment, hereby publish the South Africa's 2021 Grid Emission Factors Report (GEF Report), as set out in the Schedule hereto.

The 2021 GEF Report includes summarised information and data on electricity production and the Greenhouse Gas (GHG) emissions associated with the electricity that was produced for the 2021 calendar year. This data was used to determine the following four grid emission factors:

1. a domestic generation grid emission factor;
2. a national generation grid emission factor;
3. a transmission loss grid emission factor; and
4. a distribution loss grid emission factor.

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

The 2021 GEF Report is to provide information on the carbon intensity of the electricity supplied through the grid. The Grid Emission Factors 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 Grid Emission Factors to monitor and analyse electricity emission trends, guide climate change modelling and inform climate change mitigation policies. Furthermore, regularly updated Grid Emission Factors 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.

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SCHEDULE

South Africa's 2021 Grid Emission Factors Report

2023

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Abbreviations

DFFE	Department of Forestry, Fisheries and Environment
DGGEF	Domestic generation grid emission factor
DLGEF	Distribution loss grid emission factor
EU	European Union
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.

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 European Union (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 2021 calendar year data.

South Africa's 2021 GEFs are shown in Figure 1.

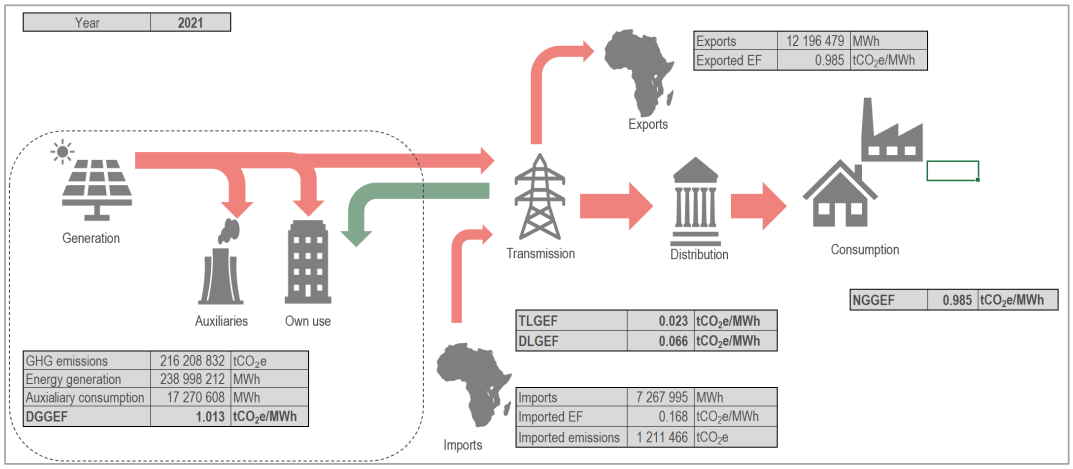

Figure 1: South Africa's Electricity Grid Information 2021

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

Table 1: South Africa's 2021 Grid Emission Factors

GEF	Value (tCO_2e/MWh)
DGGEF	1.013
NGGEF	0.985
TLGEF	0.023
DLGEF	0.066

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 2021 DGGEF, of 1.013 tCO_2e/MWh, accurately reflects South Africa's current energy mix for electricity generation.

South Africa imported 7 267 995 MWh in 2021 from various sources and the bulk of this electricity (99.2%) 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 and below 1 tCO_2e/MWh.

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 2021 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.

2.2. Development of Grid Emission Factors

The generic equation used to determine a GEF is shown 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 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.

[1] Clean Development Mechanism, ASB0040-2018_PSB0044

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.

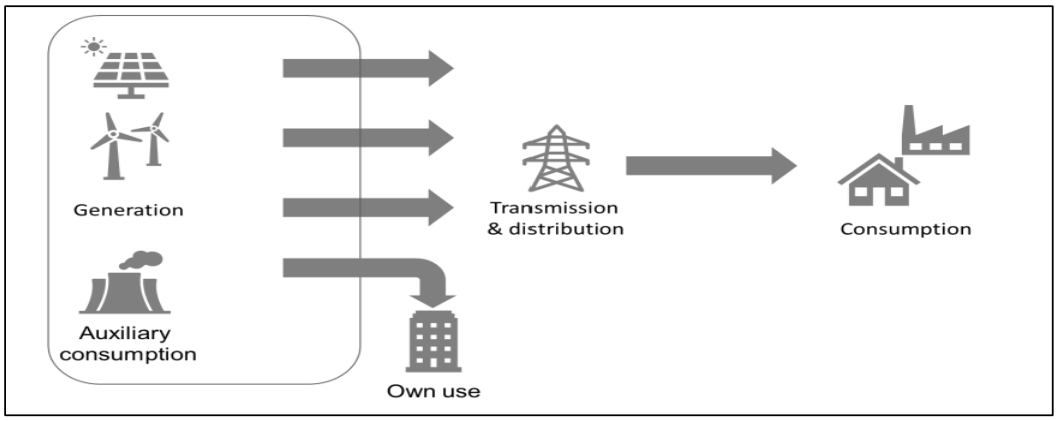

Figure 2: DGGEF Boundary

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	216 208 832	tCO_2e
Domestic Electricity Generation	238 998 212	MWh
Domestic Generation Auxiliary Consumption	17 270 608	MWh
Domestic Generation Own Consumption	8 283 388	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.

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.

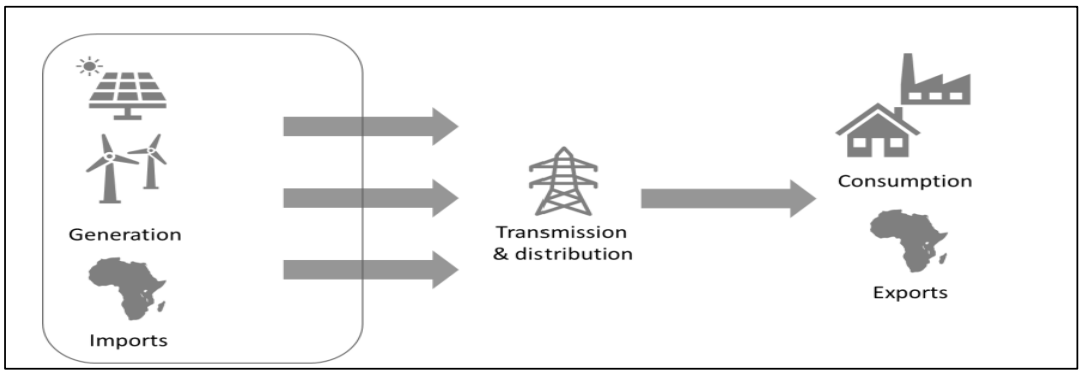

Figure 3: NGGEF Boundary

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	216 208 832	tCO_2e
Imported Electricity Emissions	1 221 023	tCO_2e
National Electricity Generation	238 998 212	MWh
National Generation Auxiliary Consumption	17 270 608	MWh
National Generation Own Consumption	8 283 388	MWh
Imported Electricity	7 267 995	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 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.

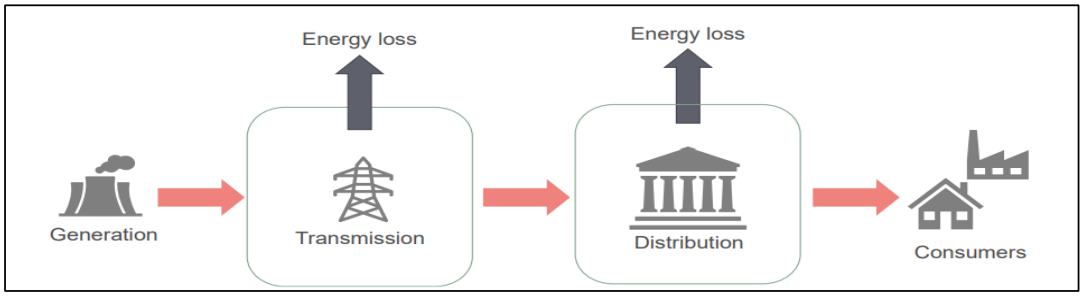

Figure 4: TLGEF and DLGEF Boundaries

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	2.3 %
Distribution Losses (including non-technical)	9.61 %
Distribution Losses (excluding non-technical)	6.73 %

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 2021 Grid Emission Factors

South Africa generated 238 998 212 MWh domestically[2], 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).

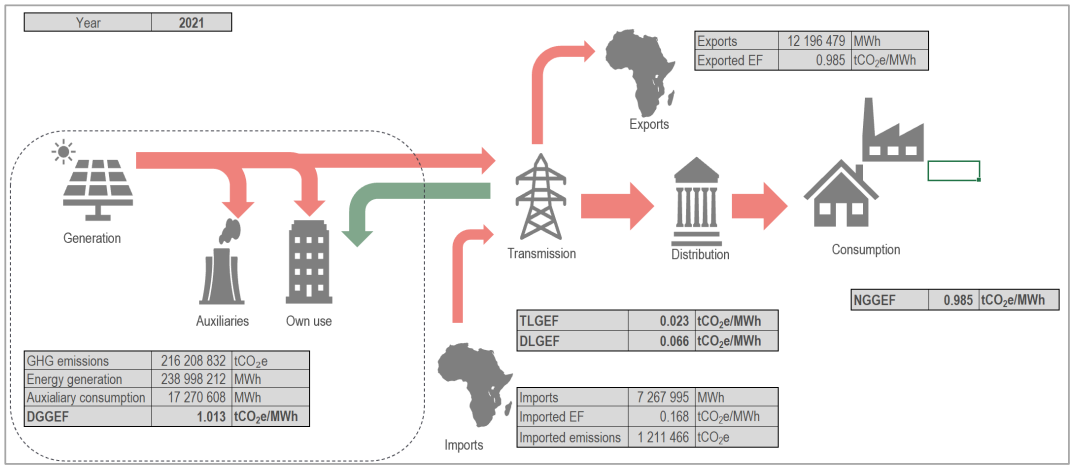

Figure 5: South Africa's Electricity Grid Information 2021

Table 6 below shows the four GEFs for 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 2021 DGGEF, of 1.013 tCO_2e/MWh, accurately reflects South Africa's current energy mix for electricity generation.

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 (99.2%) 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 and below 1 tCO_2e/MWh.

Table 6: South Africa's 2021 Grid Emission Factors

GEF	Value (tCO_2e/MWh)
DGGEF	1.013
NGGEF	0.985
TLGEF	0.023
DLGEF	0.066

[2] This value includes auxiliary consumption.

Appendix A – Example Calculations

Below are examples showing how the NGGEF, TLGEF and DLGEF should be used. The GEFs in Figure 6 below will be used. These GEFs should be used as location-based GEFs.

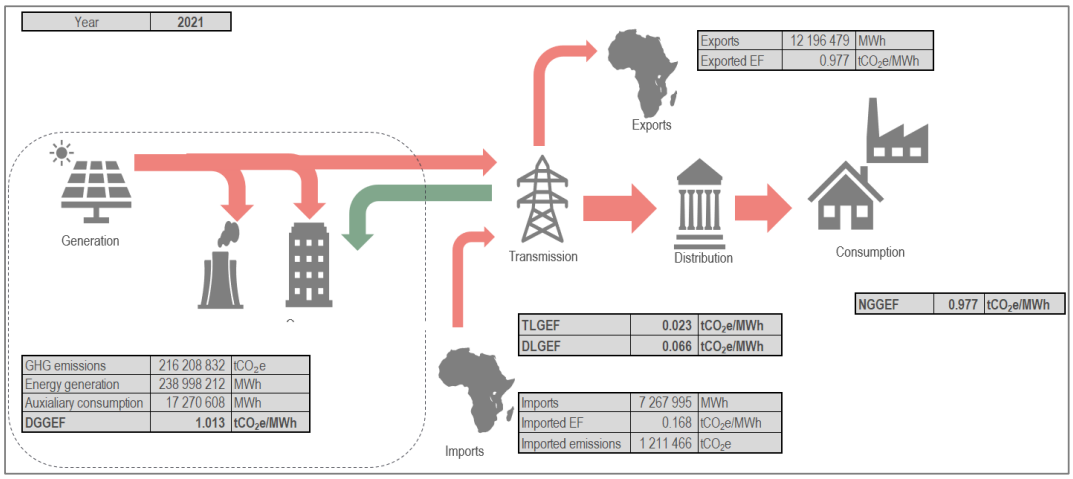

Figure 6: Example of GEFs

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

$$= 500\ MWh * 0.985 \frac{tCO_2e}{MWh}$$

$$= \mathbf{493\ tCO_2e}$$

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

$$= 500\ MWh * 0.023 \frac{tCO_2e}{MWh}$$

$$= \mathbf{11.5\ tCO_2e}$$

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)

$$= 500\ MWh * (0.023 + \ 0.066)\frac{tCO_2e}{MWh}$$

$$= \mathbf{45}\ \boldsymbol{tCO_2e}$$