Development of an emission factor for imported electricity

Report to the Government of Jersey

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Author(s)	Kathryn Hampshire
Reviewed by	Katie King
Signature	
Date	31/3/22

Company Details:	Aether Ltd Oxford Centre for Innovation New Road Oxford OX1 1BY UK Registered in England 6630896
Contact:	enquiries@aether-uk.com +44(0)1865 261466 www.aether-uk.com

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1 Introduction

1.1 Project overview and aims

In its efforts to pro-actively work towards a zero-carbon economy, Jersey Government is keen to develop means and metrics to understand priority actions for carbon reduction across all its operations and activities. Jersey Government is also keen to ensure that strategies for carbon reduction work in synergy with strategies for improved energy efficiency and energy security.

This project focused on options for establishing and understanding a nationwide grid electricity carbon factor in terms of CO_2eq/GWh electricity.

This factor will be used to help understand the carbon impacts of electricity use in Jersey.

This updated report provides a revised grid electricity factor to account for a correction in emissions from Energy from Waste.

2 Emissions associated with imported electricity

The total scope 2 emissions estimates associated with Jersey's imported electricity are based on the embodied greenhouse gas estimates associated with the production and delivery of Jersey's electricity provided by EDF France using nuclear and hydro technologies.

In 2020 a total of 2.9 kt CO_2 eq are associated with the imported electricity. This accounts for 0.8% of the total scope 1 and 2 emissions for Jersey for 2020.

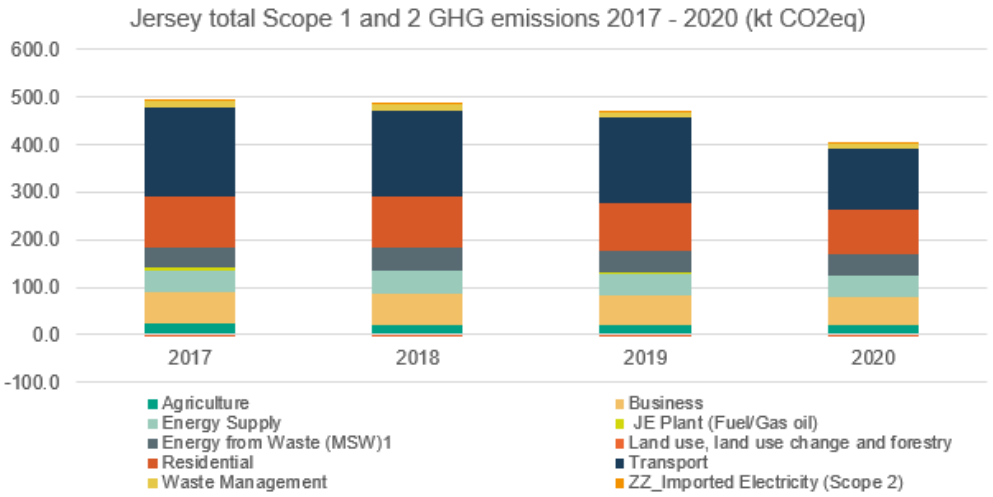
The methodology for estimating these emissions is presented in section 3.

Figure 1 below shows Jersey's scope 1 emissions (associated with on island emission sources and sinks) and the additional scope 2 emissions from imported electricity (see the row marked as ZZ_Imported Electricity (Scope 2)). The calculated implied emission factor for the imported electricity is at the bottom of table 1 below.

Jersey total Scope 1 and 2 GHG emissions 2017-2020 (kt CO_2eq)

NCFormat (kt CO_2 eq)	2017	2018	2019	2020	% for 2020
Agriculture	**23.5**	**22.1**	**20.4**	**19.7**	6%
Business	**64.7**	**64.1**	**60.9**	**58.7**	16%
Energy Supply	**48.4**	**47.7**	**46.8**	**45.5**	13%
JE Plant (Fuel/Gas oil)	4.2	2.7	3.1	1.2	0%
Energy from Waste (MSW)[1]	44.0	45.3	44.7	44.1	12%
Industrial processes	0.1	0.1	0.1	0.1	0%
Land use, land use change and forestry	**-0.7**	**-1.3**	**-0.9**	**-0.4**	0%
Residential	**107.5**	**107.4**	**102.1**	**93.7**	26%
Transport	**187.1**	**183.1**	**177.8**	**127.9**	36%
Waste Management	**11.4**	**11.5**	**11.6**	**11.6**	3%
Grand Total Scope 1	442.0	434.6	418.8	356.8	
ZZ_Imported Electricity (Scope 2)	3.0	3.0	3.0	2.9	
Total including scope 2 (imported electricity emissions)	445.0	437.7	421.8	359.7	
% of total emissions from imported electricity	0.66%	0.69%	0.71%	0.81%	

1) Previously based on estimates provided by Jersey Electricity using total mass of waste burned for energy and default IPCC emission factors. This has been updated to use the Jersey GHG inventory value for emissions from Energy from Waste.



Source: Aether

Figure 1 - Emissions relating to energy supply in Jersey

Jersey's current electricity supply is made up of:

- Imported electricity from EDF hydro and nuclear generation plant in France
- An energy recovery facility (energy from waste) based in Jersey[1]
- Ancillary/back up light fuel oil generation from Jersey Electricity

Since 2000 Jersey has been transitioning from its reliance on heavy fuel oil to electricity imported from France and generation at the energy recovery facility. This has dramatically decreased the grid electricity emission factor, particularly through the significant reduction in burning of heavy fuel oil. Due a link failure in 2013, Jersey suffered high generation emissions in 2014 due to increased use of oil. Replacement of the failed link took place in 2014/2015. Jersey has plans to extend its coverage of Photovoltaic (PV) generation which will reduce its reliance on imported electricity and electricity generation using fossil fuels and waste derive fuels. However, it is unlikely to

[1] Estimates for this report are from the Jersey GHG inventory

improve on the current carbon footprint of Jersey's imported electricity[2] if PV replaces imported electricity.

Although the majority of Jersey's electricity comes from low carbon sources there is still a residual carbon impact in the electricity it uses. This carbon comes from:

- The minimal, but carbon intensive, light fuel oil use in the Jersey generating/back-up plant
- Carbon embedded in the production of renewable and nuclear energy supplied by EDF
- Carbon associated with the other operations of Jersey Electricity including its grid system service vehicles, office operations and grid equipment
- Carbon associated with fossil-based carbon (e.g. plastics) and CH_4 and N_2O from inputs burned in the energy recovery facility and from the vehicles collection and transport of waste[3]. Further work is needed on this estimate (see recommendations).

Figure 2 presents the time series of emissions associated with Jersey's electricity supply.

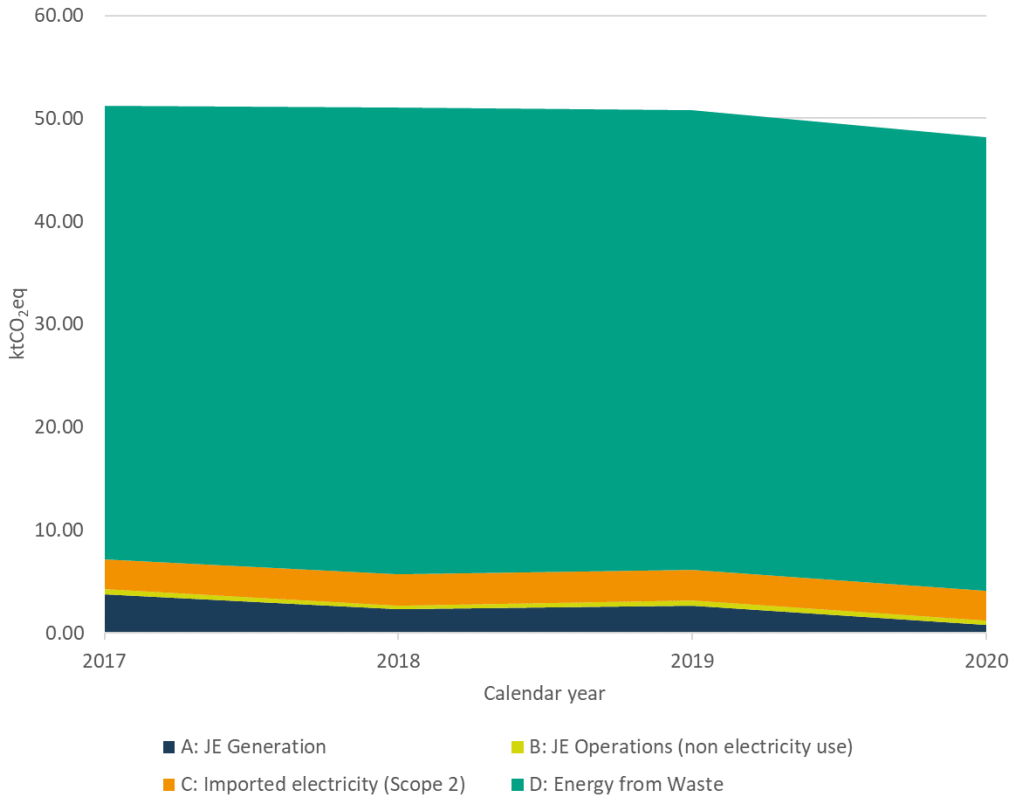


Figure 2 - Emissions relating to electricity supply in Jersey

[2] The PV array at La Collette has an intensity of 15 g CO2e per kWh (lifecycle) which are considered to be some of the lowest on the market. Increased use of PV to replace imported electricity will increase GHG emissions.

[3] This has been excluded from estimates due to lack of data.

3 Grid emission factor for estimating emissions associated with electricity use in Jersey

Options are presented below for grid electricity factors that could be used to estimate the GHG impact associated with use of electricity from the grid in Jersey. The basic equation for the calculation of the grid emission factor is as follows:

$$Grid\ EF = \frac{Emissions\ associated\ with\ electricity\ production\ (kt\ CO2eq)}{Electricity\ produced\ or\ consumed\ (GWh)}$$

Three variants of the grid electricity CO_2eq factor have been calculated (see **table 1**). These consider different components of electricity generation emissions and vary depending on whether these emissions are divided by the electricity generated or consumed.

We have highlighted in the red outlined box "1.Full scope emissions/electricity supplied" the factor as the most appropriate factor to use for estimating the total greenhouse gas emissions associated with electricity consumed.

	2017	2018	2019	2020	Trend
Electricity Generation emissions (kt CO_2eq)					
A: JE Generation	3.81	2.29	2.71	0.77	
B: JE Operations (non electricity use)	0.44	0.38	0.43	0.45	
C: Imported electricity (Scope 2)	2.96	3.04	2.98	2.92	
D: Energy from Waste	44.04	45.34	44.66	44.06	
E: Waste collection and WfE Operations		! No Data !			
Total emissions	**51.24**	**51.06**	**50.78**	**48.19**	
Electricity					
F: Total generated & imported (GWh)	666	674	660	651	
G: Total consumed (GWh)	622	635	627	619	
Losses GWh	44	39	33	32	
Losses %	7%	6%	5%	5%	
Grid electricity factor (kt CO_2eq/GWh)					
1. Full scope emissions/electricity supplied:- ***[Sum(A:E)/G]***	0.082	0.080	0.081	0.078	
2. Full scope emissions/electricity generated :- ***[Sum(A:E)/F]***	0.077	0.076	0.077	0.074	
3. Pure Scope 2:- ***[(A+D)/F]***	0.072	0.071	0.072	0.069	
Std dv.	0.005	0.005	0.005	0.005	
Min	0.07	0.07	0.07	0.07	
Max	0.08	0.08	0.08	0.08	
Imported electricity Implied Emission Factor (kt CO_2eq/GWh)	**0.0047**	**0.0048**	**0.0048**	**0.0047**	

Table 1 Emissions electricity and grid emission factor (The red outlined box highlights the recommended factor)

Note: There is very little difference between the three variants since most of the emissions come from the generation of electricity in the Energy from Waste plant. Details of the different elements included in the options are presented below:

Includes emissions associated with imported electricity

1. **Full scope emissions/electricity supplied:** This includes all **Jersey Electricity operation emissions, emissions associated with Energy from Waste, net emissions from imported electricity and transmission losses** divided by **net electricity consumed** (electricity generated and imported minus electricity use for own-use, transmission and distribution losses). It provides a factor which takes into account all possible emissions associated with the generation of electricity and attributes them to the end-user of the electricity according

to their consumption. It includes all inefficiencies in the transmission and distribution system.

Includes emissions associated with imported electricity

2. **Full scope emissions/electricity generated:** This includes all **Jersey Electricity operation emissions, emissions associated with Energy from Waste, net emissions from imported electricity and transmission losses** divided **by total electricity generated and imported** (before removing losses and own use). This excludes the effect of the use/loss of electricity in its generation, transmission and distribution.

Excludes emissions associated with imported electricity

3. **Pure Scope 2:** This includes the **in-Jersey generation emissions only.** It includes **emissions associated with Energy from Waste** but **excludes all Jersey Electricity non-electricity generation operations and excludes net emissions from imported electricity**. This emission is divided by **total electricity generated and imported** (before removing losses and own use). This provides an emission factor that is consistent with IPCC definitions of national emissions and is useful for company reporting as it avoids double counting of transmission and distribution losses.

The **GHG Protocol guidance for company reporting uses a scope 2** emission factor that avoids double counting between company reports and therefore has a narrower scope. This is consistent with the "**Pure Scope 2**" factor above. The GHG protocol scope 2 emission factors uses the energy used for the generation of the electricity and the total electricity supplied to the grid (without removing transmission losses). This approach avoids double counting with the other emissions from operations in the electricity generation companies. The GHG protocol scope 2 emission factors allocates emissions attributable to the electricity organisations consumed and not the emissions associated with the generation of the electricity lost in transmission and distribution. The latter would be allocated to the organisations operating the transmission and distribution network. Again, this is to ensure that double counting between company reports is avoided as much as possible.

The estimated implied emission factor for the imported electricity is presented above at the bottom of Table 1. Due to the imported electricity being generated from nuclear and hydro, this emission factor is **extremely low and consistently between 4.7 and 4.8 tonnes of CO_2 equivalent/GWh of electricity generated**.

3.1 Recommended grid emission factor

We recommend that, for Jersey's national electricity CO_2eq factor, it uses the emission factor presented in **Option 1: full scope emissions/by electricity supply**. This is highlighted with the red box in table 1 above and shown in table 2 below. This recommendation is based on assumptions that all emissions associated with electricity generation (including those embodied in Jersey's imported electricity) should be attributed to the electricity consumer. Option 1 provides a complete factor for electricity use that includes all possible emissions (associated with the electricity production, transmission and distribution) and any inherent inefficiencies in the delivery of the electricity available on the grid. This is different from the GHG protocol defined scope 2 implied emission factor for electricity consumption used for company reporting (see description below for Australia and UK).

	2017	2018	2019	2020
Grid electricity factor (kt CO_2eq/GWh)	0.082	0.080	0.081	0.078*

Table 2 Recommended grid electricity factors (kt CO_2eq/GWh)

* The grid electricity factor for 2020 is provisional. It has been calculated based on the assumption that all waste incinerated was used for electricity generation. However, this may not be the case, some waste may have been incinerated without electricity generation. This needs further investigation with any subsequent changes being made in the calculation.

4 Methods data sources and assumptions used

Estimates are based on information supplied by Jersey Electricity and the Jersey GHG inventory and include:

1. A breakdown of the emissions from fossil fuel use in Jersey Electricity operations. This includes heavy fuel oil and gas oil used in running the electricity generation plant and petrol and diesel used in its vehicle fleet.
2. Estimates of SF_6 used in the distribution systems electrical switch gear.
3. Estimates of refrigerant gases used for air conditioning.
4. Estimates of emissions from the Energy from Waste, energy recovery facility, based on estimates from the Jersey GHG inventory. Recommendations for improvement to these estimates are provided in the recommendations section.
5. Estimates of the emissions associated with the imported electricity. For these estimates Jersey Electricity have documents from EDF highlighting the carbon intensity of generated hydro and nuclear electricity.
6. Estimation of emissions associated with the transmission losses for imported electricity. These estimates apply the same factors as above in point 5.

Emissions estimates for the waste collection for the energy recovery facility have not been included. Recommendations for the estimation of these emissions have been provided in the recommendation section.

Note: The **grid emission factor** provides estimates of emissions associated with electricity consumption based on emissions during its production. The **same approach could be applied for the gaseous, solid and liquid fuels consumed in Jersey**, known as Well to Tank factors**.** It is more complex to calculate these additional associated emissions as Jerseys solid, liquid and gaseous fuels are imported from a range of different countries. The UK compiles estimates of end-user emissions[4] which incorporate re-allocation of emissions associated with national energy production and distribution. It is difficult to estimate the emissions associated with the production and distribution of different fuels from the data publicly available. For liquid fuels you could assume that the scope 3 emissions add between 15% and 20% to the scope 1 emissions estimates for liquid fuels.

[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/789830/1990-2017-uk-emissions-final-figures-by-end-user-sector-fuel-type.pdf

5 Examples from other countries

5.1 Australia

Australia does not import electricity via a subsea cable however they do calculate and report scope 2 emissions for organisations to use alongside their scope 1 greenhouse gas emissions inventory estimates[5]. Scope 2 emissions are derived for national total and broken down by region. Scope 2 reporting is compulsory for companies that purchase more than 20,000 kWh of electricity per year and is voluntary for smaller companies. The scope 2 emission factors for the consumption of purchased electricity are updated annually to reflect changes in the energy generation mix.

In Australia, the formula for calculating scope 2 emissions is:

Scope 2 emissions for a company in a given year = (quantity of purchased electricity + quantity of electricity consumed from operations (kWh)) X Scope 2 emission factor ($kgCO_2eq/kWh$)

Therefore, to calculate the scope 2 emission factor:

$$Scope\ 2\ EF\ (kgCO2eq/kWh) = \frac{Scope\ 2\ emissions\ (kgCO2eq)}{(Quantity\ of\ purchased\ electricity + quantity\ of\ electricity\ consumed\ (kWh))}$$

The scope 2 emission factor accounts for energy sent out on the grid, not by energy delivered and therefore end users are only allocated emissions from the electricity they consume. It therefore does not account for electricity lost in transmission and distribution. These emissions are allocated to the transmission and distribution network rather than the end user and are reported by the companies that control the networks in their scope 2 emissions (in line with GHG Protocol guidance for organisations)[6].

5.2 UK

In the UK, a small proportion of electricity is imported via interconnectors from France, Ireland and the Netherlands[7]. We assume that the emissions associated with this electricity are not included in the UK's emission factor. The UK publishes country specific emission factors for grid electricity, and these are updated annually - provided in the UK Government GHG Conversion Factors for Company Reporting. These conversion factors and the accompanying guidelines provide organisations with a methodology for calculating their scope 2 emissions from electricity used by the organisation at a site that they own or control[8]. The conversion factors are for electricity supplied to the grid that is purchased by the organisation and therefore does not include emissions associated with transmission and distribution. The guidance recommends that the emissions

[5] http://ageis.climatechange.gov.au/Electricity.aspx

[6] http://www.environment.gov.au/system/files/resources/0e76f367-dfad-451d-8f41-859acfad327a/files/ngers-technical-guidelines-2017-18.pdf

[7] https://www.ons.gov.uk/economy/environmentalaccounts/articles/ukenergyhowmuchwhattypeandwherefrom/2016-08-15

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/829336/2019_Green-house-gas-reporting-methodology.pdf

associated with transmission and distribution losses are accounted for as part of a company's scope 3 emissions.

The electricity conversion factors provided in the guidance represents average CO_2 emissions from the UK grid per kWh of generated electricity (scope 2 of the GHG Protocol). It therefore accounts for net imports of electricity via interconnectors with Ireland, the Netherlands and France but assumes these have zero emissions associated with them.

6 Recommendations for further work

1. **Improve the estimates of emissions from the energy from waste plant**. Working with Jersey Electricity and Government of Jersey, Aether can review the emission factor used for Energy from Waste to investigate how applicable the NAEI factor is for Jersey. Aether can also adjust the GHG inventory compilation spreadsheets to allow for waste being incinerated but not for electricity generation.
2. Research and include **well to tank factors for other fuels** (gaseous, liquid and solid) consumed in Jersey. This work needs to explore underlying data to that published in UK statistics which estimates the end-user emissions by sector and fuel.
3. Further develop **the tools and guidance for estimating and applying scope 2 and 3 emission factors** for electricity and other energy consumption to support decision making around Jersey's carbon neutral goals.

About the authors

Justin Goodwin: Justin Goodwin has 20 years of hands-on practical development and continuous improvement of Measuring, Reporting and Verification (MRV) systems for greenhouse gas and other air pollutant emission and projections. He is an active and well-known UNFCCC Lead Reviewer and has led reviews for the UNFCCC inventories for over 20 countries and been involved in the UNFCCC review and analysis process since 2004. Justin also advises several countries including UK, EU member States, Spain, Barbados, the West Balkan countries, Turkey, South Africa, Italy, Ireland, Iceland and Jamaica on their National Systems. Justin has contributed to the development of IPCC good practice guidance and was the lead author for the data collection chapter of the IPCC's 2006 Good Practice Guidelines. Justin has also authored several other good practice documents on projections, writing national inventory reports and developing National Systems.

Kathryn Hampshire: Kathryn specialises in emissions inventories and data visualisation. She has led work to compile and QA/QC greenhouse gas inventories for the UK Oversees Territories and Crown Dependencies and the Devolved Administrations as part of the UK emissions inventory programme. She has recently been working with Jersey, Guernsey and the Isle of Man creating technical reports, reports for the general public and visualisations of emissions data to increased understanding of emissions data and facilitate stakeholder engagement.

Photo

Aether

Oxford Centre for Innovation

New Road

Oxford

OX1 1BY UK

+44(0)1865 261466

www.aether-uk.com