METHODOLOGY FOR THE CALCULATION OF THE GREENHOUSE GAS EMISSIONS (GHG) INVENTORY OF RED ELÉCTRICA DE ESPAÑA, SAU

1. Scope of the inventory

Organisational boundaries

The calculation of Red Eléctrica de España SAU's (REE's) emissions is performed under operational control criteria. The inventory only applies to the activities that take place in Spain.

Operational scope

Emissions associated with REE's activities and facilities are quantified, taking into consideration the following scopes:

Scope 1: Direct GHG (Greenhouse Gas) emissions

Emissions resulting from the Company's controlled or owned sources:

- Stationary combustion: emissions resulting from the consumption of fuel used in diesel generating sets. (No other stationary combustion source exists at the company).
- Mobile combustion: emissions resulting from the consumption of fuel by fleet vehicles.
- Fugitive emissions: SF_6 gas leaks at electricity substations and refrigerant gas leaks from air conditioning systems.

Scope 2: Indirect GHG emissions associated with electricity consumption

- Electricity consumption.
- Electricity losses in the transmission grid.

Scope 3: Other indirect GHG emissions

- Emissions associated with the purchase of goods and services (supply chain).
- Emissions associated with business travel by plane, train and car.
- Emissions resulting from the internal transportation of materials (logistics, subcontracted to an external company).
- Emissions from employees commuting to the workplace.

2. Methodology and data to be used to calculate emissions

2.1 Direct emissions: SCOPE 1.

2.1.1 Emissions resulting from the consumption of fuel used in diesel generating sets

Diesel Generating sets are found in most of REE substations and some buildings (working premises) in order to ensure the supply in the event of electricity failure. In general (with some exceptions), the number of operating hours registered, corresponds to the time where they have been on in order to perform maintenance checks to ensure that they are in working conditions.

- Method of calculation

Calculations are based on the number of hours they have been in operation and the power of each generator (apparent power).

Apparent power (KVA)* power factor (0.8) = active power (kw)
Active power*hours of operation = energy generated (kwh)

Assumptions made: We assume a power factor of cosφ=0.8. We assume that the generating sets are operating at maximum power (which means that we are taking account of the worst possible scenario as regards emissions, since generators normally operate well below maximum power).

Emission factor used: 0.287 kgCO_2/kwh (Source: IDAE)

2.1.2 Emissions resulting from the consumption of fuel by fleet vehicles

Fleet vehicles are defined as the vehicles that are owned by REE and used by technicians to perform their work.

- Method of calculation

Emissions are calculated using the following formula: total litres of fuel consumed (by type) x emission factor (according to the type of fuel used).

Emission factors: as published by the Spanish Climate Change Office OECC at the Ministry of Agriculture, Food and the Environment (MAGRAMA). Most recent version published in May 2015.

Fuels	
Petrol (kg CO_2/l)	2.196
Diesel (kg CO_2/l)	2.471
Biodiesel (kg CO_2/l)	1.73
LPG (kg CO_2/l)	1.656

2.1.3 Fugitive emissions of SF_6 at electricity substations

SF_6 gas is a dielectric gas that is used in electrical substations. It is mainly found in the switches and at armoured substations or GIS.

- Method of calculation

SF_6 gas emissions are calculated using the following formula:

Total SF_6 leaks = Leaks from equipment in service + Leaks associated with the draining of equipment at the end of its operational life.

a. Leaks from equipment in service: the amount of gas leaking from operational equipment is regarded as equivalent to the amount used to fill the equipment in question minus the gas recovered. This information is recorded in accordance with the instructions set out in REE's internal procedures. (The amount of gas recorded includes leaks inherent in the equipment itself, leaks resulting from the breakdown or ageing of this equipment and leaks associated with accidents: emissions during operation and maintenance emissions, as defined in the Voluntary Agreement between MAGRAMA, AFBEL, UNESA, REE and the

waste and SF_6 gas managers signed in 2015). Emissions resulting from accidents and do not involve refilling operations, are also included.

b. Leaks associated with the end of the SF_6 equipment's operational life are calculated by applying the figure shown in the voluntary agreement for the equipment in question: this is calculated by applying the emission rate shown in the Voluntary Agreement (0.4%) mentioned in the previous paragraph.

CO_2 emissions: in order to convert SF_6 emissions to CO_2, the GWP for 100 years is used, as published in the fourth IPCC report (2007) of 22800.

2.1.4 Fugitive emissions of refrigerant gas from air conditioning systems.

Air conditioning equipment is fitted at both buildings and substations.

- Method of calculation

  Calculations are based on the amount of gas used to refill the gear each year (refilled gas = leaked gas).

  Refilling per type of refrigerant gas x GWP.

  The GWP figures for 100 years are used, as published in the fourth IPCC report (2007) (Regulation 517/2014), as indicated in the document issued by the Spanish Climate Change Office (OECC).

2.2 Indirect emissions. SCOPE 2

2.2.1 Emissions associated with electricity consumption

These are the emissions associated with the consumption of electricity at the different facilities. They do not include the emissions due to the loss of energy in the electricity transmission grid.

- Method of calculation

These emissions are calculated by multiplying the consumption of electricity by the average emission factor for the Spanish energy system during the year in which the inventory is prepared.

Emission factor: calculated by REE in accordance with the methodology defined by REE's Demand Management Department. (The emission factor for the Spanish mainland is used in all cases).

2.2.2 Emissions associated with electricity losses in the transmission grid

The transmission of electricity involves some loss of electricity in the grid, which means that in order to satisfy customer final demand it is necessary to increase the amount of electricity generated. There are several reasons and factors that contribute to these losses, the Joule Effect being the most significant. (The Joule Effect refers to the phenomenon by which, when a conductor carries electrical current, some of the kinetic energy from the electrons is transformed into heat due to their collision with the atoms of the conductor material along which they are travelling, thus raising the temperature of this material).

The amount lost is directly related to the location of generation points and its associated consumption points, the amount of energy required, the energy mix, international exchanges and the shape of the demand curve.

When calculating emissions, only the losses from Spanish mainland are taken into account.

- Method of calculation

Losses in the transmission grid x average emission factor for the Spanish mainland in the year in which the inventory is calculated.

Losses from the transmission network: Based on the figures published in the daily electricity balance sheet for 31st December of the year for which the calculation is to be made.

http://www.ree.es/es/actividades/balance-diario

Emission factor: the figure calculated by REE is used, as in section 2.2.1

2.3 Indirect emissions. SCOPE 3.

2.3.1 Emissions associated with the supply chain

These are emissions that are associated with the goods and services acquired by REE.

- Method of calculation

An estimated calculation is made on the basis of the emission factors (tCO_2 / millions of euros) per supplier, and this is then multiplied by the volume of expenditure per supplier each year.

Emission factors: Estimated using a methodology that follows the guidelines of the GHG protocol, based on the application of an input-output model. In the case of principal suppliers, a direct survey is carried out.

2.3.2 Emissions associated with business travel

These include emissions associated with business travel by plane, train (high-speed and long-distance) and car (private vehicles, shared leasing, rented vehicles, manager's vehicles and taxis).

2.3.2.1. Trips by plane

- Method of calculation

The International Civil Aviation Organization's methodology is used in the case of air travel.

Methodology:

http://www2.icao.int/en/carbonoffset/Documents/ICAO%20MethodologyV3.pdf

Calculation tool.

http://www.icao.int/environmental-protection/CarbonOffset/Pages/default.aspx

2.3.2.2. Trips by train

- Method of calculation

For trips taken by train, the emission factors per kilometres provided by RENFE are used, as published in its environmental report of 2007:

Emission factor: CO_2 kg/km and passenger	
High-Speed	Long-Distance
0.0211	0.02624

2.3.2.3. Trips by car

- Method of calculation

a. Private vehicle, shared leasing or rental vehicle: calculations are based on the number of kilometres travelled, using SACE's tool (an Andalusian Government's tool used to calculate the emissions based on the km).
b. Manager's vehicles: The methodology used to calculate emissions associated with fleet vehicles is used, based similarly on the emission factors established by the Spanish Climate Change Office.
c. Taxis: Emissions are calculated by the company hired to carry out this service.

2.3.3 Emissions resulting from the internal transportation of materials (logistics)

These are emissions associated with the transportation of materials between REE's various facilities. Transportation is carried out by an external company.

- Method of calculation

Emissions are calculated on the basis of the litres of diesel consumed by the company which carried out the logistics service for REE. The logistics company issues an invoice based on kilometres travelled, and to this end it monitors the kilometres travelled and litres of fuel used by each individual vehicle. Data is provided by the company providing these services.

2.3.4 Emissions from employees commuting to the workplace

Emissions associated with the employees commuting from their homes to the workplace.

- Method of calculation

Calculations are based on the kilometres travelled by employees according to each transport method employed. This information is introduced in SACE's tool and

obtained after developing a survey which is sent to all employees, although not all of them fill it out.

3. Calculation procedure

The Environment Department receives information from the different units, compiles it and makes the relevant calculations for the GHG inventory.
Once these calculations have been completed, an internal validation session is carried out, during which the figures are reviewed and the inventory is closed prior to its validation by an external independent body.

4. Uncertainty

All the processes relating to the different sources of emissions fall within the scope of REE's quality and environmental systems. These systems are respectively certified under standards ISO 9001:2000 and ISO 14001:2004.
Implementation of these quality systems minimises any uncertainty in the information used to calculate the GHG inventory.
To minimise any uncertainty associated with emission factors, official sources are used whenever it is possible.
Of all the sources considered in the inventory, only the supply chain values are considered to lie higher levels of uncertainty due to the fact that the emission factors used in their calculation are estimated.