



Derivation of Primary Energy & CO₂ Factors for Electricity in DEAP

1 Introduction

The Dwelling Energy Assessment Procedure (DEAP) calculates the energy demand for space and water heating, ventilation and lighting in the home. As part of this, the electrical energy delivered to the home for these demands is calculated. DEAP then calculates the CO₂ emissions and primary energy associated with this electrical energy as follows:

- Primary energy from electricity demand = DEAP delivered electrical energy * Primary Energy Factor for electricity
- CO₂ emissions from electricity demand = DEAP delivered electrical energy * CO₂ factor for electricity

The Primary Energy and CO₂ are calculated based on latest forecasted figures for the year 2018 from SEAI's Energy Modelling unit¹. Efficiency figures are based on Gross Calorific Value of the fuels input to electricity generation stations. This is consistent with the method applied to all fuel energy sources in DEAP (such as oil or other fuels delivered to the home). In addition, a 5% energy overhead is assumed in processing and transport of fossil fuels to electricity generating stations. Note that an overhead of 10% is applied to other fuels delivered to the dwelling, but the bulk nature of electricity generation means that the assumed overhead is lower.

2 DEAP Primary Energy Factor for Electricity – January 2017.

The primary energy conversion factor in DEAP is multiplied by the delivered electrical energy at the dwelling to determine the primary energy associated with that delivered electrical energy. The primary energy conversion factor is the inverse of electricity production efficiency from fuel source to electricity at the dwelling.

The key figures and calculations shown in the figure below are as follows:

- The ktoe (kilo-tonne oil equivalent) of each fuel forecasted for electricity generation is displayed. For example forecasts are for 1035.1ktoe Coal for use in electricity generation in 2018. A 5% overhead figure as described above is added to this value, and it is then converted to a Gross Calorific value giving 1127.5ktoe of coal input to Irish thermal plant and CHP plant.
- On this basis, the total energy forecasted for use by Irish based power plant in generating electricity is 5124ktoe.
- The total electrical energy output by Irish based power plant is 2682ktoe.
- The actual delivered electrical energy (or **T**otal **F**inal **C**onsumption) is 2463ktoe.
- Distribution losses (248ktoe) account for 8.15% of the TFC+distribution losses.
- Therefore (100-8.15)% of the total electrical energy output by Irish based power plants is the proportion of the TFC attributable to Irish Power Plants (2463ktoe).
- The combined efficiency of the grid and Irish generation plant is $2463 / 5124 = 48.07\%$.
- The inverse of this gives the primary energy factor for electricity to be used in DEAP: **2.08**.

Calculation of primary energy and CO ₂ factors for electricity in DEAP										
Based on SEAI Energy Modelling Group forecasts for 2018 accessed Q4 2015										
Based on forecasted production from public thermal power plants (PTPP), wind/hydro and CHP										
Forecasted energy balance - parts relevant to Electricity										
Amounts in ktoe										
	Coal	Milled peat	Oil	Gas	Hydro	Wind	Other RE	Wastes	Totals	Grand totals (Irish based)
Input [ktoe] for Irish public thermal power plants & CHP (NCV)	1035.1	446.7	1.1	2002.4			234.3	83		
Irish PTPP/CHP input including processing/transport overhead (NCV)	1086.9	469.0	1.2	2102.6			234.3	87.0		
Irish PTPP/CHP input including processing/transport overhead (GCV)	1127.5	486.5	1.2	2333.6			257.5	95.6	4302	
Electrical energy from Irish wind+hydro					63.9	758.4			822	
Total Energy into Irish plant including processing/transport overhead (GCV)										5124
Total power output from Irish PTPP & CHP & wind+hydro										2682
Own use and distribution losses					219					
Total final elec consumption (TFC)					2463					
Assumed distribution losses & own use as a percentage of TFC+dist. Losses					8.15%					
Total final elec consumption as generated by Irish PTPP + wind/hydro, after allowing for own use/losses										2463
Efficiency of generation/transmission										
Average generation/distribution efficiency (Irish PTPP/CHP/wind/hydro) including processing/transport overhead based on GCV input					48.07%				Avg generation efficiency	52.34%
Primary energy factor assumed at entrance to power station (overhead for mining and transport of fuel)					1.05					
Primary energy factor for electricity delivered to dwelling					2.08					

Figure 1: Derivation of DEAP primary energy factor for electricity

3 DEAP CO₂ Factor for Electricity – January 2017

The CO₂ conversion factor in DEAP is multiplied by the delivered electrical energy at the dwelling to determine the CO₂ emissions (in kg) associated with that delivered electrical energy. The CO₂ factor is based on the carbon/energy content of each fuel forecasted for use in generating the consumed electrical energy. Like the primary energy factor, the CO₂ factor is based on the fuel input to Irish Power Plant with an additional 5% for processing/transport on a GCV basis.

The key figures and calculations for CO₂ conversion factor derivation are as follows and are based the diagram below and the previous diagram:

- Emission factors taken from energy in Ireland in consultation with EPSSU (http://www.seai.ie/Publications/Statistics_Publications/Energy_in_Ireland/).
- CO₂ figures, multiplied by a gross calorific conversion factor as shown below.
- CO₂ emissions for Hydro, wind and other renewables assumed to be 0.
- The electrical energy equivalent (kWh) per TOE is taken from <http://www.iea.org/stats/unit.asp>, as shown below.
- The TCO₂/ TOE is multiplied by the ktoe figure from the previous diagram to determine the CO₂ emissions for each fuel in kt/yr.
- The combined total of all fuels in kTCO₂/ yr for electricity production is 12288.21.
- From the previous section the total electricity consumed derived from Irish plant is 2235ktoe, and the CO₂ intensity associated with this is (11729.82 / 2463) or 4.762 TCO₂/ TOE.
- Therefore, there are (4.762 / 11.630) or **0.409kgCO₂/kWh**

CO ₂ emissions associated with electricity consumption									
	Fuel inputs								Sum
	Coal	Peat	Oil	Gas	Hydro	Wind	Other Re	Wastes	
CO ₂ emission factors [kg/kWh] based on GCV	0.325	0.399	0.250	0.185	0.000	0.000	0.000	0.167	
CO ₂ emission factors [kton/ktoe]	3.78	4.64	2.91	2.15	0.00	0.00	0.00	1.94	
CO ₂ emitted [kt/y] based on GCV including overhead for processing/transport	4263.45	2257.10	3.58	5020.16	0.00	0.00	0.00	185.53	11729.82
Multiplication factor converting [kg/kWh] to [ton/toe] from http://www.iea.org/stats/unit.asp									11.630
CO ₂ factor for electricity delivered to the dwelling. kg CO ₂ per kWh of TFC attributed to Irish power stations									0.409 [kg CO ₂ /kWh]
Notes									
Electricity from renewables taken to have primary energy factor of 1									

Figure 2: Derivation of DEAP CO₂ factor for electricity