Eco-sheet

1 kWh generated using different energy sources

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This eco-sheet has been produced by Leonardo ENERGY in the context of its project 'Efficiency and ecodesign'. It aims to quantify the environmental impact from generating 1kWh of electricity using different energy sources.

A well-diversified generation mix is essential to address challenges such as energy security and economic efficiency, with some energy sources having a much higher environmental burden than others.

The eco-sheet shows that there is no silver bullet solution. When looking at CO2 emissions only, it would be clear what options to take. However, this is not the only environmental consideration. Not preferring any particular method of electricity generation, the eco-sheet lists the main environmental impact categories (according to the Apeldoorn declaration [Apeldoorn, 2003]) and benchmarks them against the electricity generation mixes for the EU 25 and EU 15.

1 Product description and typical application

The product of this eco-sheet is a kWh of electricity, delivered to a customer. Electricity is consumed in homes, office buildings, industry and transport for the purposes of lighting, appliances, driving motors, heating buildings and powering electronics.

2 Scope of the LCA

The declared units for the LCA are the production, utilization and recycling phases. All LCA data were taken from the GaBi4 database. The modelling and the inventory data (specifically regarding data quality aspects) were performed in accordance with ISO 14040 series as far as applicable.

The modelling leading to the environmental burden of a kWh consumed takes into account fuel extraction, transport and refining (where applicable), the construction of the power plant and the losses in the electricity transmission and distribution system.
Inventories have been developed for the consumption of 1 kWh generated using 7 different technologies and energy sources:

- Coal
- Lignite
- Gas
- Hydro
- Nuclear
- Oil
- Wind

The average value of the losses in the electricity networks in Europe was used: 7,89% [IEA Statistics].

These 7 generation technologies were also compared against the EU 25 and EU 15 electricity mixes, using the following data [IEA Statistics].

	EU 25	EU 15
Losses	8.09%	6.32%
Hydro	11.01%	11.74%
Nuclear	32.19%	33.57%
Wind	1.91%	2.15%
Coal	21.14%	18.75%
Lignite	9.43%	7.68%
Oil	4.66%	4.85%
Gas	19.66%	21.25%

3 Results

3.1 Inventory

The table below compiles the results obtained from the LCA modelling of the 7 different technologies and for the EU 25 and EU 15 generation mixes. The results are expressed on the amounts of CO2, NOx and SO2 emissions, and the weights on the 'Big 6' Impact Categories (Primary Energy Consumption, Acidification Potential, Eutrophication Potential, Global Warming Potential, Ozone Layer Depletion Potential and Photochemical Ozone Creation Potential [Apeldoorn, 2003]).

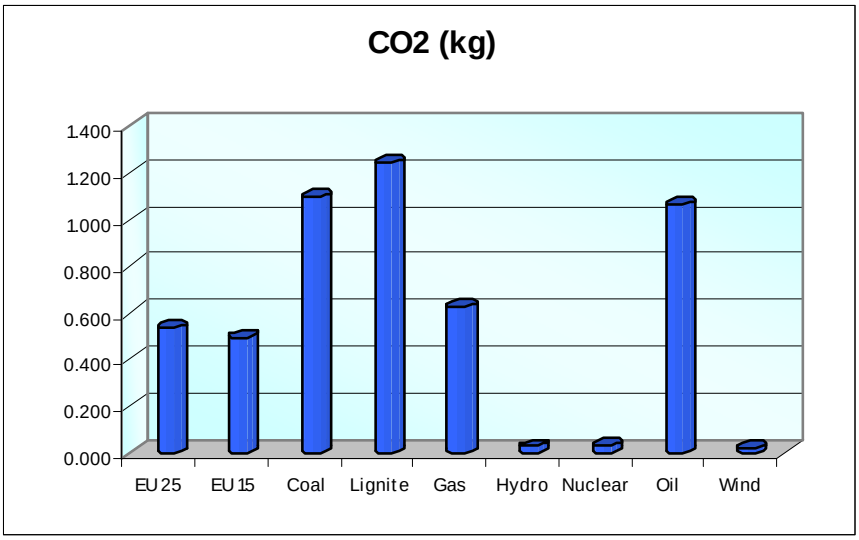
Further information on the environmental implications of electricity generation could be achieved by looking at other impact categories as for example the eco-toxicity potential or water use. However, these would refer to more local impacts and can be better addressed by a Risk Assessment study on a case by case basis.

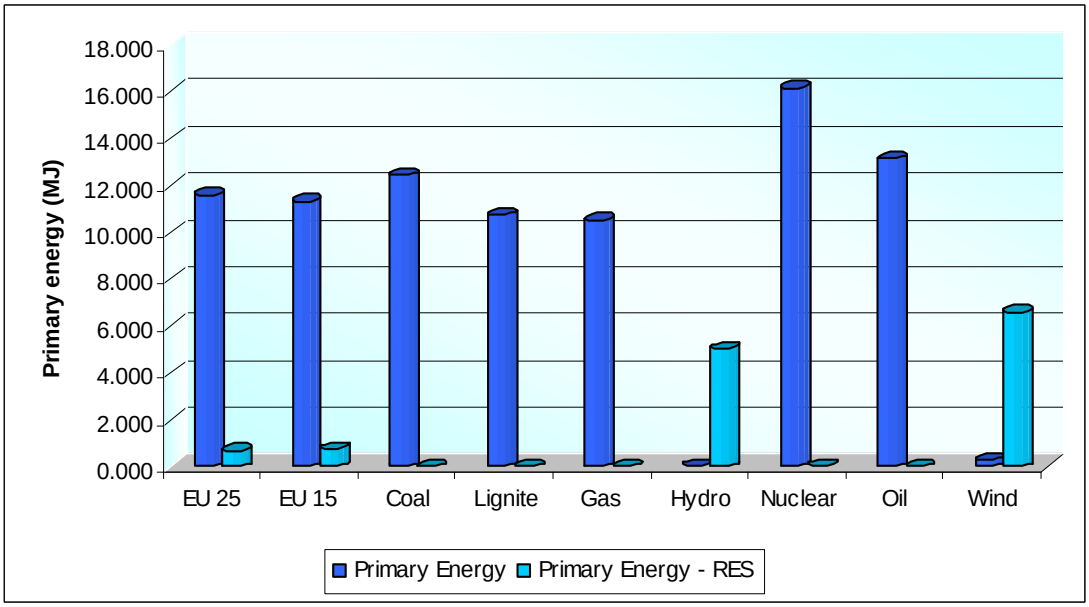
Parameters	Unit	EU 25	EU 15	Coal	Lignite	Gas	Hydro	Nuclear	Oil	Wind
Primary energy consumption (non-RES)	MJ	11.585	11.309	12.431	10.738	10.532	0.024	16.160	13.148	0.278
Primary energy consumption (RES)	MJ	0.695	0.736	0.010	0.015	0.005	5.030	0.025	0.015	6.590
Carbon dioxide	kg	0.537	0.494	1.097	1.242	0.625	0.026	0.033	1.064	0.018
Nitrogen Oxides	kg	9.62E-04	8.66E-04	2.62E-03	1.85E-03	5.98E-04	9.04E-06	5.63E-05	1.99E-03	3.55E-05
Sulphur dioxide	kg	2.25E-03	1.95E-03	4.43E-03	1.01E-02	3.92E-04	2.22E-06	1.34E-04	5.01E-03	5.80E-05
Acidification potential	kg SO_2-eq	2.93E-03	2.56E-03	6.28E-03	1.14E-02	8.18E-04	8.62E-06	1.76E-04	6.41E-03	8.65E-05
Eutrophication potential	kg Phosphate-eq	1.54E-04	1.41E-04	3.93E-04	2.57E-04	1.44E-04	1.75E-06	1.32E-05	2.88E-04	1.66E-05
Global warming pot. (100 yrs)	kg CO_2-eq	0.57668	0.53065	1.21	1.2543	0.68384	0.026459	0.037747	1.0981	0.019891
Ozone layer depletion pot.	kg R11-eq	1.38E-07	1.42E-07	1.18E-09	3.08E-09	9.42E-10	8.44E-11	4.26E-07	1.73E-09	2.95E-09
Photochemical Ozone creation pot.	kg Ethene-eq	1.76E-04	1.56E-04	3.77E-04	5.81E-04	9.61E-05	7.80E-07	1.13E-05	3.86E-04	1.08E-05

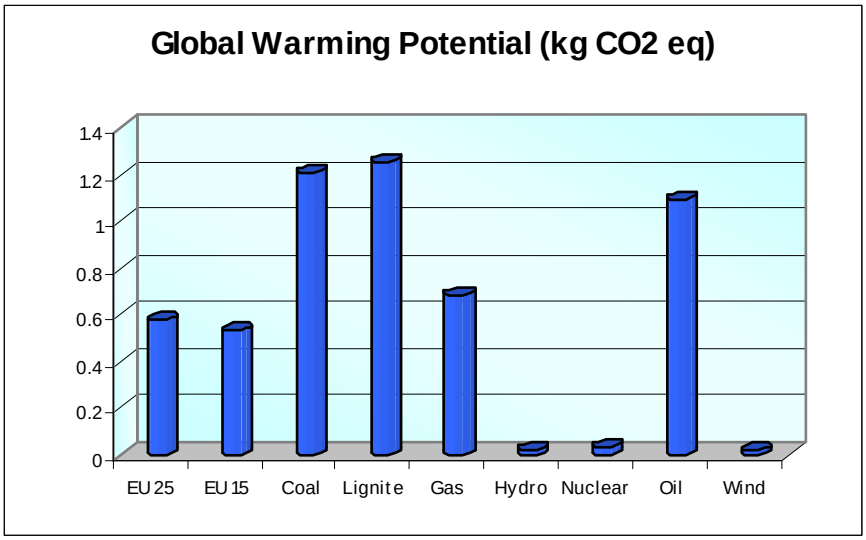
Table 4 – Inventory results (including environmental impact categories CML 2001) per life generation source, EU25 and EU15 mixes, as produced by the Eco-design Toolbox

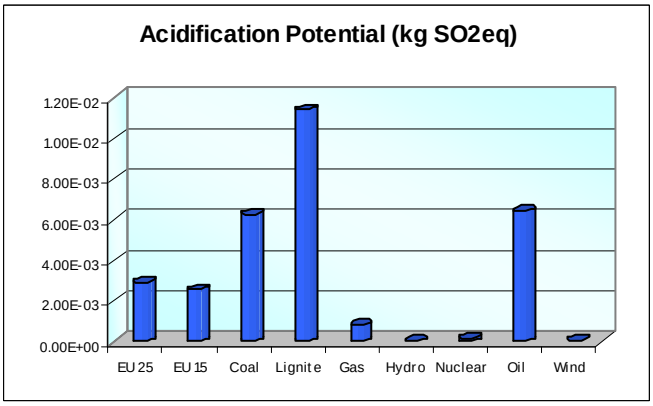
3.2 Impact results

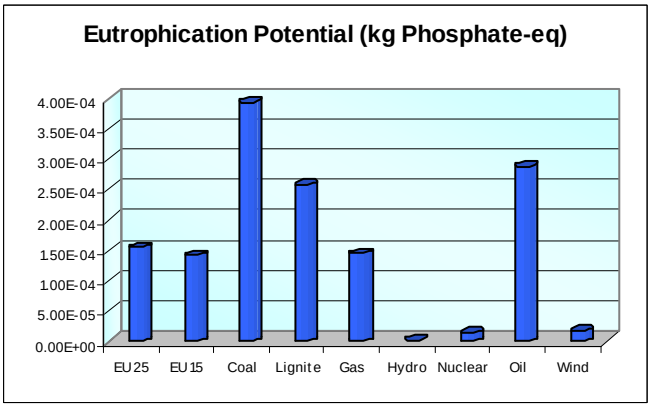
The following series of charts provides a simple graphic illustration of the results obtained, comparing the production of 1 kWh from different sources.

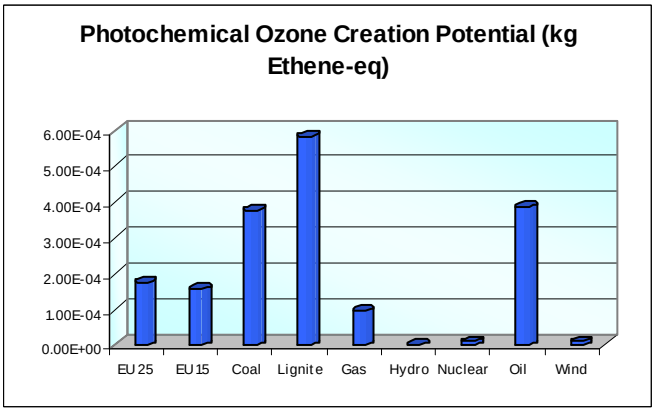


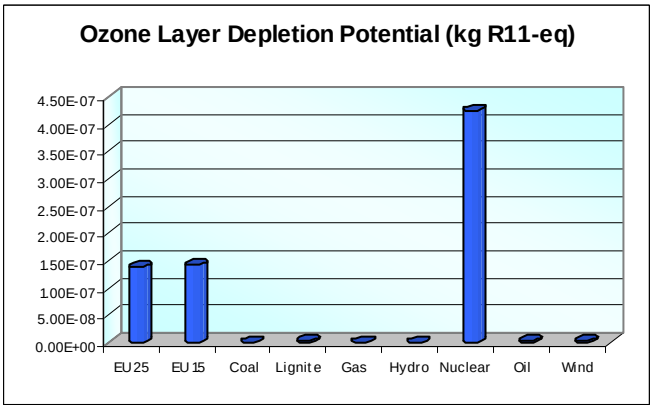



Global Warming Potential (kg CO2 eq)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
EU 25
EU 15
Coal
Lignite
Gas
Hydro
Nuclear
Oil
Wind


Acidification Potential (kg SO2eq)
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
EU 25
EU 15
Coal
Lignite
Gas
Hydro
Nuclear
Oil
Wind


Eutrophication Potential (kg Phosphate-eq)
4.00E-04
3.50E-04
3.00E-04
2.50E-04
2.00E-04
1.50E-04
1.00E-04
5.00E-05
0.00E+00
EU 25
EU 15
Coal
Lignite
Gas
Hydro
Nuclear
Oil
Wind


Photochemical Ozone Creation Potential (kg Ethene-eq)
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
EU 25
EU 15
Coal
Lignite
Gas
Hydro
Nuclear
Oil
Wind


Ozone Layer Depletion Potential (kg R11-eq)
4.50E-07
4.00E-07
3.50E-07
3.00E-07
2.50E-07
2.00E-07
1.50E-07
1.00E-07
5.00E-08
0.00E+00
EU 25
EU 15
Coal
Lignite
Gas
Hydro
Nuclear
Oil
Wind

4 References

[GABI] The respective tools and models have been provided by PE Europe, Hauptstrasse 111-113, D-70771 Leinfelden-Echterdingen (Stuttgart), Germany, www.gabi-software.com

[Toolbox, 2005] The original information of this environmental declaration sheet is taken from the results of the GaBi 4 i-Report referring to the ecodesign toolbox 2005 (for information, contact Sergio Ferreira, email saf@eurocopper.org)

[IEA Statistics] www.iea.org, 2004

[Apeldoorn, 2003] Improvement of LCA characterization factors and LCA practice for metals
http://www.leidenuniv.nl/cml/ssp/projects/declaration_of_apeldoorn.pdf