RE-DISS II
Reliable disclosure systems for Europe

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Different approaches to handle environmental indicators for electricity disclosure

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Content

1 Introduction ... 4
2 Environmental indicators for electricity disclosure ... 5
2.1 Scopes and approach for the disclosed environmental indicators ... 5
2.2 Fossil and biogenic CO_2 ... 7
2.3 CO_2 and GHG emissions ... 8
2.4 Comparisons ... 8
2.4.1 CO_2 vs. GHG emissions ... 8
2.4.2 Direct vs. LCA emissions ... 11
2.5 Summary – direct and LCA, CO_2 and GHG emissions ... 13
2.5.1 Emissions variations: electricity from biomass and fossil energy sources ... 14
2.6 Radioactive waste ... 15
3 Different disclosure approaches for CO_2 emissions and nuclear waste ... 19
3.1 Status of the methodology for electricity disclosure indicators ... 20
3.2 Overview electricity disclosure in different countries ... 21
3.3 Further work on common guidelines and figures for electricity disclosure ... 22
4 References ... 23

List of Tables

Table 1: Overview of current disclosure practice in a selection of European countries. 21

List of Figures

Figure 1: Differences between scopes 2 and 3, shown for electricity consumed by a product/company. 6

Figure 2: Comparison of direct CO_2 vs. GHG emissions for examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented. 9

Figure 3: Comparison of LCA CO_2 vs. GHG emissions from examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented. 10

Figure 4: Comparison of direct vs. LCA CO_2 emissions for examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented. 11

Figure 5: Comparison of direct vs. LCA GHG emissions from examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented. 12

Figure 6: Summary of direct and LCA, CO_2 and GHG emissions from examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented. 13

Figure 7: Ranges in biomass CO_2 and GHG emissions compared to the average presented data and to other technologies. 14

Figure 8: Direct and LCA GHG emissions from examples of fossil electricity technologies specified for different plant efficiencies. 15

Figure 9: Impact of the burn-up of nuclear fuel (heavy metal, HM) and the average net electric efficiency of the plant on the mass of spent nuclear waste per kilowatt-hour of electricity produced. 17

Figure 10: Different paths and types of information for explicit and implicit electricity tracking. 20

1 Introduction

The Electricity Market Directive (Directive 2009/72/EC, Article 3(9)) requires all suppliers of electricity to disclose their electricity portfolio with regard to energy source and environmental impact, specifying at least the emissions of CO_2 and the amount of radioactive waste relating to the electricity generation. The term “environmental attributes” is often used when referring to this disclosed information.

The disclosed information should be given to all customers regardless of whether or not they have made an active choice of product specific electricity. However, the Directive does not provide any further specifications on how such environmental indicators exactly have to be defined, and which elements of the product chain have to be taken into account. Some guidance in this field is provided by a note of DG Energy & Transport (2004) to the member states. However, this document is not binding and needs to be updated and extended. As was already found by the E-TRACK I+II projects, not all European countries actually require the disclosure of environmental indicators to electricity consumers.

This report outlines different approaches, in general, to handle environmental indicators for electricity generation. In addition, an overview of disclosure practice in a selection of European countries is presented and recommendations for further work in order to harmonise disclosure practices with regard to environmental indicators for electricity are given.

2 Environmental indicators for electricity disclosure

In accordance with the Electricity Market Directive, the energy source, the emissions of CO_2 and the amount of radioactive waste (RW) relating to the electricity generation need to be disclosed. Member States (MS) may require additional environmental indicators to be disclosed, but this has not been used much so far. In this report, the disclosed attributes are categorised into the following categories:

- Energy sources
- Environmental indicators
    - CO_2 or GHG
    - Radioactive waste
    - Other

In general, the disclosed attributes related to different electricity generation options depend largely on the energy carrier and source for electricity generation, as well as the generation technology. However, the environmental indicators also depend on other issues, such as the method/approach used for calculating the indicators, the specificity level of data etc. This is described more in depth in the following sections.

2.1 Scopes and approach for the disclosed environmental indicators

As stated above, the method/approach used for calculating the environmental indicators impacts on the final indicator result. The two major approaches for calculating environmental impacts relate to whether or not upstream, and eventually downstream, impacts (throughout the whole electricity generation value chain) or only direct impacts from the generation (conversion) step are included in the calculation approach. If the approach includes the entire ("cradle to grave" or "cradle to gate") value chain of electricity generation, it should be based on the Life Cycle Assessment (LCA) methodology, which is an internationally standardised (ISO 14044) method for quantifying environmental impacts that are associated with any products. If only direct emissions, resulting from the electricity conversion step, are included, this approach reflects for example how the national inventories' according to the Kyoto protocol are calculated. In this case upstream and downstream emissions are covered by other sectors.

These different approaches are also reflected in the Greenhouse Gas (GHG) Protocol (The GHG Protocol n.d.), which is the most widely used international accounting tool for (corporate and product) greenhouse gas emissions. The GHG protocol categorises direct and indirect GHG emissions into three broad scopes:

1. Scope 1: All direct GHG emissions related to the reporting entity
2. Scope 2: As in Scope 1 + direct GHG emissions related to the generation of purchased electricity, heat or steam, thus indirect emissions for the customers purchasing these energy products.

3. Scope 3: As in Scope 2 + indirect emissions from purchased products and services beyond energy products, e.g. from extraction and production of purchased materials, outsourced activities, waste disposal, etc.

With regard to electricity consumption, Scope 2 reflects the direct emission approach as described above, while Scope 3 takes the life cycle perspective. The differences between scopes 2 and 3 with reference to electricity generation and consumption are illustrated in Figure 1.

Figure 1: Differences between scopes 2 and 3, shown for electricity consumed by a product/company.

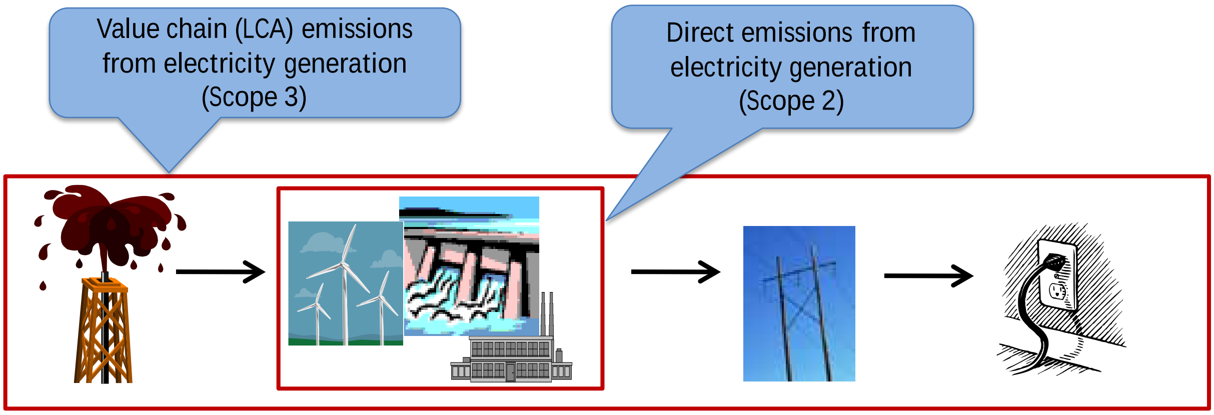


Figure 1 shows how the different scopes include the different varying life cycle stages in the electricity value chain. Scope 1 only includes direct emissions related to the reporting entity (in addition it may also include grid losses, but those emissions are excluded in this discussion). Thus, the emissions from the <u>consumption</u> of purchased electricity will always be zero, irrespective of the energy source used for the electricity production. Scope 2, however, includes the electricity production stage and thus the direct emissions related to the generation of the purchased electricity. Scope 3 includes the entire value chain for electricity generation, which means that the emissions related to extraction of fuels, production of infrastructure relating to the building of dams, power plants etc., as well as the plants' end of life treatment also need to be included. For both scopes 2 and 3, the emissions relating to the production stage of the generated electricity are strongly affected by the energy source (fossil, non-fossil), in addition to the technology used for the electricity production (thermal, mechanical, photo-electric).

It should be emphasised that the same emissions can be claimed more than once when using different scopes. This is, however, not a problem as this is how the scopes are defined: all indirect emissions in scopes 2 and 3 are "slices" of scope 1 emissions (The GHG Protocol 2012). Double counting occurs only when the same emissions are claimed more than once within the same scope (Clouse 2011).

When determining and comparing environmental indicators for electricity generation it is important to take the relevant scope into consideration in order to know whether or not the entire value chain related to electricity generation should be included. This impacts whether only the emissions reflecting the electricity generation step should be included or if indirect emissions originating from other life cycle activities, such as harvesting and transport of fuel, and building of constructions, should also be included.

Another aspect to take into consideration when determining environmental indicators for electricity generation from combined heat and power (CHP) production plants, is the principle of how emissions/waste are being allocated between the generated heat and power. According to the EU Energy Efficiency Directive (2012/27/EC), general principles and reference values are given for the calculation of generated electricity and heat from cogeneration. On this basis, the emissions and environmental burdens from the total power and heat generation can be allocated to the generated heat and power. According to LCA methodology, this is normally done on the basis of exergy, energy or economic values. The share of electricity generated from CHP plants in EU27 was 11,6 % of total electricity generation in 2010 (European Commission 2012). An overview of the share of CHP electricity per country is presented by Eurostat (2013).

Relevant generic resource and emission data based on primary energy sources and/or technology can be provided by different sources, such as national and international emissions inventories and energy statistics, recognised LCA databases etc. In addition, it is possible to collect resource and emission data for specific plants or group of plants by specific LCA studies or Environmental Product Declarations (EPDs) (Statkraft 2013, EB 2013, Vattenfall 2010, Vattenfall 2011, Vattenfall 2013). Hence, environmental indicators for electricity generation may be presented by a variety of data sources, from generic database data to plant specific data. In addition, the environmental indicators may represent either direct or LCA data, which means that it is important to be aware of which types of data are actually reported.

For purposes of electricity disclosure, however, the environmental indicators for a given year must be available no later than four months after the end of that year, in order to be displayed in time to consumers. This makes it difficult to use many of the statistical publications, which are usually published only one or more years after the year to which the data refers to.

2.2 Fossil and biogenic CO_2

With regard to direct CO_2 emissions from combustion of biomass, it is common to utilize the rule of zero discount rate for biogenic CO_2, i.e. the difference in time scale between CO_2 emissions from biomass combustion and uptake from the regrowth of forest is equal to zero (Laser et al. 2009, González-García et al. 2012). This view is also supported by USEPA (2011), which does not consider the time lag from emission to uptake of biogenic CO_2 when biomass is used in the energy sector.

According to the IPCC (2006), emissions of CO_2 from biomass fuels are, in order to avoid double counting, estimated and reported in the AFOLU (Agriculture, Forestry and Other Land Use) sector as part of the AFOLU methodology (the emissions from combustion of biomass are reported as information items). This is based on the IPCC (1996) which states that CO_2 emissions from biomass combustion should not be included in national CO_2 emissions from fossil fuel combustion. If energy use, or any other factor, is causing a long term decline in the total carbon embodied in standing biomass (e.g., forests), this net release of carbon should be evident in the calculation of CO_2 emissions described in the Land Use Change and

Forestry Chapter. Also the ILCD handbook by the European Commission Joint Research Centre (2011) recommends the 100 year timeframe as default, and between the lines the zero discount rate for biogenic CO_2 is assumed.

The zero discount rate is also used by the EU Renewable Energy Directive (2009/28/EC) for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators, given in Article 19 and Annex V (part C, Methodology). It should, however, be noted that other greenhouse gases from biomass fuel combustion are considered net emissions (IPCC, 1996).

2.3 CO_2 and GHG emissions

When determining CO_2 emissions in general, it is important to be clear about whether the data represent only CO_2 emissions or total GHG (Greenhouse Gas) emissions. If total GHG emissions are presented, the emissions of CO_2 have been summarised with other GHG gases, such as methane and N_2O, which usually are converted into CO_2 equivalents according to their greenhouse gas potential.

2.4 Comparisons

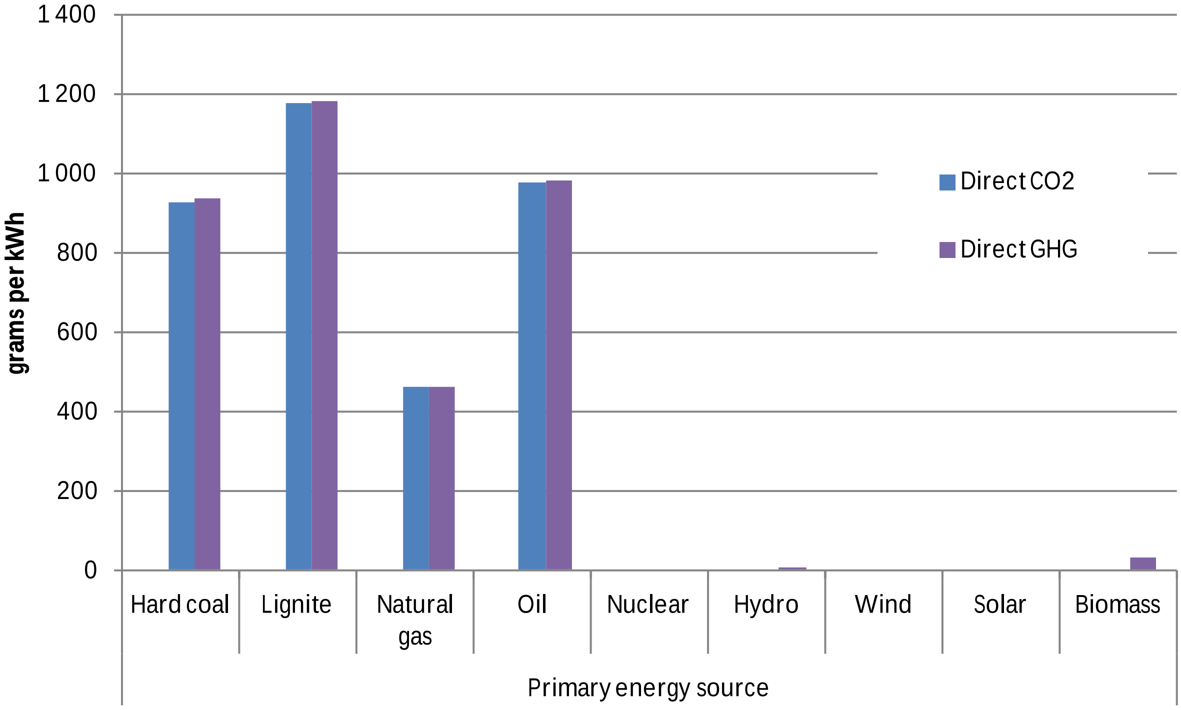
In the following chapters different comparisons of CO_2 vs GHG emissions and direct vs LCA emissions are presented.

2.4.1 CO_2 vs. GHG emissions

Figure 2 shows direct CO_2 and GHG emissions from fossil, nuclear and renewable electricity technology cases. These examples show representative production data for typical technologies used in Germany based on the Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011). The exception is the biomass data which represents average values for all relevant biomass processes (not specifically for Germany) in the Ecoinvent database. This database contains international industrial life cycle inventory data in a variety of fields, including electricity, and is included in the leading European LCA software tools, such as SimaPro and Gabi. The software simulation tool SimaPro has been used in order to calculate the direct and LCA results based on the method IPCC 2007 GWP 100a for the following Ecoinvent data:

- Electricity, hard coal, at power plant/DE U
- Electricity, lignite, at power plant/DE U
- Electricity, natural gas, at power plant/DE U
- Electricity, oil, at power plant/DE U
- Electricity, nuclear, at power plant/DE U
- Electricity, hydropower, at power plant/DE U
- Electricity, at wind power plant/RER U
- Electricity, production mix photovoltaic, at plant/DE U
- Electricity from biomass (average values representing 22 relevant processes in the Ecoinvent database, mainly cogeneration processes).

Figure 2: Comparison of direct CO_2 vs. GHG emissions for examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented.



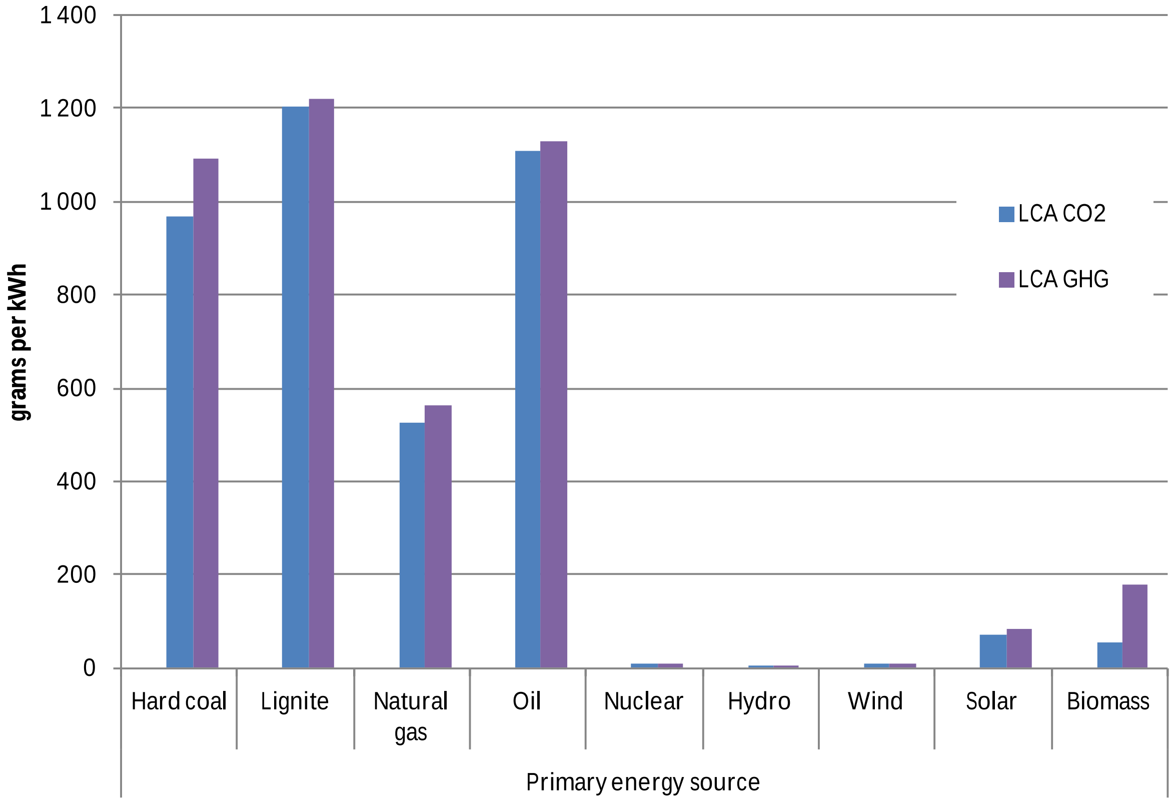
Source: Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011).

First of all, the figure clearly shows that the major contributors to direct CO_2/GHG emissions are electricity generation based on fossil energy sources. In addition, the emissions vary to a large extend (from about 420 to 1.200 grams per kWh) dependent on the fossil energy source. Within the fossil fuels, the highest and lowest emissions come from electricity generation based on lignite and natural gas, respectively. The figure also shows, not surprisingly, that direct GHG emissions are larger than direct CO_2 emissions as greenhouse gases beyond CO_2 also are included in the GHG indicator. However, the increase is relatively small for the direct emissions, about 1 % of total direct CO_2 emissions for the fossil fuelled electricity production.

It can be seen from Figure 2 that the nuclear and renewable technologies do not contribute to direct CO_2 emissions. Nuclear, wind and solar electricity generation neither contribute to direct GHG emissions. Reservoir hydro power may, to a smaller or larger degree, contribute to direct GHG emissions by the decomposition of biomass from land flooded by the reservoir (Raadal et al., 2011). Also biomass electricity generation contribute to direct GHG emissions as other GHG gases (beyond CO_2) from the combustion process are not considered CO_2 neutral.

Figure 3 shows a comparison of LCA CO_2 emissions vs. LCA GHG emissions for the same technologies as shown in Figure 2.

Figure 3: Comparison of LCA CO_2 vs. GHG emissions from examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented.



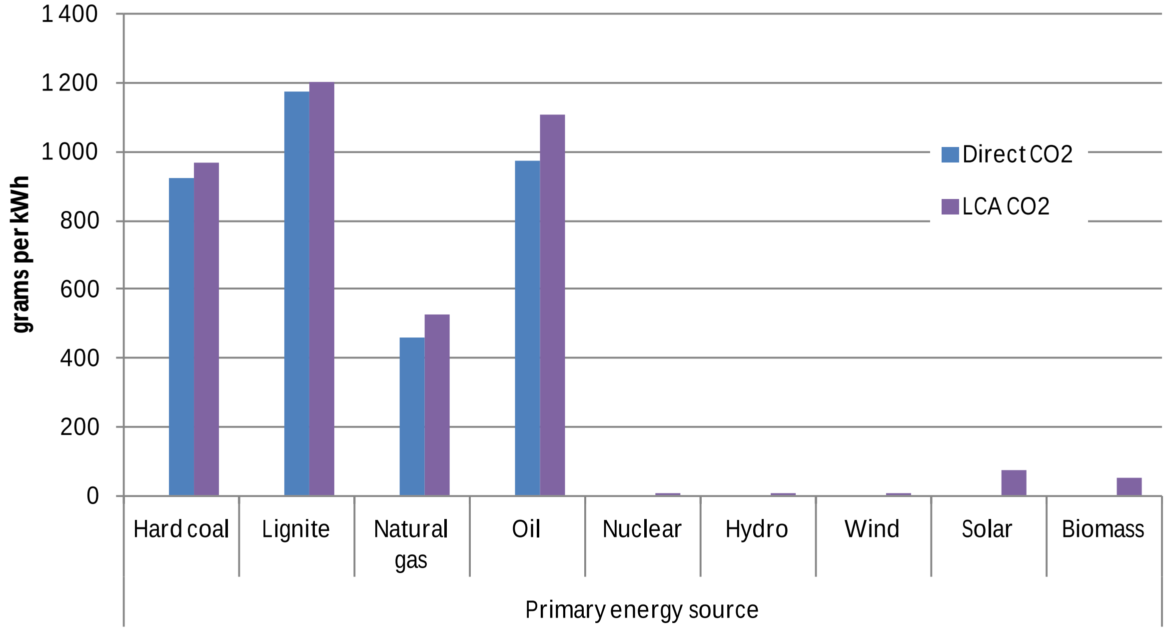
Source: Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011).

Figure 3 shows that when taking the LCA perspective, also the renewables and nuclear technologies contribute to CO_2/GHG emissions, although the emissions are low compared to the emissions from the fossil technologies. The figure further shows that the differences between CO_2 and GHG emissions become larger when looking at the LCA data: For the fossil technologies, the increase in GHG emissions compared to CO_2 emissions varies between 1,4 % (lignite) and 12,9 % (hard coal). For nuclear power, the increase is about 12 %, while for the renewable technologies the difference lies between 9 % (wind) and 220 % (biomass).

2.4.2 Direct vs. LCA emissions

Figure 4 compares direct and LCA CO_2 emissions for the same examples of fossil, nuclear and renewable electricity technologies as those presented in section 2.4.1

Figure 4: Comparison of direct vs. LCA CO_2 emissions for examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented.

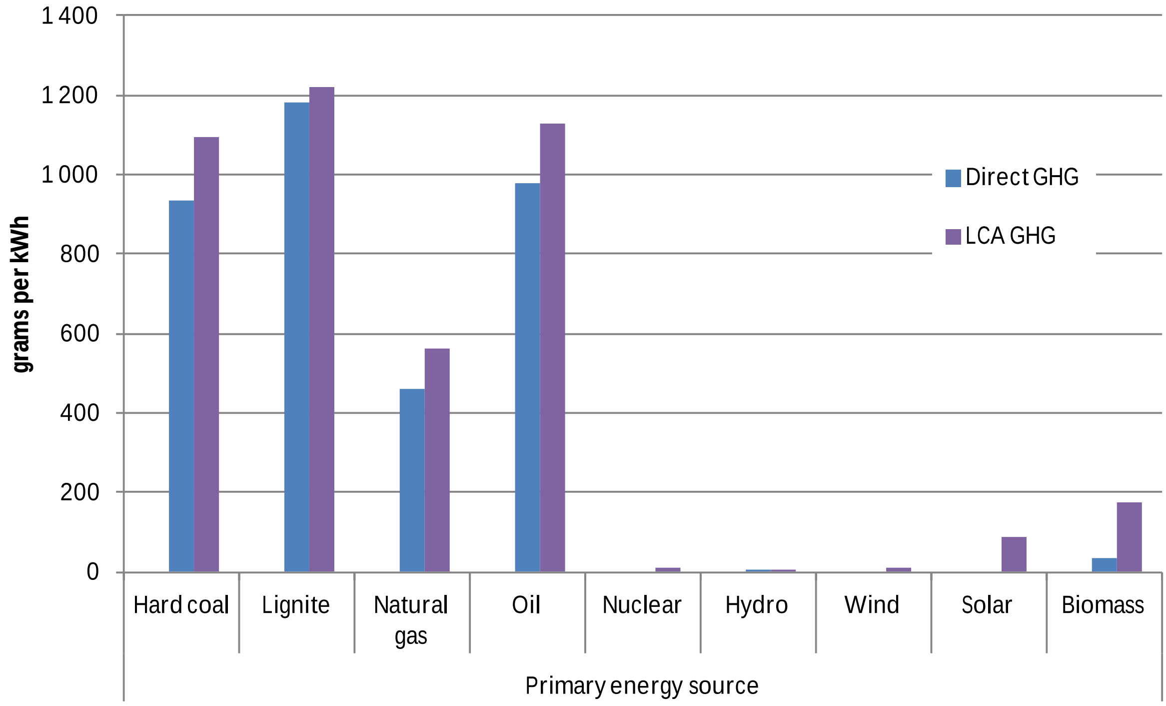


Source: Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011).

As seen from Figure 4, the total emissions increase when taking the LCA approach compared to the direct emissions approach. This is obvious as CO_2 emissions throughout the entire value chain are included in the LCA results. The relative increase varies between 2,5 % (lignite) to 13,7 % (oil) for the fossil based technologies. For nuclear and the renewable technologies the direct CO_2 emissions are zero, hence the relative increase when taking an LCA perspective is not possible to calculate.

Figure 5 compares direct and LCA GHG emissions for the same examples of fossil, nuclear and renewable electricity technologies as those presented in section 2.4.1

Figure 5: Comparison of direct vs. LCA GHG emissions from examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented.



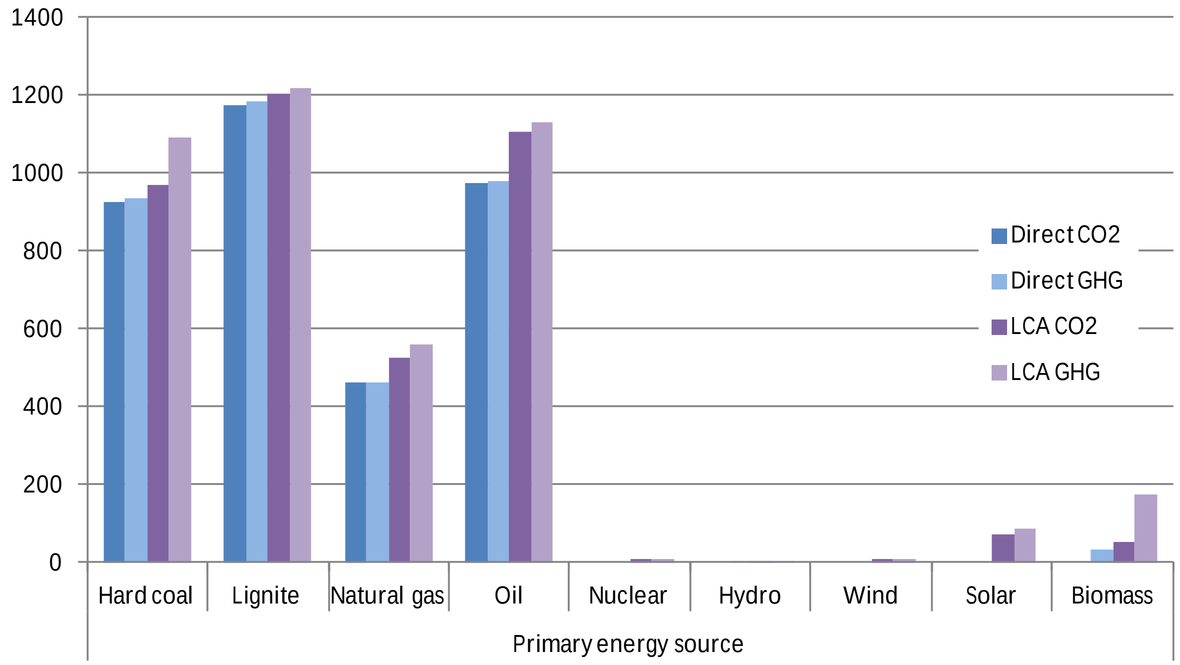
Source: Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011).

When comparing GHG emissions from fossil electricity technologies Figure 5 shows that the relative increase varies between 3,1 % (lignite) and 16,7 % (hard coal) when “moving” from direct to LCA GHG emissions. In addition, the emissions from the renewable technologies become significant when taking the LCA approach due to the extended system boundary for the electricity generation value chain (as commented under Figure 3).

2.5 Summary – direct and LCA, CO_2 and GHG emissions

Figure 6 shows a summary of the presented direct and LCA, GHG and CO_2 emissions for the different electricity technologies. The figure summarises the variations in CO_2 and GHG emissions presented in Figure 2 to Figure 5.

Figure 6: Summary of direct and LCA, CO_2 and GHG emissions from examples of fossil, nuclear and renewable electricity generation technologies based on different energy sources (typical technologies used in Germany). For electricity from biomass, average values (not specifically for Germany) are presented.



Source: Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011).

Electricity generation based on lignite gives the highest emissions, irrespective of whether the emissions are calculated as direct or LCA, CO_2 or GHG. Electricity from lignite is followed by electricity from the energy sources oil, hard coal and natural gas.

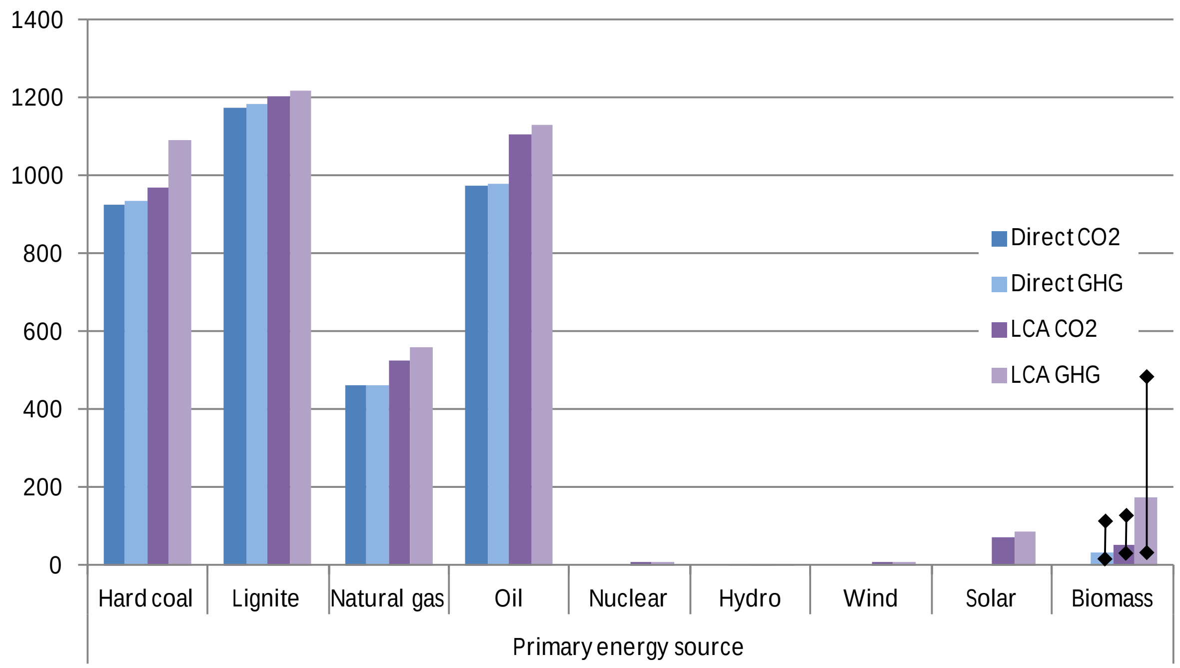
With regard to direct emissions from renewable energy sources, biomass is the only source that may cause significant emissions. However, when it comes to LCA emissions, all the renewable sources contribute due to the extended electricity generation value chain (system boundaries).

2.5.1 Emissions variations: electricity from biomass and fossil energy sources

<u>Electricity from biomass</u>

In order to show the ranges in CO_2 and GHG emissions from biomass electricity generation, minimum and maximum values for the 22 relevant biomass electricity technologies in the Ecoinvent database are added to Figure 6 and presented in Figure 7. Thus, Figure 7 presents the same data as Figure 6, supplemented with the respective emissions ranges for biomass electricity.

Figure 7: Ranges in biomass CO_2 and GHG emissions compared to the average presented data and to other technologies.



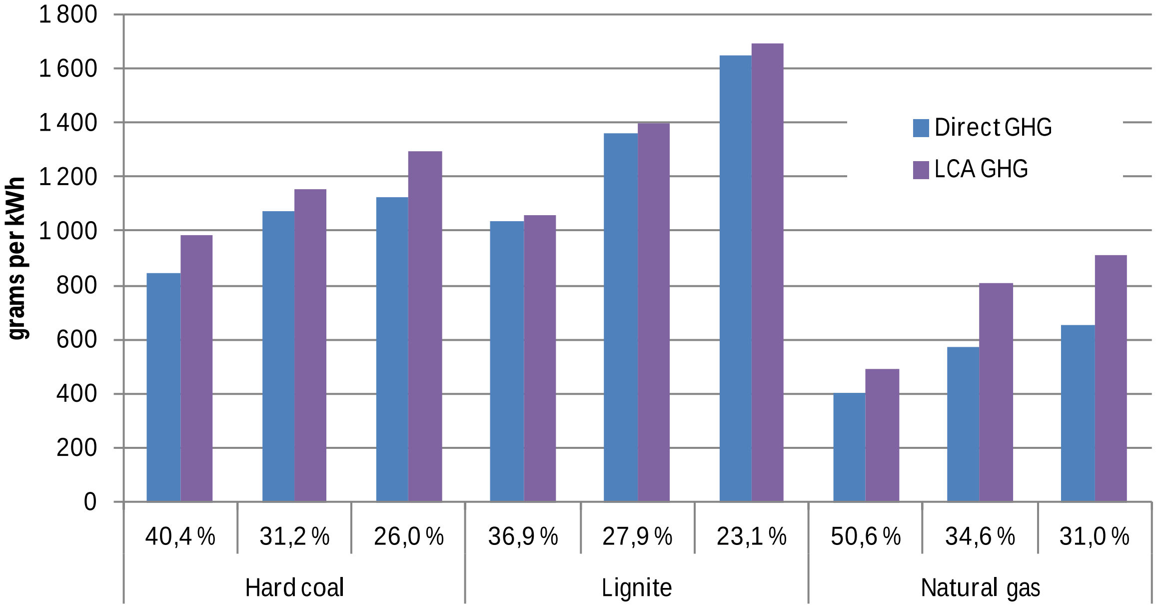
As explained in chapter 2.2, it is common to utilize the rule of zero discount rate for biogenic CO_2, i.e. the difference in time scale between CO_2 emissions from biomass combustion and uptake from the regrowth of forest is equal to zero (Laser et al. 2009, González-García et al. 2012, USEPA 2011). On this basis, there is no range in direct CO_2 emissions from biomass electricity generation as these are calculated to be zero. When it comes to direct GHG emissions, Figure 7 shows that the biomass data range from about 0,5 to 130 grams per kWh with a corresponding average of 34 grams GHG emissions per kWh.

Figure 7 clearly shows the large variations within LCA CO_2 and GHG emissions for electricity from biomass, varying between 9 – 140 grams per kWh and 13 – 480 grams per kWh, respectively. The largest values relate to cogeneration processes where the emissions are allocated based on exergy. In addition, different technology levels (new vs. old), as well as plant efficiencies may impact the varying results.

Electricity from fossil fuels

In order to show how specific plant efficiencies impact the GHG emissions from fossil electricity technologies, different plant specific GHG emissions from fossil electricity technologies based on hard coal, lignite and natural gas are presented in Figure 8. The data are based on the Ecoinvent database (Swiss Centre for Life cycle inventories 2011).

Figure 8: Direct and LCA GHG emissions from examples of fossil electricity technologies specified for different plant efficiencies.



Source: Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011).

As seen in the figure, the plant efficiency impacts the GHG emissions result to a large degree. For hard coal the GHG emissions reduction in both direct and LCA GHG emissions accounts for about 33 % as a result of increased plant efficiency from 26,0 to 40,4 %. The same trend appears for lignite and natural gas: Increased plant efficieny from 23,1 to 36,9 % cause reduced GHG emissions in the area from 59 to 88 %.

The most important parameter affecting CO_2 and GHG emissions for electricity from fossil energy sources, when considered both as direct and LCA emissions, is the amount of CO_2 emitted per kWh (or MJ) of the energy source (coal, lignite, natural gas etc.) being combusted. Thus, the plant efficiencies for fossil electricity technologies are the major parameter for the variations in CO_2/GHG emissions within each technology.

2.6 Radioactive waste

With regard to the determination of radioactive waste from electricity generation, it is important to agree on a number of issues:

- To which categories of radioactive waste should the indicator refer?

  The reported figures could relate to high-level radioactive waste only, but it could also include medium and low-level waste.

- In which units should the indicator be reported?

  The figures could be expressed in mass units (e.g. milligrams per kilowatt-hour generated), in volume units (e.g. cubic millimetres per kilowatt-hour generated) or radiation units of the waste produced at a certain point in time (e.g. Becquerel per unit of electricity generated).

- Should the indicator be reported based on plant-specific data?

  The calculations can be based on a uniform factor of radioactive waste produced per kilowatt-hour of power generation from nuclear energy or on a plant-specific factor, which could reflect the burn-up of nuclear fuel and the electric efficiency of the plant and possibly the processes of fuel supply and final storage or reprocessing.

Furthermore, the discussion on which scope should be chosen for the indicator (only direct impact of the power plant or full life-cycle) is relevant for radioactive waste as well. In a full LCA approach, the radioactive waste produced in uranium mining, fuel processing and the processes of final storage or reprocessing of spent nuclear fuels as well as low and medium-level radioactive waste from the operations of the power plants and the radioactive waste from decommissioning the plants would have to be considered.

According to the Product Category Rules (PCR) for electricity generation (The International EPD System 2011), nuclear waste shall be reported as follows:

<u>From nuclear power plant</u>

- Spent nuclear fuel reported as total weight specified in weight units (g) of spent fuel assemblies unloaded from the reactor during the reference period
- Uranium in spent nuclear fuel (expressed as initial uranium content in the fuel assemblies unloaded (g uranium atoms (U))

<u>To final repository</u>

- High-level radioactive waste (spent fuel or parts of spent fuel, demolition waste, etc. including any containers, according to legislation and nuclear core components) specified in m^3
- Medium and low-level radioactive waste (conditioned operational waste, demolition waste, etc., including binding matrix (cement, bitumen or other) and containers, according to legislation) specified in m^3.

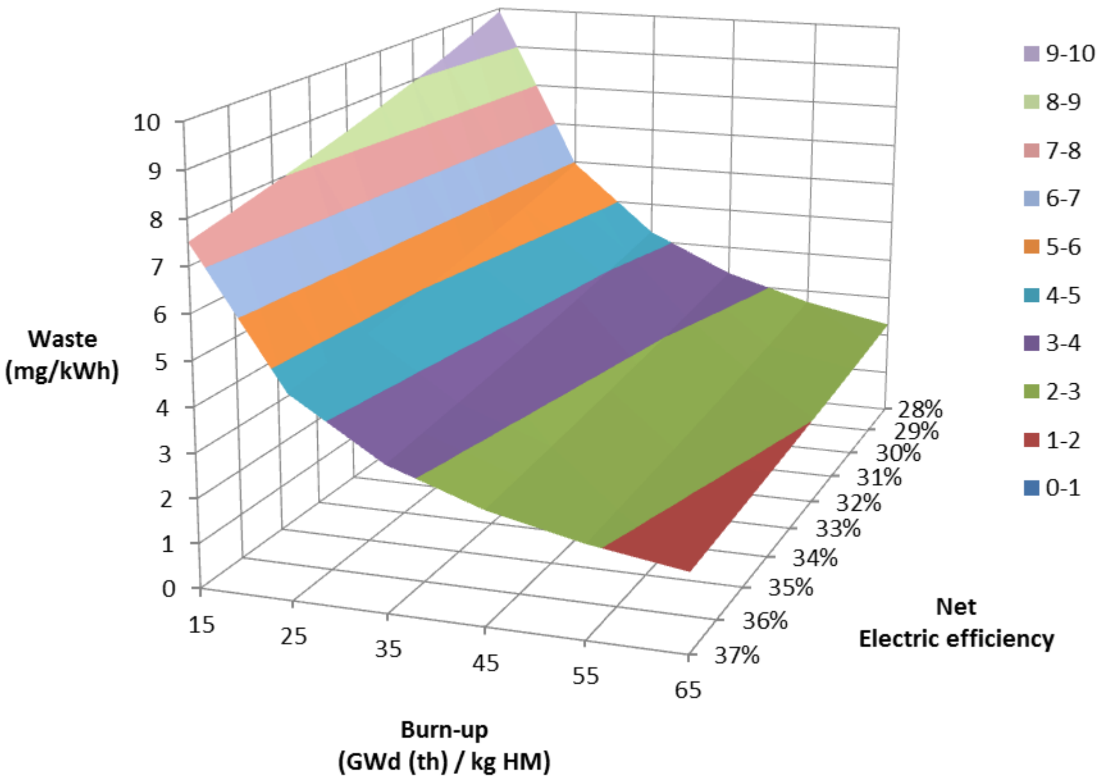
The Ecoinvent database (Swiss Centre for Life Cycle Inventories 2011) provides radioactive waste according to the following three categories:

- Nuclear spent fuel, in reprocessing [kg]
- Nuclear spent fuel, in conditioning [kg]
- Radioactive waste, in final repository for nuclear waste LLW (low and medium level radioactive waste) and HLW (high level radioactive waste), [m^3]
- Radioactive waste, in interim storage, for final repository LLW (low and medium level radioactive waste) and HLW (high level radioactive waste), [m^3]
- Radioactive waste, in interim storage conditioning, [m^3]

The different approaches and units for calculating nuclear waste from electricity show that there is a need for developing and implementing a common approach and for the disclosure of nuclear waste.

Figure 9 shows that the indicator of mass of spent nuclear fuel depends on the burn-up of nuclear fuel and the average net electric efficiency of the plant.

Figure 9: Impact of the burn-up of nuclear fuel (heavy metal, HM) and the average net electric efficiency of the plant on the mass of spent nuclear waste per kilowatt-hour of electricity produced.



Source: Own calculations.

The typical values for nuclear reactors in Europe range from approx. 2,2 mg/kWh for pressurised water reactors built after 1985 to around 9 mg/kWh for older, gas-cooled reactors.

Directive 2009/72/EC does not specify how any of the issues mentioned should be solved. Therefore it is up to the Member States to issue rules how the indicator on radioactive waste should be determined and expressed. The note of DG Energy & Transport on the implementation of electricity disclosure, which was published in 2004 based on results of the project "Consumer Choice and Carbon Consciousness for Electricity (4C Electricity)", suggests that Member States should require electricity suppliers to express the indicator on radioactive waste in the unit micrograms per kWh (thus 9,0 mg/kWh would read as 9.000 µg/kWh)[1,2].

In Germany, the electricity industry guidelines for electricity disclosure (BDEW, 2013) specify that only high-level radioactive waste (spent fuel unloaded from the reactors) should be taken into account, and that the indicator should be reported in grams per kilowatt-hour. The

1 DG Energy and Transport, 2004

2 http://www.electricitylabels.com (this project closed in 2003).

German guidelines report that based on the generation technologies used in Germany, the indicator can range between 0,0021 and 0,0027 g/kWh generated, and that as a conservative approach, the upper limit should be used uniformly for all power generated from nuclear energy.

Note however, that the recommendation to use the unit of g/kWh is not compatible with the common use of physical units. It is common practice to select the physical unit in a way which results in at least one digit before the decimal comma. Thus the recommendation should rather be to use the unit mg/kWh, which would result in a uniform indicator of 2,7 mg/kWh.

Similar regulations apply in the UK: The Electricity (Fuel Mix Disclosure) Regulations issued by the government in 2005 (UK Government, 2005) stipulate that the indicator should be determined based on a uniform waste factor, which is published by the energy ministry DECC for each financial year as part of a Fuel Mix Disclosure Data Table. The regulation also determines that the indicator should be reported to consumers in the unit grams per kilowatt-hour (see the note in the previous paragraph). The current version of the UK data table (UK Government, 2013), which is valid for the disclosure period 01/04/2012 – 31/03/2013, shows a uniform radioactive waste factor of 0,009 g/kWh (or better: 9,0 mg/kWh). This value is three times higher than the one used in Germany.

So far, the RE-DISS project has provided data for the radioactive waste indicator of the residual mixes in European countries based on a uniform factor of 3,0 mg/kWh of nuclear energy produced, which represents a typical value for modern reactors. The data for the individual countries was displayed in the unit of mg/kWh.

With regard to the direct emissions approach, the indicator of CO_2 emissions is relevant for several fuel types with different CO_2 intensities while the indicator of radioactive waste relates to nuclear power generation only. However, when taking the LCA approach, radioactive waste may be relevant for all fuel types and electricity technologies as long as one or more parts of the life cycle value chain use nuclear power or a mix of electricity containing nuclear power.

When using the direct emissions approach one could argue that the details of how the nuclear waste indicator is defined is less important as in the case of the CO_2 indicator, where the definition can have an impact on the relevance of different fuel sources to the overall CO_2 figure reported under electricity disclosure (see Figure 8). Compared to this, the indicator of radioactive waste can be seen as a variable which is proportional to the share of nuclear power production in a company mix or a specific product. Thus the details of its definition might be less important than for CO_2. In this case the definition must at least be harmonised at a national level. In order to make electricity offers and disclosure statements comparable not only within a country, the definition of the radioactive waste indicator could also be coordinated across all European countries. When taking the LCA approach, the definition of the indicator may impact on all the different fuel sources. Thus, if the LCA approach is chosen, then it is even more important to coordinate the definition of the indicator across Europe.

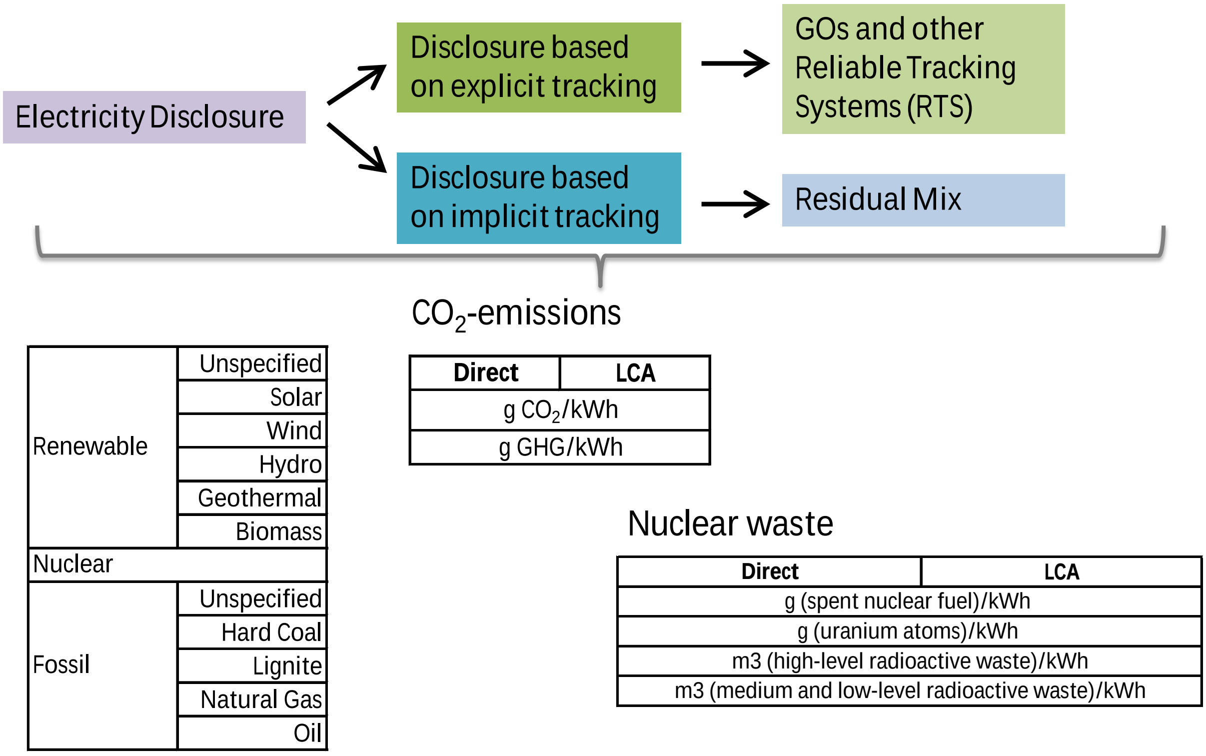
3 Different disclosure approaches for CO_2 emissions and nuclear waste

As stated in the Introduction (chapter 1), the Electricity Market Directive requires all suppliers of electricity to disclose their electricity portfolio with regard to energy source and environmental impact, specifying the emissions of CO_2 and the amount of radioactive waste relating to the electricity generation. The Directive, however, does not provide any specifications on how the CO_2 emissions and radioactive waste indicators exactly have to be defined.

Subject to national disclosure regulations, suppliers can usually use Guarantees of Origin (GOs) to account for the correct amount of electricity in order to achieve a satisfactory electricity disclosure at least with respect to RES-E. Thus, an electricity supplier can disclose the relevant fuel attribute related to the GOs. Electricity Disclosure information should, however, be provided to all customers regardless of whether the customer has made an active choice of product specific electricity or not. For a customer who buys electricity as a commodity, without any special requirements, the disclosed electricity will usually represent a mix of electricity generated from different energy sources. This electricity mix can consist of attributes as accounted for with different accounting instruments, with the Residual Mix being the central element for implicit disclosure information according to RE-DISS Best Practice Recommendations.

The Residual Mix has not yet been implemented in all European countries and other temporary solutions for implicit disclosure may therefore be used. For both explicit and implicit tracking, the energy source and environmental indicators relating to the supplied electricity generation need to be given. Based on the information provided in chapter 2, the different paths and type of information for explicit and implicit electricity disclosure may be illustrated as shown in Figure 10.

Figure 10: Different paths and types of information for explicit and implicit electricity tracking.



Source: Own calculations.

3.1 Status of the methodology for electricity disclosure indicators

According to the RE-DISS BPR (Best Practice Recommendations) (RE-DISS, 2012, item 44), “CO_2 emissions and radioactive waste should be disclosed on the supplier and product levels in direct relation to the fuel mix which is being disclosed.” In a footnote (13) it is further stated that generic technology-specific emission factors, which are defined by the domain in which the GO is used, could be applied for this purpose. The BPR does not say anything about the scope or unit related to the disclosed CO_2 emissions and radioactive waste.

The RE-DISS BPR annex “Methodology of Residual Mix Calculation. Electricity Mix Calculation According to the RE-DISS Project”, states that the following data need to be collected for the residual mix calculations (section 4.1):

- CO_2 emissions from fossil-based electricity production in g CO_2 per kWh, which only relates to direct emissions from electricity production. CO_2 data based on LCA has not yet been utilized in residual mix calculation due to absence of mutually agreed, reliable and consistent data source.
- Radioactive waste from nuclear electricity production, which is calculated as mg of radioactive waste per kWh. The level of radioactive waste should be distinguished in the future.

Thus, according to the BPR CO_2 emissions are disclosed as direct CO_2 emissions, not including other GHG gases, and radioactive waste from nuclear electricity production is disclosed as mg spent nuclear fuel per kWh of nuclear power. The BPR thus uses a direct emissions calculation approach.

3.2 Overview electricity disclosure in different countries

Table 1 gives an overview of the current practice in a selection of European countries with regard to electricity disclosure. In addition, the table shows which countries are currently using the RE-DISS Residual Mix calculation for disclosure information (with more or less adjustments).

Table 1: Overview of current disclosure practice in a selection of European countries.

			AT	BE-F	BW-W	CH	DE	DK	FI	IS a)	IT	LU	NL	NO b)	SE	ES c)	FR c)	PT c)
Energy sources	Renewable	Renewable		x	x	x 4)			x	x	x	x 4)	x 4)	x	x	x	x	x 4)
		Wind	x			x		x 11)				x	x					x
		Hydro	x			x						x	x				x	x
		Solar	x			x						x	x					x
		Biomass	x 1)			x 5)		x 12)				x	x					
		Geothermal	x			x												x
	CHP 13)	CHP														x		x 9)
		High-efficient		x	x							x				x		
	Fossil	Fossil		x	x 3)				x	x		x 6)		x	x	x 7)		
		Hard coal	x			x		x			x	x	x			x	x	x
		Lignite										x						
		Natural gas	x		x	x		x			x	x	x			x	x	x
		Oil	x			x		x			x							x
	Nuclear		x	x	x	x		x	x	x	x		x	x	x	x	x	x
	Other			x 2)	x 2)	x 2)					x 2)	x 2)	x 2)					
	Waste																	x
Environm. indicators	CO_2	g/kWk	x				x	x	x	x		x	x	x	x	x	x	x
	Radioactive waste	mg/kWh	x				x 14)	x	x	x		x	x	x	x		x 8)	
		m^3/kWh														x		x
	Other							x 10)										
Use RE-DISS Residual Mix								x	x	x				x	x			

1) Includes solid and liquid biomass, biogas and landfill and sewage gas
2) Other and unknown
3) Other than gas
4) Other renewables
5) Biogas
6) Other fossil
7) Gas in CC
8) Long and short time radioactive waste
9) Separated into RES and fossil
10) Large range of indicators, such as N2O, CH4, GHG, particles, Nox, biomasss ash etc.
11) Includes also hydro and solar
12) Includes also waste and biogas
13) Do not represent an energy sources
14) Disclosed as g/kWh

Sources:

In general: RE-DISS country profiles, http://phase1.reliable-disclosure.org/documents/

a) Data taken from Iceland's disclosure website: http://www.os.is/media/frettir/665-OS-yfirlysing2012-stodlud-A4-HR-LOKA.pdf

b) Data taken from Norway's disclosure website: http://www.nve.no/no/Kraftmarked/Sluttbrukermarkedet/Varedeklarasjon/Varedeklarasjon-2012/

c) Data received per email from Diane Lescot (Observ'ER) Sep 18 2013

Based on the data collection work for Table 1, it seems that the direct emissions/waste approach is the most widespread approach for electricity disclosure of CO_2 emissions and radioactive waste. In addition, the table shows that the most commonly used reference unit for disclosed radioactive waste is mg per kWh, except from Spain and Portugal who disclose nuclear waste as m^3 per kWh.

In order to give some examples of disclosure based on explicit tracking, the current practice in Denmark and Germany are presented in the following.

In Denmark, Energinet.dk (the issuing body for guarantees of origin) has developed guidelines for how the suppliers can calculate and provide their customers with disclosure information using explicit tracking, based on the direct emissions approach. Based on a calculation sheet, the suppliers can insert information about the amounts of electricity delivered from different energy sources based on guarantees of origin and the relevant indicators are automatically calculated (Energinet.dk 2013). All renewables are assumed to be CO_2 free and radioactive waste is provided as mg waste per kWh.

In Germany, the guidelines published by the electricity branch association (BDEW 2013) recommend the following with regard to electricity environmental indicators:

- Nuclear waste:
    - No differentiation between high and low radioactive waste
    - Highest value of the range for plant-specific radioactive waste/kWh for German nuclear power plants (i.e. a conservative value), expressed in g/kWh
- CO_2:
    - Values according to official ETS monitoring data; this means:
        - If available, plant specific data (relevant for own production and bilateral contracts)
        - Only direct emissions
    - For CHP, the allocation of CO_2 emissions should follow the national regulation FW 308.
    - Emissions from waste incineration plants are considered being CO_2 neutral (as is the case in ETS).

3.3 Further work on common guidelines and figures for electricity disclosure

Based on the presented possibilities and practices for electricity disclosure based on explicit and implicit tracking, it is clear that there is a need for developing a harmonised practice for determining environmental indicators used for disclosure purposes.

One major objective of the further development of the Residual Mix calculations within the RE-DISS II project is to provide even better data for CO_2 emissions and radioactive waste. The project will investigate and discuss with stakeholders whether this data should be given not only based on direct emission, but also as LCA indicators. In addition, the fuel categories are intended to be given on a more detailed level by separating the fossil and renewable categories into sub categories.

The above described work on more detailed information for implicit disclosure will also provide valuable information with regard to explicit disclosure. As one major activity for the Residual Mix calculations is to categorise country specific data for direct (and LCA) indicators for the major electricity technologies, this information represents valuable information for explicit disclosure as well.

In addition, there is a need for a common practice with regard to whether the CO_2 emissions should be disclosed as "only" CO_2 emissions or if other greenhouse gases also should be included, which means that total GHG emissions are disclosed. For nuclear waste, the determination of a common procedure to calculate the indicator for each country is of importance and the unit for this indicator (mg or volume per kWh) needs to be harmonised.

These issues will be further developed in the RE-DISS II project with the aim of providing common guidelines and figures for electricity disclosure in Europe.

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