Review of the report
"Background analysis of the quality of the energy data to be considered for the European Reference Life Cycle Database (ELCD)"[1]

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Summary

The evaluation of LCI data related to electricity generation and supply of energy carriers from different LCI databases initiated by the JRC and aiming at an unbiased analysis of data quality is highly appreciated and should be further pursued covering also other economic sectors. However, the current attempt for a comparative quality assessment fails in reaching this goal due to a number of reasons:

- The quality assessment is lacking transparency: The main source of information concerning the evaluated LCI data from the GaBi database is a confidential report from PE International. Often, key information required to judge the quality of the data is not provided in the evaluation report.
- Several of the evaluated ELCD datasets are not actually part of v3.1 (the current version) of the ELCD database. The study uses data from the commercial Gabi database and labels them ELCD data.
- Two highly relevant evaluation criteria for such an assessment are missing: 1) transparency of LCI data and 2) appropriate documentation of dataset content.
- The quality ratings of datasets from the ecoinvent database are – in comparison to ELCD and GaBi datasets – often too low; these rating cannot be justified and are therefore questionable.
- The evaluation report contains many inconsistencies, errors, and wrong statements; this indicates that adequate resources for a comprehensive quality assessment were missing and that authors, editors and reviewers of the report might be lacking sufficient technical understanding of the analyzed sector.
- The review panel (employees of PE International, publisher of the Gabi database) cannot be regarded as an independent party as they have clear commercial interests.

Overall, the general conclusion of the evaluation report that "*ELCD datasets showed the best quality rating (meaning that the other databases ranked almost at the same level or lower) in the majority of the considered technologies*" seems to be biased, is not supported by sufficiently detailed information concerning the content of the ELCD datasets and sometimes not even the visible facts, is in some cases referring to data that is not even in the ELCD at all and can therefore not be justified.

General comments:

The initiative of the JRC for a systematic comparative quality assessment of LCI data related to electricity supply and generation and supply of energy carriers from different LCI databases based on well-defined indicators is highly appreciated. Such an evaluation can serve as decision support for LCA practitioners in research, industry and administration for the selection of background LCI data; it is also a valuable tool

[1] European Commission. 2013. Background analysis of the quality of the energy data to be considered for the European Reference Life Cycle Database (ELCD). Editors: Simone Fazio, Marco Recchioni, Fabrice Mathieux. Authors: Daniel Garrain, Cristina de la Rùa, Yolanda Lechòn. European Commission, Joint Research Centre, Institute for Environment and Sustainability.

for identification of data gaps, lack in quality of certain LCI data and the need of updates and extensions concerning specific technologies, processes and economic sectors. Finally, such an evaluation could contribute towards an international harmonization of LCI databases, which would substantially increase "resource efficiency" in collection of LCI data and in daily LCA practice.

The approach taken by the JRC should be further pursued covering other economic sectors of the selected (and maybe further) LCI databases. It is recommended that suppliers of different LCI databases will be encouraged to collaborate with the evaluators in the future in order to provide the information required for the quality assessment in a transparent and publicly accessible way. These database suppliers should also be included in the review of the data evaluation aiming to find a consensus in the results evaluated.

However, this review suggests that the present attempt for evaluation failed to a large extent in reaching one of its main goals: an unbiased analysis of the quality of energy related LCI data for European countries. The main reasons are discussed in the following:

- The boundary conditions of the background analysis concerning the quality of energy related LCI data in the ELCD database are inappropriate for such a comparative quality assessment: Even though the authors of the report can be regarded as independent researchers and LCA experts, the report was edited (to an unknown extent) by JRC, which cannot be regarded as independent party in this context. Moreover, the review panel almost exclusively consists of employees of PE International, owner of the GaBi LCI database. GaBi LCI datasets are the basis of the evaluated ELCD datasets and the GaBi database is one of the evaluated sources of energy-related LCI data for the ELCD. Therefore, the review panel cannot be regarded as fully objective as the people involved have a commercial interest in a positive evaluation of their products.
- The main source of information used for the evaluation of GaBi LCI data is quoted as "*PE (2012a). Documentation of energy datasets in GaBi 5.0. Confidential report provided by PE International, 2012.*" A confidential report must not represent the most relevant source of information used for a comparative quality assessment of LCI data. Such a comparative evaluation must be transparent and open to the public including the source(s) of information and data used.
- Both of the issues raised above are especially critical in this specific situation, as such a quality assessment is to some extent a subjective exercise and (as the report states) "…*expert judgment values have been applied in many cases*" (pg. 229).
- Several datasets, evaluated as coming from the ELCD database, cannot be found in the ELCD database, v3.1 (access date: 21.1.2015): Electricity from nuclear power; Electricity from hard coal; Electricity from lignite; Electricity from natural gas; Electricity from nuclear power; Electricity from biomass; Electricity from photovoltaic; Rapeseed Methyl Ester. These datasets are in fact part of the GaBi database, but the report labels them as ELCD data and repeatedly refers to them as such. It also uses these datasets to support the core conclusion of the study, which is that the ELCD contains high quality data. Therefore, the core conclusion of the study is critically flawed.
- The evaluation is carried out based on the six indicators previously established by ILCD, which is perfectly fine. However, two highly relevant evaluation criteria for such a comparative assessment are missing: 1) transparency of LCI data and 2) adequate documentation of dataset content. Transparency is a prerequisite for evaluation of LCI data quality and can only be guaranteed with access to LCI data on a unit process level providing all quantified individual exchanges and environmental flows. However, transparency alone is not sufficient: only with appropriate documentation on a unit process level (even better: on the level of individual

exchanges within the unit processes), the six ILCD evaluation criteria can, as the authors recommend, be "*…taken into account by the LCA practitioner to evaluate the quality [of LCI data]…*" (pg. 230).

- The evaluation as such is lacking transparency: in case of many of the evaluated ELCD/GaBi datasets, the sections "General comments and/or relevant information" and "Technological representativeness" do not provide the required information in a sufficiently transparent way in order to justify the rating of criteria. Often, data sources used for establishment of LCI datasets are not provided, or only on a general level, which is insufficient.
- From the reviewer's subjective point of view, the quality ratings of datasets from the ecoinvent database are – in comparison to ELCD datasets – often too low. It seems that the rating of the ecoinvent datasets suffers from their transparent documentation which reveals detailed data sources and discusses potential limitations. Selected examples for this observation concerning specific datasets will be provided in the subsequent section "Specific comments".
- The report contains a number of inconsistencies, errors, and implausible statements: Readers may get the impression that the authors and editors might not fulfill their own requirement, namely that "*…in order to ensure the appropriateness and robustness of the methodology applied [in the evaluation], deep knowledge on the analysed topic is required.*" (pg. 229).
- As a consequence of the issues raised above, the general conclusion of the evaluation that "*ELCD datasets showed the best quality rating (meaning that the other databases ranked almost at the same level or lower) in the majority of the considered technologies.*" (pg. 5) seems to be biased, is not supported by sufficiently detailed information concerning the content of the ELCD datasets, and can therefore not be justified.

Specific comments:

A number of comments referring to specific statements and data quality judgments in the report are provided in the following to support the general statements made above. These selected comments intend to represent the general impression left by the report; they refer to both methodological aspects as well as the evaluation of data quality based on a sample of datasets (EU-27 electricity mix; electricity from natural gas, nuclear, hydroelectric power, photovoltaics; natural gas mix; biofuel). The comments listed here are thus only a selection of all issues concerning the report; the report with the complete set of more than 300 single comments is available upon request.

- Pg. 4: "*The methodological report, … has been disclosed with a large panel of relevant stakeholders…*".

  This statement is not correct. A large panel might have been asked for participation in the review; however, as stated in Annex 2, the methodological report was ultimately only reviewed by five persons (four of them from PE International), the summary by four persons (all of them from PE International).

- Pg. 5: "*…, nor can [the conclusions obtained] be used to compare databases among them.*"

  That statement is in contradiction to the conclusion of the authors' two paragraphs below: "*ELCD datasets showed the best quality rating (meaning that the other databases ranked almost at the same level or lower) in the majority of the considered technologies.*" Even if the conclusion refers to energy sector related datasets only, quality of LCI data of the evaluated databases will be compared based on this report, and that is legitimate, even recommended from the reviewer's point of view.

- Pg. 12, 13; Tables 2 & 3: Selection of energy datasets.

  The selection of datasets is in general reasonable. However, a few issues warrant discussion/justification to guarantee an unbiased selection of datasets, which is not driven by the (potentially limited) data content of certain databases:
  1) Why are heating technologies and heat supply not included? The heating sector is an important part of the energy sector.
  2) Why is only the EU27 electricity mix evaluated, but no country-specific electricity supply mixes? Country-specific electricity supply mixes are often more appropriate for LCA practitioners.
  3) The selection is quite limited concerning biofuels. Considering the EU goal of increasing shares of renewables, this narrow selection does not seem to be appropriate.
  4) There is no rationale provided for the selection of the specific locations/geographies for hydro, wind, biomass, and solar electricity generation (RER, EU27, DE, DE) as well as for biofuels (DE).
  5) Why is electricity generation with oil power plants not included?
  6) "Electricity from biomass": There is no reason not to include datasets from the ecoinvent database. It includes electricity from wood-fueled CHP plants (representing solid biomass) as well as electricity from several other types of biomass (biogas from different feedstocks).

- Pg. 17: The authors state that "*The review has been based on the available documentation/information of database providers. The unavailability of certain information does not automatically mean that a dataset is worse than other data.*"

  That is correct, but if dataset documentation/information is insufficient for a qualified evaluation, this needs to be stated explicitly with a statement like: "Criterion not evaluated due to lack of sufficient documentation". This has been the case only once throughout the whole evaluation, but should have been stated more frequently in the case of the ELCD/GaBi datasets.

- Pg. 19: The modus operandi for scoring the "Completeness" criterion.

  It needs to be highlighted that this modus operandi is subjectively introduced by the authors. A different approach (e.g. scoring "1" only in case of all impact categories and all elementary flows being completely covered, or introduction of an energy-sector related weighting of impact categories (according to importance)) would lead to a very different evaluation of this criterion.

- Table 4: Selected elementary flows for the evaluation of the "Completeness" criterion for electricity generation technologies.

  The number of elementary flows selected for each impact category should partially be higher:
  1) Electricity mix: All elementary flows identified as being relevant for a technology should be included for the electricity mix. Depending on technology shares and dominance of single flows in terms of impact, each of these could be relevant for the mix.
  SF6 and N2O emissions to air need to be included; these are generated due to electricity transformation and distribution and might dominate the climate change LCIA results in case of power generation with low greenhouse gas intensity.
  2) Biomass: concerning climate change, CH4 emissions to air and CO2 from land use change are missing.
  3) Particulate matter formation: NOx and ammonia emissions to air are missing for all technologies.
  4) Eutrophication (marine): Is there a reason for including nitrate emissions to water only for the electricity mix, but not for any single generation technology?

5) Resource depletion (minerals, fossil & renewable): includes lignite instead of hard coal for lignite power generation; include copper and platinum for all technologies; include silver, cadmium, tellurium and gallium for photovoltaics.

- Table 5: Selected elementary flows for the evaluation of the "Completeness" criterion for oil, gas and biofuels.

  The number of elementary flows selected for each impact category should partially be higher:
  1) RME: Include CH4 emissions to air and CO2 from land use change in the climate change category.
  2) Particulate matter formation: Include PM2.5, NOx, SO2 and ammonia emissions for all energy chains.

Evaluation of specific datasets from different databases:

In general, the report needs to contain an overview table with all ratings (per dataset and per criterion). Otherwise, it proves very difficult for readers to get an overview.

- **"Electricity mix, EU27" (pg. 28ff)**

1) ELCD database: "Electricity grid mix 1kV - 60kV, EU-27 (AC, technology mix | consumption mix, at consumer)"

- Technological representativeness: Provided information cannot be regarded as sufficient for the quality rating "1". Missing: Is the infrastructure of the electricity grid included? Are SF6 and N2O emissions from transformer stations included? Are electricity losses quantified in a country-specific way?
- Time-related representativeness: It is not clear whether this rating only refers to the shares of countries contributing to the EU27 mix (annual production), or is supposed to cover the complete energy generation chains. If energy chains are included, the period 2009-2014 is not correct; much older data are part of the generation chains.
- Precision/uncertainty: It is not clear whether the "complete product system" refers to the electricity mix as such (i.e. shares of different countries and generation technologies), or also includes the complete power generation chains. If complete energy chains are included, the provided info is insufficient for a qualified rating.
- Methodological appropriateness and consistency: The infrastructure of electricity transmission & distribution is not mentioned at all; this is a key aspect of electricity mix datasets. Without this information, the quality rating "1" cannot be justified.

2) ecoinvent database: "Electricity, medium voltage, production RER, at grid/kWh/RER (< 50 kV)"

- General comments and/or relevant information: The statement "*It [the electricity mix] does not include transformation, transport nor distribution losses.*" (pg. 35) is wrong. Electricity supply datasets at medium voltage level do include country-specific transformation, transport and distribution losses between power plant busbar and supply (i.e. on high and medium voltage level) and this is transparently documented in the associated documentation.

- Geographical representativeness: The statement that "*Assumptions for transmission network, losses and emissions are based on Swiss data.*" (pg. 36) is partially wrong. Electricity losses are quantified in a country-specific way.
- Precision/uncertainty: The rating "3" with the justification "*There is no information about the emission factors or direct emissions*" (pg. 38) cannot be regarded as a fair evaluation and the quoted justification is wrong. Ecoinvent datasets contain quantified uncertainty information for all environmental flows and data sources of emission factors or direct emissions are provided in the associated documentation in a transparent way.
- Methodological appropriateness and consistency: The statement "*It [the dataset] includes the treatment of residues (ash) but not the EoL modelling of plant decommissioning.*" (pg. 38) is wrong. End-of-life of infrastructure (including power plants) is mostly included as part of the infrastructure datasets. The rating "3" cannot be justified based on the reasons provided. The statement "*Allocation procedure has been applied to the waste rather to electricity (only in the case of waste incineration plants).*" (pg. 38) is misleading: Firstly, this allocation procedure is only applied to electricity from waste incineration, which insignificantly contributes to national electricity mixes (in the order of max. a few percent). Secondly, this allocation procedure is part of a consistent treatment of waste treatment within the complete ecoinvent database. Thirdly, the evaluation of the electricity mix dataset of the ELCD database does not comment on the allocation with regard to waste incineration, i.e. the datasets from the different databases cannot be compared concerning this aspect.

3) GEMIS database: "El-generation-mix-EU-27-2010 (PRIMES)"

- General comments and/or relevant information: The information provided is insufficient to be able to judge the quality of this dataset. There is no explanation given as to whether this this lack of information is a result of insufficient documentation of this dataset in the GEMIS database.
- Technological representativeness: There is not a single comment concerning the way power generation technologies are modeled and represented in the electricity mix, e.g. whether these are country-specific or represent EU averages, etc. The information provided is insufficient to account for any rating.
- Time-related representativeness: It's not clear whether this rating only refers to the shares of countries contributing to the EU27 mix (annual production), or is supposed to cover the complete energy generation chains. Therefore, the rating cannot be judged.

4) E3 database: "Electricity / Electricity-Mix-EU (10-20 kV-level) / CONCAWE"

- General comments and/or relevant information: Very little information is provided.
- Technological representativeness: Electricity generation chains and data sources are hardly discussed.

Concerning results, findings and recommendations: Based on the limitations listed above, the statement that the "*ELCD dataset achieves the highest score in all quality criteria with the only exception of the precision criteria which has a score of 2.*" (pg. 46) does not seem to be justified. The recommendation that "*The methodology (M) criterion could be improved with the inclusion of the EoL modelling of PV facilities, as it will be shown in the section dealing with PV electricity dataset using data from Ecoinvent (2009).*" (pg. 46) contradicts the previous statement "*It [the electricity mix (?) dataset] includes the treatment of residues (ash) but not the EoL modelling of plant decommissioning.*" (pg. 38).

- **Electricity from natural gas, UK/GB (pg. 82ff)**

1) ELCD database: "GB: Electricity from natural gas (AC, mix of direct and CHP, technology mix regarding firing and flue gas cleaning | production mix, at power plant | 1kV - 60kV)"

- General comments and/or relevant information: The relevant information concerning the LCI data for natural gas based power generation has been extracted from the confidential report from PE International (PE 2012a) and can therefore not be evaluated by third parties. Information concerning natural gas exploration, production and processing is missing in Table 32 – the quality of these processes can therefore not be judged. Table 32 contains a contradiction concerning SO2 emissions. These are both quantified according to (EEA 2009) and "*not referenced*". It's not clear whether the power plant emission data match the natural gas composition.
- Technological and geographical representativeness: as long as data sources for natural gas production in the different production regions are not provided, this criterion cannot be judged and the rating is intransparent.

2) ecoinvent database: "Electricity, natural gas, at power plant/GB"

- General comments and/or relevant information: The documentation of the natural gas electricity generation chain provides complete information concerning all process steps. However, some information in Table 34 in incorrect: the infrastructure used for electricity generation is not a 400 MW combined cycle plant in Germany, but a 100 MW open cycle gas power plant with a much lower electric efficiency than stated here.
- Technological representativeness: There is no reason for a rating below "1". The justification provided "*The technology aspects have been modelled as an average plant in Europe, based in a CHP plant sited in Germany.*" (pg. 89) is wrong. Only the power plant infrastructure (irrelevant in terms of LCIA results) has been modeled as average plant; but not based on a CHP plant in Germany. The so-called "CHP plant" in Germany is used for representing "best available natural gas power generation technology in Europe" and is a combined cycle (CC) plant. All other relevant LCI data in this chain (power plant performance and emissions, natural gas supply) are country-specific for GB.
- Precision/uncertainty: The statement "*Main emissions and technology aspects in the power plant are determined using information from a plant sited in Germany in 2001.*" (pg. 91) is wrong. See comments concerning TeR. Based on this incorrect statement, rating "2" cannot be justified.
- Methodological appropriateness and consistency: The statement that "EoL modelling is not included, …" (pg. 91) is wrong. EoL is included, assuming recycling of metals (i.e. the infrastructure). Due to cut-off-modeling, the EoL treatment of these recycled materials is not explicitly accounted for.

3) GEMIS database: "Gas-CC-UK-2010"

- General comments and/or relevant information and TeR: the provided information is not sufficient to judge the quality of the LCI data. Yet, the reason for this lack in information is not discussed. is not clear as to what extent the single power plant represents installed natural gas power plants in UK in 2010, therefore the rating cannot be judged.
- Geographical representativeness: The information explicitly provided does not justify the low rating "4".

4) E3 database: no dataset evaluated.

- The report does not provide any rationale why natural gas based power generation datasets in this database have not been evaluated. According to Table 3, at least a dataset for Germany would be available.

Concerning results, findings and recommendations: The statement "*ELCD fossil fuels datasets achieve the highest scores in the quality criteria related to technological representativeness, completeness and methodology. The other criteria are rated with a score of 2.*" (pg. 96) does not seem to be justified based on the provided information. Only insufficient information concerning the ELCD fuel chains is provided (mainly regarding fuel extraction) and the evaluation of the ecoinvent datasets cannot be justified due to several errors and inconsistencies in the evaluation.

- **Electricity from nuclear power (pg. 98ff)**

1) ELCD database: "FR: Electricity from nuclear power (AC, technology mix of BWR and PWR | production mix, at power plant | 1kV - 60kV)"

- General comments and/or relevant information: The name of the dataset is misleading, since there are no BWR in France. The general comment is not appropriate: "*…is taken into account as well as the country / region specific nuclear fuel supply chain.*" (pg. 98). That's not correct: According to Table 41, uranium mining and milling is based on (Dones 1996) reflecting mining and milling in the US only. Since France is not only importing uranium from the US, the country specific fuel supply chain is not represented. IPPNW (2010) is used as source for "Uranium supply"; this reference mainly refers to uranium supply of Germany and states that uranium supply chains from mining to the power plants are very intransparent. The information for France concerning uranium imports does not represent the necessary data for establishing a uranium supply chain for French nuclear power plants; and, if LCI data for mining and milling are from the US only, statistical data for French uranium supply are irrelevant. Tailings from uranium mining and milling do not seem to be included in the LCI data. This is a very serious limitation, since emissions from these tailings dominate many of the LCIA indicators (based on results from the ecoinvent database, v2.2). Many of the used primary data sources are old and final disposal of high active radioactive waste is not included.
- Technological representativeness: The rating "1" is completely inappropriate: data from several potentially inconsistent sources are used, which are partially outdated; uranium supply is not country-specific; and, uranium tailings are missing. A rating "4" seems to be justified.
- Geographical representativeness: A rating better than "3" cannot be justified; mining, milling and reprocessing (partially also enrichment) are not FR chain specific.
- Time-related representativeness: A rating better than "4" cannot be justified; Hardly any of the LCI data originate from the time period 2009-2014, specified as reference period.
- Methodological appropriateness and consistency: A rating better than "3" cannot be justified; tailings from uranium mining and milling are a central aspect of the nuclear cycle and are missing; EoL of high-level nuclear waste is not modeled.

2) ecoinvent database: "Electricity, nuclear power plant, pressure water reactor 1000MW/FR"

- General comments and/or relevant information: Table 44 does not include the source for LCI data of emissions from uranium tailings, (Doka 2009)[2]. The comment in Table 44 concerning EoL

[2] http://www.doka.ch/PSIuraniumtailingsDoka.pdf

of radioactive waste "*Long term emissions not accounted for.*" (pg. 103) is misleading: According to the primary source (Nagra 2002), there are no long-term emissions exceeding the natural level of radioactivity.
- Technological representativeness: The rating "2" is rather inappropriate, "3" would better reflect the lack of France specific uranium supply and some extrapolations from Swiss nuclear power LCI.
- Geographical representativeness: A rating "2" seems to be more appropriate; see comment concerning TeR.

3) GEMIS database: "Nuclear-power plant – PWR-FR-2000" and "Nucler-powerplant-PWR-FR-2010 (EPR)"

- General comments and/or relevant information: Some information provided in Table 46 is not clear.
- Technological representativeness: The modeling of the fuel chain is not country-specific, EoL of nuclear waste is not included and the datasets do not represent the installed reactor park. A rating "3" seem to be appropriate.
- Geographical representativeness: Seems to be as good as for ELCD data, i.e. rating "3" would be more appropriate.

4) E3 database: "Power Station / Nuclear (DWR-F)"

- General comments and/or relevant information: Information provided is insufficient.

Concerning results, findings and recommendations: The rating of LCI data of nuclear power in France in the ELCD database is too generous (see comments above for details). Overall, the quality of these LCI data seems to be worse than the quality of nuclear power in the ecoinvent database, even if also these inventories refer to outdated data and need to be updated.

- **Electricity from hydroelectric power (pg. 114ff)**

1) ELCD database: "ELCD database EU-27: Electricity from hydro power (AC, technology mix of run-off-river, storage and pump storage | production mix, at power plant | 1kV - 60kV)"

- General comments and/or relevant information: The dataset represents a mix of different types of hydro power plants – reservoirs, run-of-river, and pumped storage. This approach is more than questionable, since as opposed to reservoir and run-of-river plants pumped storage plants do not represent electricity generation, but electricity storage technologies. Their environmental performance distinctively differs from the other two types of hydro plants and almost exclusively depends on the origin of electricity used for pumping. The fact that "*Dataset developers have not provided any information extra in order to list the references and the sources by stage of the process, like other technologies.*" (pg. 114) makes a reasonable evaluation of the dataset quality impossible. This needs to be stated by the evaluators.
- Technological representativeness: Based on the lack of specific information concerning this dataset (including data sources), the rating "1" cannot be justified.
- Geographical representativeness: Based on the lack of specific information concerning this dataset (including data sources), the rating "1" cannot be justified.
- Time-related representativeness: 2009 as reference year for hydro power plants which have been built decades ago, seems to be arbitrary and inappropriate. Among the data sources

provided in this section, sources concerning plant construction are missing; those are quite relevant for the environmental performance. The rating "1" cannot be justified.

- Methodological appropriateness and consistency: There is a fundamental flaw in mixing pumped storage with reservoir plants (see comment regarding general comments). The statement that "*…hydropower has not multifunctionality.*" (pg. 117) is wrong (river flow control against flooding, irrigation), albeit reflects the usual procedure in LCA. Due to lack of information, also this criterion cannot be reasonably evaluated.

2) ecoinvent database: "Electricity, hydropower, at run-of-river power plant/RER" and "Electricity, hydropower, at reservoir power plant/RER (alpine and non-alpine regions)"

- General comments and/or relevant information: Table 52 provides detailed information about the inventories. However, it's not correct that material requirements and land use are not referenced. The Annex of the public "Wasserkraft" ecoinvent report contains the list of plants considered and the associated references.
- Technological representativeness: The rating "3" cannot be justified due to several reasons:
  a) there can hardly be better LCI data for reservoir plants. A sample of 50 dams - even if they are all in Switzerland - should cover most of the site-specific aspects in mountain regions in EU; and reservoir plants are per definition in mountain regions.
  b) there are very good reasons for specific modeling of run-of-river and reservoir plants: different infrastructure, reservoirs require a dam, reservoirs are located in the mountains (minor), GHG emissions from reservoir lakes are potentially much higher than for run-of-river, different operation regime (run-of-river = continuous and to a certain extent stochastic; reservoirs can be dispatched).
  c) one could argue about the small sample for run-of-river, but these are - within the common capacity in EU - very similar.
  d) several sources have been used for estimation of GHG emissions from reservoirs.
- Geographical representativeness: The rating "3" cannot be justified, since the sample of dams and run-of-river plants can be regarded as representative for Europe.
- Time-related representativeness: The rating "3" cannot be justified. Most of the hydro plants have been constructed in periods provided as reference time frame and all data sources refer to this time frame, therefore this is fully legitimate and reflects the current hydro park in CH/EU.
- Precision/uncertainty: The rating "3" cannot be justified. Main reference is not an "internal document"; the power plant sample used as basis for the LCI data and the associated data sources are part of the public ecoinvent report "Wasserkraft".
- Methodological appropriateness and consistency: The justification for the rating "2" is insufficient. All relevant aspects are included in the LCI modeling.

3) GEMIS database: "Hydro-dam-big-generic"

- General comments and/or relevant information: hardly any information is provided.
- Technological representativeness: The rating "4" does not seem to be justified, "3" would be more appropriate. In case of hydro power, a generic plant model can be representative to a certain extent.
- Geographical representativeness: The rating "5" does not seem to be justified. In case of hydro power, a generic plant model can be representative to a certain extent for specific geographies.

4) E3 database: no dataset evaluated.

Concerning results, findings and recommendations: The statement that "*ELCD dataset achieves the best rating in four quality criteria.*" (pg. 126) cannot be justified based on the intransparent and

incomplete information provided concerning this ELCD dataset. A serious quality evaluation of this dataset needs to state "This ELCD dataset cannot be evaluated in a serious way due to lack of information and documentation concerning the LCI data." Furthermore, the statement "*It must be highlighted that ELCD includes the emissions due to biomass degradation, while other datasets do not consider them.*" (pg. 126) is wrong: hydro power datasets of the ecoinvent database do include these emissions, accounted for in a region-specific way.

- **Electricity from solar power (photovoltaics) (pg. 156ff)**

1) ELCD database: "DE: Electricity from photovoltaic (AC, technology mix of CIS, CdTE, mono crystalline and multi crystalline | production mix, at power plant | 1kV - 60kV)"

- General comments and/or relevant information: Table 70, supposed to provide an overview of the PV manufacturing chain only provides very incomplete information. Therefore the general information is not transparent, data sources are missing, information about technology performance and data quality along the manufacturing chain is not provided.
- Technological representativeness: due to lack of transparent documentation/discussion, this rating cannot be judged. Global shares of different PV modules might not reflect conditions in Germany in an appropriate way. Production chains seem neither to reflect German conditions, nor the world PV market. Information concerning roof-top vs facade installations and open ground units are missing. Due to these issues, the rating "1" cannot be justified.
- Geographical representativeness: The fact that German production plants have been considered does not mean that this reflects the installed PV modules in Germany, they could also come from China, the US, anywhere. A comment about the used annual yield is missing. Therefore, the rating "1" cannot be justified.
- Precision/uncertainty: The information provided in this context is insufficient for judging the data quality and does not justify a rating "1".

2) ecoinvent database: "Electricity, production mix photovoltaic, at plant/DE"

- General comments and/or relevant information: The statement that "*The model for photovoltaic (PV) energy systems describes the production of electricity with photovoltaic small power plants newly installed in Switzerland.*" (pg. 161) is not correct. The model reflects specific PV manufacturing chains and the produced modules are installed in various countries, operated with country-specific annual yields.
- Technological representativeness: A rating worse than for the ELCD dataset cannot be justified; as opposed to the evaluation of the ELCD dataset, the documentation is transparent and data sources are provided. The justification for the rating "2" is misleading: LCI data do not reflect average world production, but are from specific production plants. Technology shares do not need to be in line with the European context, but with installations in Germany, if the DE DS is evaluated.
- Geographical representativeness: Any rating worse than for the ELCD dataset cannot be justified. The justification for the rating "2" provided is misleading: The dataset refers to PV electricity generation in Germany, not to PV cell manufacturing; one would need to know where the modules installed in DE are actually produced for an appropriate evaluation of this issue. The only correction factor applied refers to the annual yield and the used value is perfectly specific for Germany. The statement "*Country-site specific information related to the grid would increase the geographical representativeness.*" (pg. 163) is completely out of context.

Concerning results, findings and recommendations: Based on the limited and intransparent documentation of the ELCD dataset, the statement "*The ELCD dataset performs the best in 5 of 6 categories*." (pg. 174) is not justified and the rating cannot be judged. Also the statement "*Among the other databases, the ELCD dataset contains the most updated information and provides deep details concerning the precision of the data used.*" (pg. 174) is wrong. The documentation of the ecoinvent LCI data is more transparent and these data are very much up-to-date. Details concerning data precision are not provided for the ELCD dataset.

- **Natural gas mix (pg. 195ff)**

1) ELCD database: "EU-27: Natural gas mix (technology mix | consumption mix, at consumer | medium pressure level (< 1 bar))"

- General comments and/or relevant information: The "real" sample of gas production facilities/countries needs to be provided including data sources in order to justify any rating (i.e. LCI data from which production countries are available). Since "*Dataset developers have not provided any additional information in order to list the references and the sources by stage of the process, like other technologies.*" (pg. 195), data quality cannot be rated due to lack of transparency. This should have been stated by the evaluators. This applies to all indicators.
- Technological representativeness: "*…information regarding the technology description of a refinery*" (pg. 195) seems to be out of context. Refineries are needed for crude oil processing.

2), 3), 4) ecoinvent, GEMIS, E3 databases:

- The evaluations of datasets from these databases seem to be fair and mostly justified in a correct way.

Concerning results, findings and recommendations: Based on the limited and intransparent documentation of the ELCD dataset, the statement "*ELCD dataset performs better than any other database in five quality criteria.*" (pg. 212) is not justified and the rating cannot be judged. As the evaluators state themselves "*…based on the information provided by the dataset, it is not possible to know the particular relevant sources used for the different stages analysed by the dataset, i.e. NG transport, processing, etc.*" (pg. 198). Nevertheless, they rate data quality mostly as "1".

- **Biofuel dataset (pg. 213ff)**

1) ELCD database: "DE: Rapeseed Methyl Ester (RME) (technology mix | production mix, at producer)"

- General comments and/or relevant information: Since detailed information concerning upstream processes (oil extraction and purification and rapeseed cropping) is not available, the quality of the LCI data cannot be judged.
- Technological representativeness: The dataset refers to the German production mix; therefore, imports must not be included (which is correctly modeled, but criticized by the reviewers). Due to lack of detailed information, the rating "2" cannot be justified.
- Geographical representativeness: The statement "*The data set represents the national / regional consumption mix (supply mix) including domestic production and imports.*" (pg. 214) is wrong. According to the name of the dataset, it represents the production mix and does not include imports.
  - Time-related representativeness: Due to the mismatch between age of data sources and reference period, a rating "3" seems more appropriate.

- Precision/uncertainty: The statement "*Elementary flows basically come from literature, but there is no enough available information for many processes on the fuel chain.*" (pg. 215) is perfectly legitimate and highly appreciated. However, if the information for many processes of the fuel chain is insufficient, how can the other indicators (except of completeness) be evaluated?
- Methodological appropriateness and consistency: No information concerning indirect land use is provided. If this issue is not considered in the LCI modeling, rating "4" would be more appropriate.

2) ecoinvent database: "Rape methyl ester, at esterification plant/RER"

- Technological representativeness and geographical representativeness: the justification of ratings "2" and "3", respectively, is inappropriate; the dataset is supposed to represent production in Europe, not the European market.

3) GEMIS database: "Refinery\Rapeseed oil-ME-iLUC(50%) (arable)-DE-2010 en"

- General comments and/or relevant information and technological representativeness: According to table 98, there are a lot of gaps in the modeling of the LCI data for the RME production chain. If that's the case, rating "2" cannot be justified.

Comments concerning overall conclusions (pg. 229ff):

As the authors of the review report correctly state, "*…deep knowledge on the analysed topic [energy related LCI data] is required*" (pg. 229) for a solid and unbiased comparative quality assessment of energy related LCI data. However, the authors seem to lack this deep knowledge, as indicated by several wrong statements which lead to unjustified quality ratings. This seems to be even more relevant "*…since expert judgment values have been applied in many cases.*" (pg. 229).

As the authors of the review report also correctly state, "*…[evaluation] criteria should be taken into account by the LCA practitioner to evaluate the quality [of datasets]…*" (pg. 230). However, a transparent, accessible and comprehensive documentation of LCI data on the unit process level is required for any LCA practitioner to be able to judge the quality of LCI data according to these criteria. Therefore, it is recommended to additionally evaluate "transparent and complete documentation" as further quality indicator.

The author of this review report does not agree with the statement that "*Concerning the different technologies analysed, ELCD datasets have the best quality rating in the majority of the technologies, …*" (pg. 231). This statement and the quality rating cannot be justified on such a general level, mainly due to lack of accessible documentation of the underlying GaBi/ELCD datasets. It should be mentioned again that the majority of the technology-specific datasets are not in fact part of the ELCD despite being labeled as such in the report. In several cases, the evaluation of datasets from other databases than ELCD cannot be considered as justified; often, statements concerning these datasets are simply wrong. The transparent and honest (in terms of limitations) documentation of ecoinvent datasets leads to a low rating, while ELCD/GaBi DS are evaluated better without providing the required details concerning data sources used as well as processes and technologies covered in the LCI of the energy chains.