Lessons learned from assessing life cycle impacts for an environmental product declaration: Examples for run-of-river power plant

Meili C, Jungbluth N
ESU-services Ltd., Vorstadt 14, CH-8200 Schaffhausen, Switzerland

meili@esu-services.ch

Abstract. When conducting life cycle assessments (LCA) for environmental product declarations (EPD), researchers struggle with many methodological questions. For certain products there are several standards (e.g. ISO and EN) and Product Category Rules (PCR) available which all seem applicable. These standards, however, might lead to different results. Depending on the standard, system boundaries might be drawn differently than typically done in ones preferred background database. Another common issue is a lack of a clear definition of assessment methods (version, download of factors) to be applied. Or on a more practical level, you might not know how or where to obtain certain requested figures from your LCA data or even how to start with building an appropriate model in the LCA-software. The authors of this paper explain each of these issues with an example from their practical work, provide their instant solutions and make suggestions for general improvement of the situation. In general, they call for a more precise and practical guideline and easy-to-use LCIA methods for conducting EPDs.

1. Introduction
Environmental Product Declarations (EPD) present transparent, verified, and comparable information about the life-cycle environmental impact of products. The overall goal of an EPD is to provide relevant and verified information to meet various communication needs. An important aspect of EPD is to provide the basis of a fair comparison of products and services by its environmental performance. EPDs can reflect the continuous environmental improvement of products and services over time and are able to communicate and add up relevant environmental information along a product's supply chain. EPDs are based on principles inherent in the ISO standard for Type III environmental declarations (ISO 14025) giving them a wide-spread international acceptance.

Consultants at ESU-services dealt with these questions in projects and trainings. Here, we present some lessons learned when assessing life cycle impacts for an EPD on run-of-river power plants [1], revisioning a PCR for electricity [2], reviewing of an EPD on concrete products\(^1\) and EPD of consulting services [3]. During such work the following challenges have been identified when trying to elaborate EPD:

http://www.graspointner.at/fileadmin/Prospekte/FCT_one_screen.pdf
The choice of the correct LCIA indicators is often difficult because PCR lack details such as version of method or default characterisation factors for the methods to be used. Also, there seem to be contradictory hints in standards of different countries.

When distinguishing between upstream, core and downstream module, relevant aspects for optimisation were hidden in background-data. Getting transparency using unit processes from ecoinvent was more helpful for this goal.

Some indicators do not follow customary practice and logic of LCA, e.g. stating which parts of resources is used for materials or reporting on waste instead of including emissions of waste treatment.

There are no indications on how to set findings in perspective. With bare numbers on several single emissions, the values give no order of relevance and little encouragement for improvement.

2. Goals
The main goal of this paper is to provide suggestions for the optimization of guidelines and easy-to-use methods for conducting EPDs.

The following questions are tackled:

- Which standard (ISO, EN) and Product Category Rules (PCR) to apply?
  - How to draw system boundaries accordingly?
  - Which life cycle impact assessment methods match the standard?
  - How to obtain other requested information from LCI data?
- Restrictions concerning databases to be used.
- How to build an appropriate model in the LCA-software of choice?
- How to set findings in perspective and foster encouragement improvement?

3. Example: Run-of-river power plant

3.1 Goal and scope

3.1.1 Goal
The main goal of one underlying case study was to provide insights for the optimization of run-of-river power plants to the operators. It also enables the power plant operator to make a rough calculation for the environmental impacts due to electricity production in the client's existing and prospective power plants. In order to simplify the calculation of results the approach follows the Product Category Rules (PCR) guidelines for developing an environmental product declaration (EPD) for this type of power plants.

The model provides results for the two functional units: kilowatt-hour electricity, produced in a run-of-river power plant, “at power plant” and “at final customer”. For electricity at customer, also transformation to low voltage and transmission through different grid levels is included [1].

3.1.2 Scope and system description
Modelling is done according to latest available PCR [2], in accordance with ISO 14025:2006. Data collection is based on a model for run-of-river power plants without reservoirs in Switzerland [4-6].

For the impact assessment, besides required impact categories according to PCR for EPDs also an assessment with the Swiss-specific ecological scarcity method is implemented to simplify communication with Swiss stakeholders [7].

The model is implemented in excel and allows exchange of parameterized data in the EcoSpold v1-format. Thus, it is also possible to easily import the life cycle inventory analysis in SimaPro in order to do more detailed assessments.
The following modules of the life cycle are modelled (see Figure 1):

- **Upstream processes**: Provision of auxiliaries for ongoing operation, mainly lubricants and corrosion protection.
- **Core process, operation**: Water and land use for the operation of the turbine, as well as emissions from the use of lubricants (chemical oxygen demand, COD).
- **Core process, infrastructure**: Materials and energy requirements for the construction and dismantling of the power plant (dams, canals, power plant, etc.) and the installation of components in the power plant (turbines, generators, etc.), including necessary material and energy consumption, e.g. diesel and explosives.
- **Downstream operation**: Operation of the transmission and distribution network for the supply of electricity to end customers. Includes power losses during transformation and transmission, use of SF6 and associated losses.
- **Downstream operation, infrastructure**: Construction and disposal of the transmission and distribution network for supplying electricity to the end customer.

![Figure 1](https://example.com/figure1.png)

**Figure 1** Illustration of the life cycle structure and rough system boundaries. Rectangles with extended lines show processes that should be included, dashed lines show processes that could be included. Construction includes necessary renewals during the technical lifetime, decommissioning includes demolition and treatment of the various waste fractions according to the polluter-pays principle (cf. PCR CPC 17 2007).

### 3.2 Issues identified

1. The PCR requests a distinction of upstream, core and downstream processes as described above. No clear guidance was given, if and how e.g. a lubricant used for maintenance of the turbine should be allocated to the upstream or core process. In theory, according to the structure in Figure 1, production and emissions related to production of the lubricant should be allocated to the upstream process and emissions caused in the use phase during the processing of the turbine should be allocated to the core process. Unfortunately, in several commercially available databases only “system processes” are included. They show cumulated results of the lifecycle inventory of processes and products. Therefore, it is not possible to distinguish the share of emissions from production and other upstream processes from emissions occurring during the use phase. On the other hand, also in unit processes often there is a lack of direct emission data, so these emissions would need to be assessed in an additional model.

2. Some indicators do not follow customary practice and logic of LCA, e.g. the PCR requests statements on which parts of resources are used for materials. In lifecycle inventory data, resources are accounted for in the first stage of a production process. It is not recorded for which
purpose the derived materials (e.g. mineral oil products in the production of lubricants) are used finally. From an environmental point of view, when only looking at resources, there is no difference if a resource is consumed for the provision of energy (e.g. combustion of mineral oil) or the production of a material. (e.g. use of mineral oil as ingredient substance of the lubricant). Issues of accompanying emissions etc. are covered by other indicators than the resource use. Also, the PCR requests reporting on the level of different waste categories. This is also not state of the art in the LCA practice. There, all emissions of waste treatment should be tackled in process stages looking at the waste treatment. Reporting on the amount of waste per se is not an environmental indicator as the relevance for the environment can only be assessed when knowing more about the further treatment of it (e.g. type of filters used in incineration plants, landfill sealing, recycling shares).

3. For the commissioner and especially the final target group of a report (customers of the product under study), it is difficult to set findings in perspective as they are not used to the metrics of LCA and have no feeling what the consequences of the release of e.g. 1 kg of CO2-eq would be. With bare numbers on several single emissions, the values give no order of relevance and little encouragement for improvement. The PCR and the ISO-standards give no indications on how to foster such an encouragement.

3.3 Solutions

1. For the project at hand ecoinvent unit processes were screened to determine direct emissions to the environment for lubricant oil and paint used in infrastructure and core processes. Where the emissions made more than 2% of total process related emissions according to the assessment criteria, they were included in the parameter model.

2. To get the indicator results requested according to the PCR, information was exported from the life cycle inventory data and hand-picked to be presented together with the impact assessment. To improve workflows in other consulting companies, this lack of user-friendliness was reported to the developer of a common LCA-software. They agreed to provide a more comprehensive EPD methodology with their next release. Nevertheless, it is also questionable if an extensive list of single emissions reported in an EPD can lead to better choices by the decision maker. Also, here more guidance by PCR developers would be necessary.

3. To set things in perspective it could be helpful to show results in comparison with best available technology, average technology and on an individual as well as on a national or global scale.

4. Developing a key parameter model proofs to be a valuable tool for simplifying the work on EPD for several similar products in one product group.

4. Suggestions for general improvements

It is suggested, that product category rules (PCR) include more detailed, practical guidance on how to fit a certain process into the life cycle structure as shown in Figure 1. Additionally, it is suggested, that providers of LCA software include an LCIA methodology to easily access all indicator information requested by the EPD-framework.

The PCR ideally also provides sources for information on how to put EPD results in perspective. Such sources could include a list of former EPDs and links to international environmental target values. So far PCR do not deal sufficiently with the requirements for such simplified tools. Requirements for the review of the tool and the publication of results should be integrated in the PCR.

5. Discussion

The purpose of this paper and conference presentation is to show some shortcomings in common PCRs and initiate a discussion about the usefulness of EPD. It contains only some subjectively selected
examples. The authors neither claim to deliver a comprehensive paper nor a perfect solution. In the best case, the here mentioned examples are useful as a starting point for further discussions and improvements in the general PCR-framework.

References
1. Jungbluth N, *Key parameter model for the calculation of the EPD of hydropower plants* 2018, ESU-services GmbH: Schaffhausen, CH.
2. PCR CPC 17, *Product Category Rules (PCR) for preparing an Environmental Product Declaration (EPD) for Electricity, Steam, and Hot Water Generation and Distribution, Product Group Classification UN-CPC 171 and 173*. 2019, The International EPD Consortium (IEC). Retrieved from www.environdec.com.
3. Jungbluth N, Annaheim J, & Meili C, *Environmental report and product declaration 2018*. 2019, ESU-services GmbH: Schaffhausen, CH. Retrieved from http://esu-services.ch/news/reporting/.
4. Flury K & Frischknecht R, *Life Cycle Inventories of Hydroelectric Power Production*. 2012, ESU-services Ltd.: Uster. Retrieved from www.esu-services.ch/data/public-lci-reports/.
5. Itten R, Frischknecht R, & Stucki M, *Life Cycle Inventories of Electricity Mixes and Grid*. 2012, ESU-services Ltd.: Uster, Switzerland. Retrieved from www.esu-services.ch/data/public-lci-reports/.
6. Frischknecht R, Jungbluth N, Althaus H-J, Doka G, et al., *Overview and Methodology*. 2007, CD-ROM, ecoinvent report No. 1, v2.0, Swiss Centre for Life Cycle Inventories: Dübendorf, CH. Retrieved from www.ecoinvent.org.
7. Frischknecht R, Büsser Knöpfel S, Flury K, & Stucki M, *Ökofaktoren Schweiz 2013 gemäss der Methode der ökologischen Knappheit: Methodische Grundlagen und Anwendung auf die Schweiz*. 2013, Umwelt-Wissen Nr. 1330, tieze und ESU-services GmbH im Auftrag des Bundesamt für Umwelt (BAFU): Bern. Retrieved from www.bafu.admin.ch/uw-1330-d.