Review Statement

Validation of LCI data and reports of the project "Update of life cycle inventory data for natural gas and crude oil supply to Switzerland and Europe with the reference year 2019"

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Introduction

In the reports, the SimaPro database, and the connected datasets under review here, ESU-services Ltd. updated the life cycle inventory data for the crude oil and natural gas supply for Switzerland and Europe.

The ecoinvent Centre is an important supplier of high quality life cycle inventory (LCI) data, which is used frequently by companies, research institutes and public entities, such as the Swiss Federal Office for the Environment (Bundesamt für Umwelt, BAFU) and the Swiss Federal Department of Environment, Transport, Energy and Communications (Eidgenössischen Departemente für Umwelt, Verkehr, Energie und Kommunikation, UVEK). However, the present data for natural gas and mineral oil products in ecoinvent v3.7 are outdated.

Therefore, BAFU and the Swiss Gas Industry Association (Verband der Schweizerischen Gasindustrie, VSG) have commissioned an update of the UVEK database according to the methodological guidelines of ecoinvent v2 and to provide the data in the EcoSpold v1 format (XML). The data will be implemented in the database presently used for LCA work conducted on behalf of Swiss authorities.

This project is based on former reports on this subject which formed the starting point for the investigation [Faist Emmenegger et al. 2015; Meili / Jungbluth / Annaheim 2018; Meili / Jungbluth / Wenzel 2018; Schori / Frischknecht 2012]. This update focused on the Swiss perspective for the supply of crude oil and natural gas but also provided the data for the average European (EU28) supply.

The following stages were included in the update according to their importance for the Swiss market in separate reports:

- Natural gas and crude oil extraction
- Crude oil mix and transports to refinery
- Natural gas transport and supply for the Swiss and European market (high and low pressure)

General remarks

All data and reports investigated in this project were validated according to chapter 9.4 of the DQR ecoinvent v2 (ecoinvent Report "Overview and Methodology - Data v2.0") [Frischknecht et al. 2007].

The following documents were subject to review:

- Report: Christoph Meili; Niels Jungbluth; Maresa Bussa (2021) Life cycle inventories of crude oil and natural gas extraction. ESU-services Ltd. commissioned by BAFU & VSG, Schaffhausen, Switzerland, (Final version: 05/27/21)
- Report: Christoph Meili; Niels Jungbluth; Maresa Bussa (2021) Life cycle inventories of long-distance transport of crude oil. ESU-services Ltd. commissioned by BAFU & VSG, Schaffhausen, Switzerland, (Final version: 05/27/21)
- Report: Maresa Bussa; Niels Jungbluth; Christoph Meili (2021) Life cycle inventories for longdistance transport and distribution of natural gas. ESU-services Ltd. commissioned by BAFU & VSG, Schaffhausen, Switzerland, (Final version: 05/27/21)
- About 100 datasets in XML format (EcoSpold v1) representing the new unit processes in the oil/gas supply chain linked to the SimaPro database
- The SimaPro database with the new data connected to the background systems to achieve complete cradle-to-gate LCI and LCIA results for the oil and gas supply in the Swiss and European market. (Final version: 05/18/21)

The review process was initiated in October 2020 and completed on 28 May 2021. The draft study reports, datasets and the SimaPro database were provided to the reviewers.

This review statement is only valid for the specific reports, data and database mentioned above, but not to any other report versions, derivative reports, excerpts, press release, and similar documents.

Completeness of the documentation

All new datasets are described transparently in the report, and all necessary meta information and flow data is available for each dataset. All SimaPro datasets include references to the respective report. For unchanged datasets from previous reports proper references are included.

Consistency with the quality guidelines

The reviewers checked whether the unit processes have been modelled according to the ecoinvent quality guidelines [Frischknecht et al. 2007]. The quality guidelines cover for example the estimation of transport distances or the calculation of energy demands in the inventory.

Plausibility check of the life cycle inventory data

Selected input and output flows were checked for plausibility. The validation showed that the life cycle inventory data is very detailed and contains all relevant inputs and outputs for natural gas and crude oil production, transport, and distribution. Changes to the previous version as for example for the emissions to air are transparently documented and justified.

Completeness of inputs and outputs

From the perspective of the reviewers' environmental and technical knowledge the modelled flows are complete. When unclear, certain aspects were discussed and confimed with the practitioners.

Mathematical correctness of calculations

Selected inputs and outputs e.g. the methane emission breakdown and CO_2 emisisons, were controlled in view of mathematical correctness, and considered as meaningful and explainable.

Reviewers' feedback

The reviewers gave feedback to the practitioners. In 3 iteration rounds around 170 comments were compiled, discussed, and successfully addressed. The reviewers acknowledge the unrestricted access to all requested information, the dedicated efforts of ESU to address the comments provided, as well as the open and constructive dialogue during the review process.

Final statement

Overall, the reports, datasets and the connected model can be considered very detailed and robust. The reviewers found the methodology and its execution to be adequate for the defined purposes of the study. Furthermore, underlying data, the model, assumptions and calculations are appropriate and valid and lead to plausible results. The interpretation reflects the results in a suitable manner, discusses uncertainties as well as perspectives for future improvement of the environmental performance.

A particular challenge was the fact that the reviewed reports and data sets include parts that were transferred unchanged from the earlier versions of the model. These data were not reviewed. The reviewers recommend an update of at least some of these older data sets. The most important ones are included in the list of suggestions in the next section.

Recommendation for future updates

The following list comprises suggestions to improve the results of the model of oil and gas extraction and transport in follow-up projects. Most of these points were discussed with the ESU practitioners during the review process and are also listed in the respective outlook sections of the reports.

- It is recommended to update the LCI for the gas and the crude oil import mix regularly as this has a strong influence on the overall results. Also, the knowledge about methane emission in the oil and gas industry is evolving quickly (e.g., a whole range of dedicated research satellites has been launched recently).
- It is recommended to build a similar model based on ecoinvent v3 data and related modelling standards and to have it incorporated into the ecoinvent database.
- The LCI is built up for different life cycle stages. It is recommended to do an assessment and interpretation of the global warming potential of each step and the full chain, in order to better understand possible deviations from data sources like the analysis in the World Energy Outlook 2018 [IEA 2018, page 486ff] or in [Masnadi et al. 2018]. Such comparison would also allow to separate the influence of the more recent methane emission data from the other GWP contributions.
- A full LCA of the presented LCI data is also recommended as it would give the opportunity to improve the environmental impact of the Swiss and European oil and gas consumption.

- More recent data for the natural gas transmission and distribution infrastructure are available. It would be recommended to update the material needs for different infrastructure facilities (pipelines, liquefaction facility, etc) and the infrastructure requirements of the transport processes (e.g. km pipeline/m³ natural gas transported). The infrastructure for seasonal storage of natural gas is not yet considered in the inventories. Its relevance should at least be estimated roughly. The energy demand and emission factors of the gas turbines for modelling of the transport and distribution activities are based on older data and rough estimates and should be updated as well.
- As the import of LNG is increasingly important for the European natural gas supply, it is recommended to investigate the process in more detail in a future update.
- Data for shipping of crude oil and especially associated sulphur dioxide emissions are outdated and do not reflect the implementation of the IMO 2020 reduction in maximum sulphur content for marine fuel [IMO 2020]. An update is recommended.
- A distinction between conventional and unconventional oil and gas production is desirable, especially with a potential increase in the share of unconventional LNG from the USA in the future.
- The assessment of methane releases from oil and gas fields shows that abandoned or closed oil and gas fields still can lead to emissions of methane in future. An estimate of these emissions should be included in a future update.
- Due to the availability of more specific national data on flaring of associated petroleum gas (APG) and unintentional methane emissions during oil production, and its high relevance for the country-specific environmental impacts of crude oil extraction, the composition of the crude oil import mix gets a higher importance.
- The re-injection of CO_2 as a means of carbon capture storage (CCS) and a replacement of injected water might become more important and thus should be included in the analysis.

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References

Faist Emmenegger, M.; Del Duce, A.; Zah, R. (2015): Update and extension of the inventory data for energy gases. Quantis.

Frischknecht, R.; Jungbluth, N.; Althaus, H.-J.; Doka, G.; Heck, T.; Hellweg, S.; Hischier, R.; Nemecek, T.; Rebitzer, G.; Spielmann, M. (2007): Overview and methodology. ecoinvent report.

IEA (2018): World Energy Outlook 2018. IEA. S. 661.

IMO (2020): IMO 2020 – cutting sulphur oxide emissions. https://www.imo.org/en/Media-Centre/HotTopics/Pages/Sulphur-2020.aspx. (27.05.2021).

Masnadi, M. S.; El-Houjeiri, H. M.; Schunack, D.; Li, Y.; Englander, J. G.; Badahdah, A.; Monfort, J.-C.; Anderson, J. E.; Wallington, T. J.; Bergerson, J. A. (2018): Global carbon intensity of crude oil production. In: *Science*. American Association for the Advancement of Science. Vol. 361, No.6405, S. 851–853.

Meili, C.; Jungbluth, N.; Annaheim, J. (2018): Life cycle inventories of crude oil extraction. In: *ESU-services Ltd Fair consuting in sustainability*.

Meili, C.; Jungbluth, N.; Wenzel, P. (2018): Life cycle inventories of long distance transport of crude oil. In: *ESU-services Ltd. Commission ed by BFE, BAFU, Erdöl-Vereinigung, Schaffhausen, Switzerland*.

Schori, S.; Frischknecht, R. (2012): Life Cycle Inventory of Natural Gas Supply. ESU-services Ltd. S. 124–124. *http://treeze.ch/fileadmin/user_upload/downloads/PublicLCI/Schori_2012_NaturalGas.pdf%0Aesu-services.ch/fileadmin/download/publicLCI/Schori_2012_NaturalGas.pdf*.