

ライフサイクルアセスメント

生命週期評估

전 과정 평가

வாழ்க்கை வட்டப் பகுப்பாய்வு

ارزیابی چرخه عمر

Evaluarea Ciclului de Viață

Posuzování Životního Cyklu

Bizi zikloaren analisi

Olelusringi hindamine

Lífssferilsgreining

Levenscyclusanalyse

Livscyklusvurdering

29 years experience in LCI modelling for
oil and gas extraction: developments and
challenges in updating LCI data

Niels Jungbluth, Christoph Meili, Maresa Bussa
ESU-services Ltd., Schaffhausen, Switzerland



29 years experience in LCI modelling for oil and gas extraction: developments and challenges in updating LCI data

Niels Jungbluth, Christoph Meili, Maresa Bussa
ESU-services Ltd., Schaffhausen, Switzerland



84th LCA Discussion Forum - LCA development

Did we forget about data? Challenges and needs

Thursday, 21 September 2023, ETH Zentrum campus, GEP-Pavillon and online



Dr Niels Jungbluth

Clients from industry, NGOs, administration, universities

25+ years and 400 projects experience in life cycle assessment

We assist you

Founded 1998 @ETHZ



Samuel Solin Christoph Meili Dr Maresa Bussa Martin Ulrich

Company database with more than ten thousands of datasets

All economic sectors covered

My most relevant LCI projects for oil and gas extraction

- *Ökoinventare von Energiesystemen (1994, 1996)*
- LCA of kerosene and LPG in India (1994-1996)
- Erdöl und Erdgas (ecoinvent 2000, 2003 und 2007)
- LCI oil products (BAFU, BFE, Erdölvereinigung, 2018)
- LCI oil and gas supply (BAFU & VSG, 2021)
- LCI oil and gas (ecoinvent v3.9.1, 2022 and v3.10, ongoing)

First comprehensive LCI in 1994-96: Ökoinventare von Energiesystemen LCA of LPG and kerosene in India

- Estimates partly based on bottom-up approaches
- Data available from measurements done e.g. at universities
- Comprehensive inventory of pollutants, e.g. detailed emission profiles for single NMVOC
- Literature sources in printed format
- Direct contacts e.g. to oil extracting companies and refineries
- No electronic documentation, only numbers

Updates 2000-2003: ecoinvent v1 and v2

- Some data are available in environmental reports of single companies
- Focus on energy use and main pollutants
- No newer data for many pollutants reported in the first version
- Different data sources with different scopes had to be combined for an estimate
- EcoSpold v1 for electronic documentation

Updates in 2016-21: UVEK/KBOB/ESU databases

- Most information available on the internet
- Data available from global statistics, large measurement campaigns or industry associations
- More information found for European situation and less for Africa, Russia or Middle East
- Reports of global oil companies cannot be assigned to single countries nor single stages often only relative changes are shown → **Not suitable for LCI work anymore**
- Focus on literature on main air pollutants like NO_x, SO_x, NMOVC, CO
- No current information found for specific pollutants reported in former versions (heavy metals, single NMVOC, water pollutants)

Archetype models for LCI based on global statistics

	B	F	G	J	K	L	P	Q	R	V	W	X	AB	AC	AD	AE
	US_obs	Name	Location	InfrastructureProcess	Unit	combined gas and oil production offshore	crude oil, at production offshore	natural gas, at production offshore	combined gas and oil production onshore	crude oil, at production onshore	natural gas, at production onshore	combined gas and oil production	combined gas and oil production offshore	combined gas and oil production onshore	Data for this scenario	Explanation for Data entry
		Location				US_obs	US_obs	US_obs	US_obs	US_obs	US_obs	US_obs	US_obs	US_obs	US_obs	
		InfrastructureProcess				0	0	0	0	0	0	0	0	0	2016_obsolete	
		Unit				a	kg	Nm3	a	kg	Nm3	a	kg OE	kg OE	kg OE	
resources, in ground		Oil, crude	-	-	kg	1.02E+11	100%		4.54E+11	100%		5.56E+11			5.56E+11	kg crude oil extracted per country and year (total kg on- and offshore per year)
		Oil, crude	-	-	kg	9.36E+6	100%		4.16E+7	100%		5.09E+7	4.29E-5	4.29E-5	4.29E-05	Value calculated based on entries below.
		Gas, natural/m3	-	-	Nm3	1.38E+11		100%	6.12E+11		100%	7.50E+11			7.50E+11	Billion cubic meters natural gas extracted per country and year (total m3 on- and offshore per year)
water resource		Water, unspecified natural origin,	GLO	-	m3	0	100%	0%	1.63E+8	100%	0%	1.63E+8		3.60E-4	3.60E-04	Fresh water withdrawn for enhanced oil recovery
		Water, salt, ocean	GLO	-	m3	3.68E+7	100%	0%	0	100%	0%	3.68E+7	3.60E-4		3.60E-04	salt water use for offshore production assumed to be the same as freshwater use onshore
		Water, fossil	GLO	-	m3	9.60E+07	100%	0%	2.64E+08	100%	0%	3.60E+08	9.40E-4	5.81E-4	3.60E-04	Line stays empty (used to balance water input and output)
water emission		Water, US_obs	-	-	m3	0	100%	0%	4.27E+8	100%	0%	4.27E+8		9.41E-4	9.41E-01	assumed to be equal to produced water discharged
		Water, US_obs	-	-	m3	1.33E+8	100%	0%	0	100%	0%	1.33E+8	1.30E-3		1.30E+00	assumed to be equal to produced water discharged
		Water, US_obs	-	-	m3	0	100%	0%	0	100%	0%	0	0	0	0.00E+00	Line stays empty (used to balance water input and output)
		discharge, produced water, offshore	OCE	0	kg	1.33E+11	100%	0%	0	100%	0%	1.33E+11	1.30E+0		1.30E+00	Amount of untreated, produced water discharged offshore per kg OE produced offshore
		discharge, produced water, onshore	GLO	0	kg	0	100%	0%	4.27E+11	100%	0%	4.27E+11		9.41E-1	9.41E-01	Amount of untreated, produced water discharged onshore per kg OE produced onshore
technosphere		chemicals inorganic, at plant	GLO	0	kg	1.21E+8	47%	53%	5.36E+8	47%	53%	6.56E+8	5.53E-4	5.53E-4	5.53E-04	Inorganic chemicals used for enhanced oil recovery
		chemicals organic, at plant	GLO	0	kg	9.19E+7	47%	53%	4.09E+8	47%	53%	5.01E+8	4.22E-4	4.22E-4	4.22E-04	Organic chemicals used for enhanced oil recovery
		transport, lorry >16t, fleet average	RER	0	tkm	1.84E+8	47%	53%	8.18E+8	47%	53%	1.00E+9	8.45E-4	8.45E-4	8.45E-04	Distance for chemical transport by lorry (km) multiplied by sum of chemicals (kg)
		transport, freight, rail	RER	0	tkm	1.27E+8	47%	53%	5.66E+8	47%	53%	6.94E+8	5.85E-4	5.85E-4	5.85E-04	Distance for chemical transport by rail (km) multiplied by sum of chemicals (kg)
Infrastructure		well for exploration and production, offshore	OCE	1	m	8.07E+5	47%	53%	0	0%	0%	8.07E+5	3.70E-6		3.70E-06	Average meter of well to produce one kg of oil equivalent
		well for exploration and production, onshore	GLO	1	m	0	0%	0%	1.03E+8	47%	53%	1.03E+8		1.06E-4	1.06E-04	Average meter of well to produce one kg of oil equivalent
oil		pipeline, crude oil, offshore	OCE	1	km	0	100%	0	0	0	0	0	0	0	0.00E+00	length of Pipeline to production plant, offshore per kg oil equivalent extracted
		pipeline, crude oil, onshore	RER	1	km	0	0	0	4.25E+3	100%	0	4.25E+3	0	6.95E-9	6.95E-09	length of Pipeline to production plant, onshore per kg oil equivalent extracted

➤ Excel models for extraction and transports facilitate data exchange in different formats

Updates in 2022-23: ecoinvent database

- Global annual statistics (BP, IOGP, Worldbank, IEA)
- Satellite measurements for CH₄ (IEA methane tracker)
- Focused research on water balance (based on IOGP data)
- Established automatized models for transports of oil and gas
- High efforts for electronic documentation

Publication

- Life cycle inventory analysis (LCI and not a full LCA)
- All reports are available on <http://esu-services.ch/data/public-lci-reports/>
- Full SimaPro library including updates for refinery based on UVEK 2018 with latest updates offered by ESU-services
<http://www.esu-services.ch/fileadmin/download/tender/ESU-background-databases.pdf>
- Integration in ecoinvent since v3.9 (only extraction and mixes)

Summary

- Full methane emissions need to be accounted for all products from oil and gas
- Industry measurements do not show the full methane picture
- Changes mainly relevant for cradle-to-gate analysis (plastics, chemicals)
- Changes are relevant for relative comparisons between fossil-based products with biobased and other alternative products
- Regular updates of mixes and methane emissions necessary

Outlook/Suggestion

- Huge changes due to Russian war on mixes, flaring and fugitive emissions expected
- Regular updates of oil/gas mixes, e.g. every 2-3 years and/or usage of 5-year average data
- Link PlasticsEurope and other industry data to up-to-date LCI
- Include future emissions due to abandoned oil and gas fields
- Harmonize and update data for coal (ongoing at PSI)
(effect seems to be of low relevance)

➤ Ask us for extended LCI models for missing countries and/or products

Thank you very much for your attention!

Contact:

jungbluth@esu-services.ch

meili@esu-services.ch

bussa@esu-services.ch

Website:

<http://www.esu-services.ch>

Funding by several institutions

- Swiss federal office for the environment, CH
- Swiss federal office for energy, CH
- ecoinvent, CH
- Carbonminds, DE
- CDLCI Coöperatie U.A., NL
- Avenenergy Suisse, CH
- Gazenergie (VSG), CH
- Plastics Europe, RER
- ESU-services, CH

Here we presented our own personal conclusions

Copyright notice

All rights reserved. The contents of this presentation (a. o. texts, graphics, photos, logos etc.) and the presentation itself are protected by copyright. They have been prepared by ESU-services Ltd.. Any distribution or presentation of the content is prohibited without prior written consent by ESU-services Ltd.. Without the written authorization by ESU-services Ltd. this document and/or parts thereof must not be distributed, modified, published, translated or reproduced, neither in form of photocopies, microfilming nor other - especially electronic - processes. This provision also covers the inclusion into or the evaluation by databases.

Permitted is the use of contents published on our webpage according to scientific standards (small parts copied or cited with clear citation given to the webpage were downloaded).

Contraventions will entail legal prosecution.



In case of any questions, please contact:

Dr. Niels Jungbluth, CEO - Chief Executive Officer
ESU-services Ltd. - fair consulting in sustainability
Rheinstrasse 20
CH-8200 Schaffhausen
www.esu-services.ch
tel +41 44 940 61 32
jungbluth@esu-services.ch