ライフサイクルアセスメント
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전 과정 평가
வாழ்க்கை வட்டப் பகுப்பாய்வு
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Posuzování Životního Cyklu
Bizi zikloaren analisi
Olelusringi hindamine
Lífsferilsgreining
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**Updated LCI for the supply of oil and gas considering all methane releases**

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

Presentation for
Forum for Sustainability through Life Cycle Innovation e.V.
14. September 2022

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Dr Niels Jungbluth

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Samuel Solin | Christoph Meili | Maresa Bussa | Martin Ulrich

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Updates 2018-22 on behalf of the Swiss Federal Offices for the Environment and Energy, the Swiss Gas & Oil Associations and ecoinvent

# EXTRACTION OF CRUDE OIL AND NATURAL GAS

# Project outline

- Full update of data for crude oil and natural gas extraction and transportation
- Reference year 2019
- Documentation of harmonized Life Cycle Inventories
  in SimaPro and EcoSpold v1 format
- Global data sources used where possible
  → consistency, simplification of data collection
- Basis for update of LCI databases used by Swiss authorities (UVEK/KBOB) and ecoinvent v3.9

# Extraction: Updates 2022

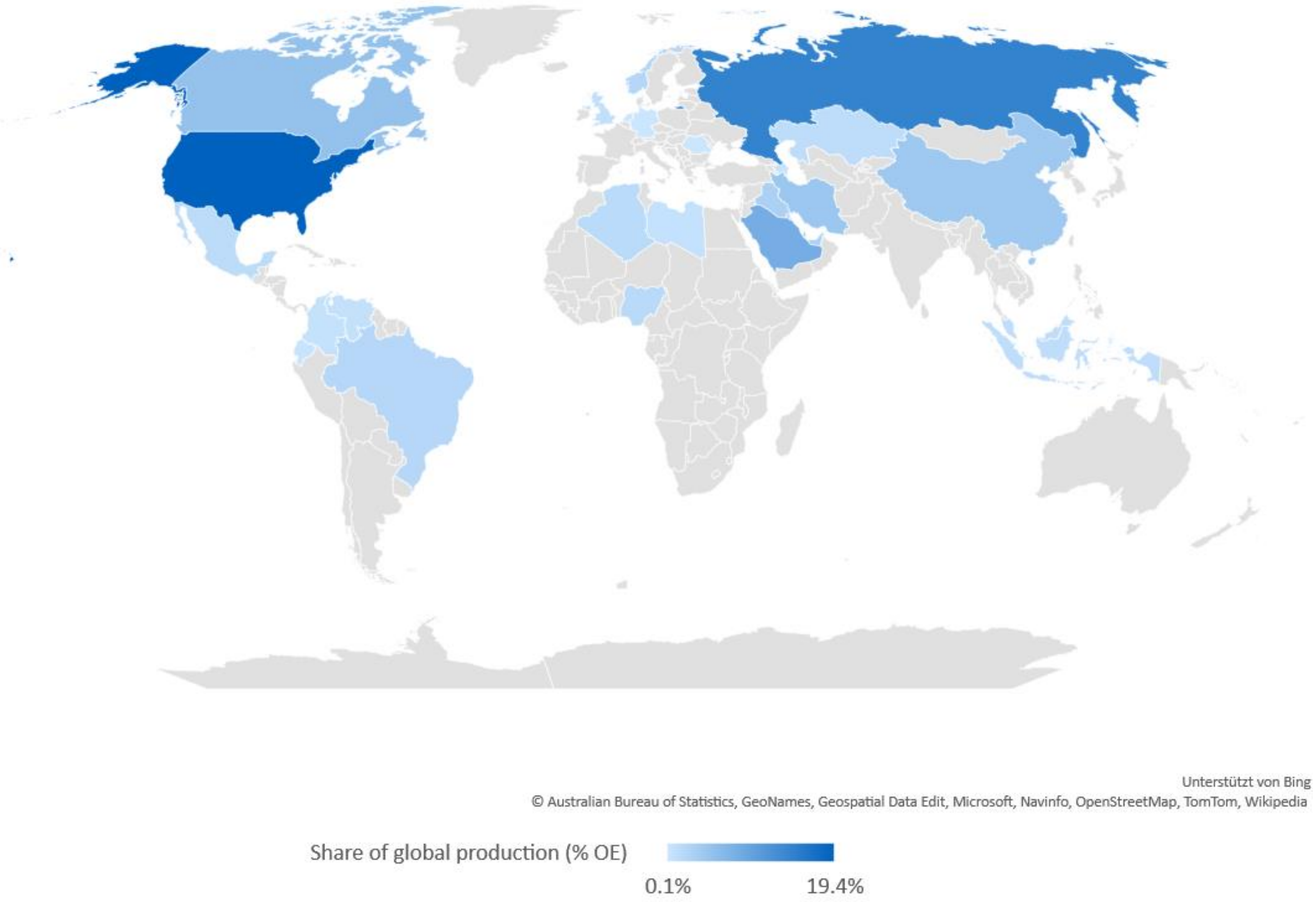
- 27 countries: on- and offshore extraction of crude oil and natural gas
- Focus on most relevant specific data sources
- Country and resource specific data for flaring and methane emissions
- Updated resource, water and energy uses and direct emissions (mainly reported by IOGP)
- Adjusted energy content for allocation
- Fire suppression agents: Halon 1211 replaced by HFC-23

# Selection criteria for 27 countries of extraction to be analysed

- Gas and oil supply mixes for Europe, North America, the global region and Switzerland are analyzed
- Selection by ecoinvent: Countries with share higher than 2% for import mix of natural gas or crude oil to above mentioned regions
- Additionally: Countries with high extraction rates in Latin America (CO, EC, VE)

# Total of 27 extracting countries covered

| Origin | share of global production |
|---|---|
| Unit | % OE |
| United Arab Emirates | 3.0% |
| Azerbaijan | 0.7% |
| Brazil | 2.2% |
| Canada | 5.4% |
| China | 4.3% |
| Colombia | 0.7% |
| Germany | 0.1% |
| Algeria | 1.7% |
| Ecuador | 0.4% |
| United Kingdom | 1.1% |
| Indonesia | 1.2% |
| Iraq | 3.1% |
| Iran | 4.7% |
| Kuwait | 2.0% |
| Kazakhstan | 1.4% |
| Libyan Arab Jamahiriya | 0.8% |
| Mexico | 1.6% |
| Malaysia | 1.2% |
| Nigeria | 1.8% |
| Netherlands | 0.3% |
| Norway | 2.2% |
| Qatar | 2.9% |
| Romania | 0.1% |
| Russian Federation | 14.5% |
| Saudi Arabia | 8.4% |
| United States | 19.4% |
| Venezuela | 0.9% |




➢ Selection covers 86% of global energy production from crude oil and natural gas

# Sources of natural gas emissions

- Release of unburned natural gas to the atmosphere, due to production and processing of crude oil & natural gas.
- In industry: Unwanted release of natural gas in technical process chain, e.g. due to insufficient flaring, accidents or leakage.
- However, it may also occur due to forced changes in geological structures (e.g. due to fracking).

➢ Satellite measurements show that emissions are more diffuse and less connected to the flaring rate than expected by industry

# Flaring, venting and fugitive emissions

- Country-specific satellite data are available for all emission sources
- Flaring for oil and gas combined (Worldbank 2022 & Skytruth 2020)
- Venting and fugitive emissions (IEA 2022) distinguished for
  - oil & gas
  - on- & offshore
  - up- & downstream
  - conventional & unconventional

# Methane emission: consulted and used sources of information (Examples for biggest extracting countries)

| Source | Crippa et al. 2019, data from EDGAR, up- & downstream (2012) | IOGP 2020, upstream only (2019) | UNFCCC 2020, up- & downstream (2018) | UNFCCC 2020, up- & downstream (2018); Production: BP (2018) | IEA 2022, up- & downstream (2019); Production: BP (2019) | **IEA 2022, upstream (2019); Production: BP (2019)** |
|---|---|---|---|---|---|---|
| Unit | kg/kgOE | kg/kgOE | kg/kgOE | kg/kgOE | kg/kgOE | kg/kgOE |
| **Russian Federation** | 8.76E-03 | 1.12E-03 | 6.37E-03 | 6.16E-03 | 1.26E-02 | 1.11E-02 |
| **Saudi Arabia** | 4.45E-03 | 1.00E-04 | n.a. | n.a. | 4.33E-03 | 4.03E-03 |
| **United States** | 8.26E-03 | 1.25E-03 | 1.37E-02 | 5.58E-03 | 9.13E-03 | 7.40E-03 |
| **Global** | 1.01E-02 | 6.01E-04 | 7.93E-03 | 4.15E-03 | 1.06E-02 | 8.86E-03 |

- Methane emissions reported by IOGP "industry data" are order of magnitude lower than calculated from national and global emissions in relation to national and global production data

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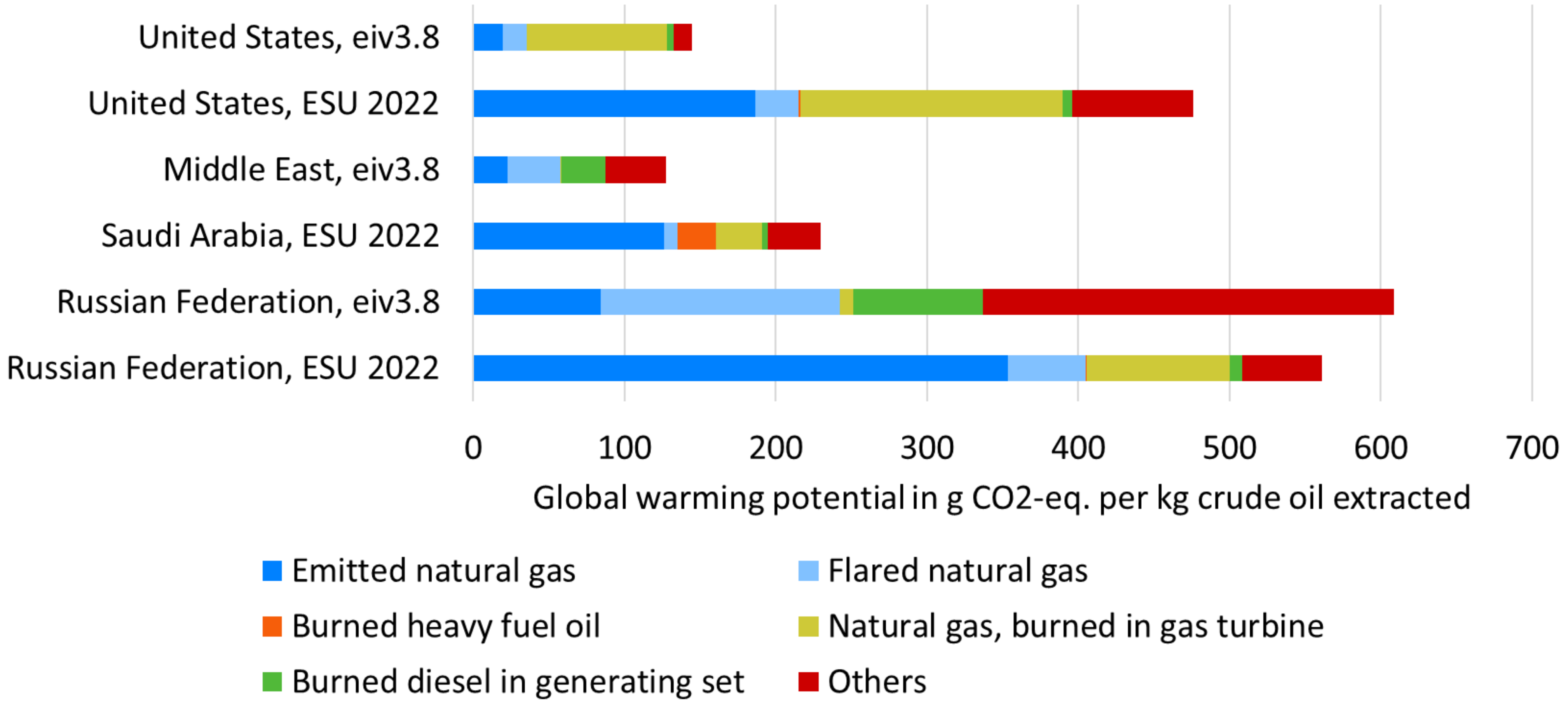
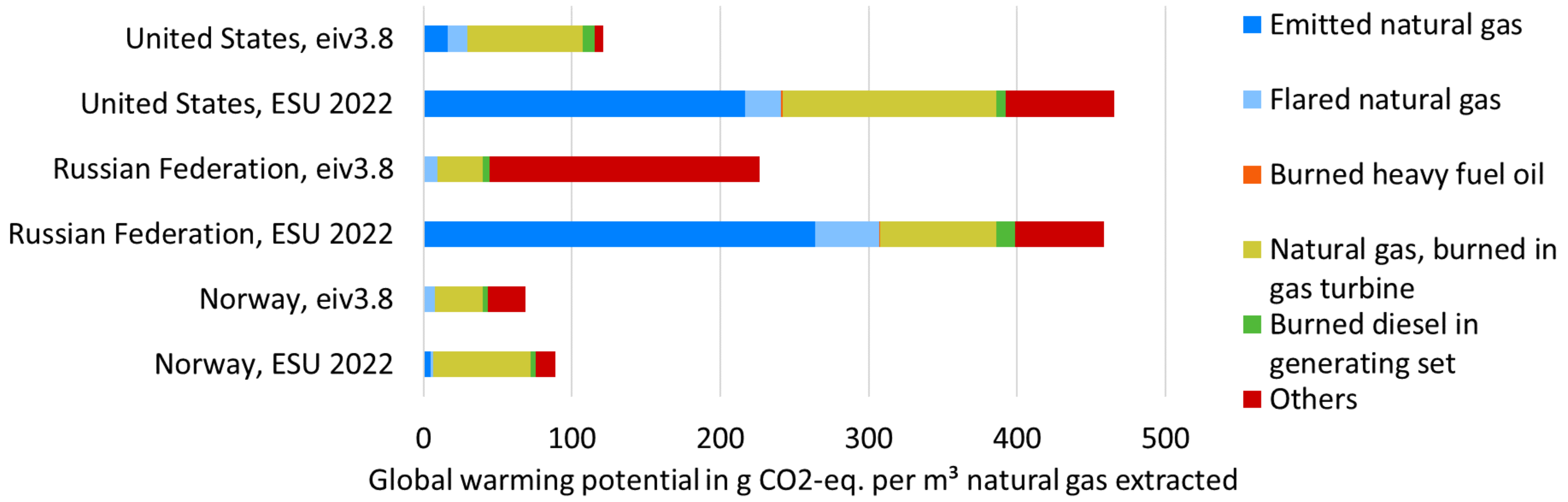
# Crude oil from important extracting countries 2019: GWP 100a in ecoinvent v3.8 compared to our study




➢ New data for methane emissions are significantly higher than bottom-up estimates in former LCI

# Natural gas from selected extracting countries 2019: GWP 100a in ecoinvent v3.8 compared to our study




- Same findings as for crude oil

# Extraction: Global warming potential

- Wide variety of emissions depending on origin
- Main differences due to methane emissions and flaring
- GWP due to direct methane emissions about 9-times higher than reported in ecoinvent v3.8
- Global average about 2.5-times higher than reported in ecoinvent v3.8

# Extraction: Results environmental impacts

- Wide variety of environmental impacts depending on origin
- Main differences in overall impact according to ecological scarcity method due to global warming potential and main air pollutants
- Both depend mainly on flaring and natural gas emissions (e.g. venting, fugitive)

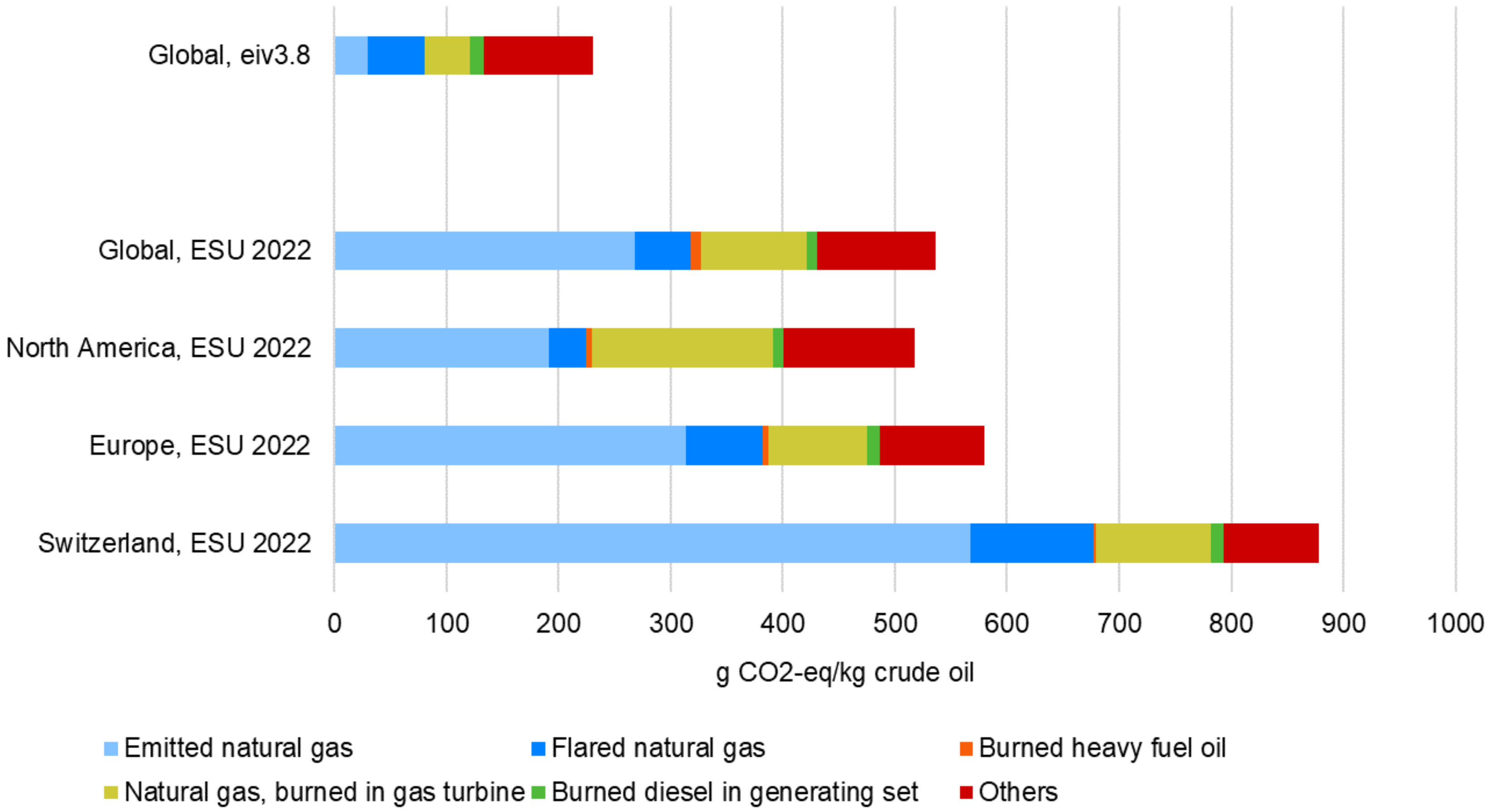
Last update 2022 for 2019

# TRANSPORT AND MIX OF CRUDE OIL FOR REFINERIES

# Crude oil transport: Updates

- Supply mixes for Europe, Norhtern America, Switzerland and global situation
- Same port of origin and destination independent of journey
- Extrapolation from shares of analysed countries to model 100% of the mix
- No updates for infrastructure and direct emissions
- One dataset for modelling average supply to refinery (easier to handle updates)

# Crude oil mix transported to refinery: Results GWP 100a




- ➢ Updated LCI about factor 2.3 higher GWP than in ecoinvent v3.8

# Crude oil transported to refinery: Results

- New datasets show higher GWP due to higher methane emissions in crude oil mix
- Transport itself has small relevance (~2% of GWP)
- Regional import mixes show large variety depending on the origin of crude oil. E.g. Switzerland imported a higher share of crude oil from Libya, where methane emissions were highest compared to other countries.

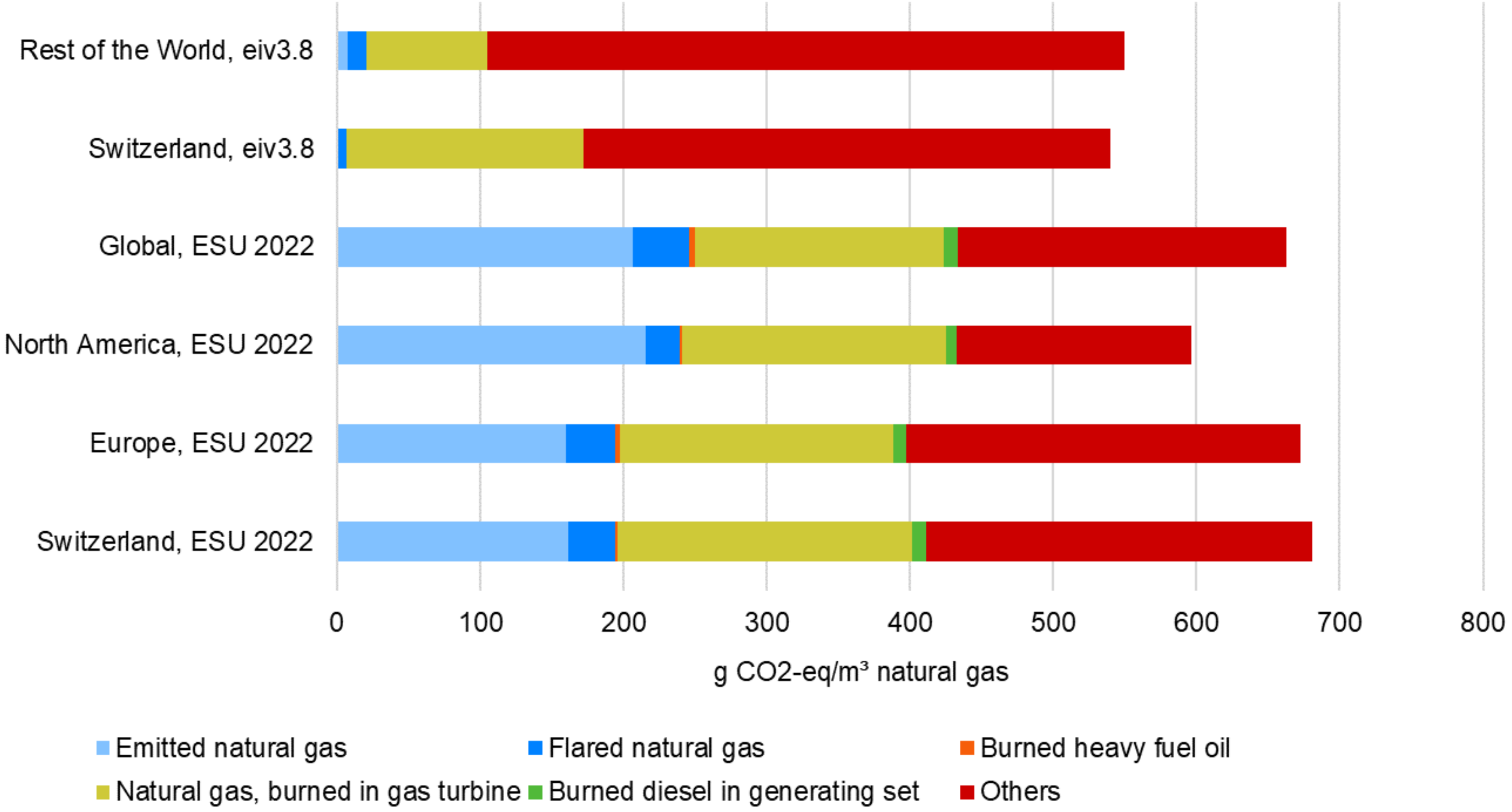
Last update 2022 for 2019

# TRANSPORT, MIX AND DISTRIBUTION OF NATURAL GAS TO END CONSUMERS

# Natural gas transport: Updates in LCI

- Low pressure Supply mixes for GLO, RNA, RER and 12 specific countries with one dataset per importing country (mix and transports) instead of old detailed model
- Energy demand and leakage rates of pipeline transport, regional and local distribution
- Offshore pipeline from RU (North Stream 1)
- Fire suppression agents: Halon 1211 replaced by HFC-23
- Energy demand and emissions of liquefaction and evaporation
- Fuel consumption and emissions of LNG carriers

# Natural gas transport to low pressure:




- ➢ Updated GWP about 20% higher than ecoinvent v3.8
- ➢ Downstream emissions more relevant and thus lower increase

# Key messages natural gas transport

1. Consumption mix plays important role
2. Differentiation between Pipeline and LNG-imports matters
3. Effect of methane from extraction less pronounced than for crude oil due to higher downstream emissions

Own update to harmonize assumptions for cumulative data in 2021

# INFLUENCE ON PLASTICS DATA

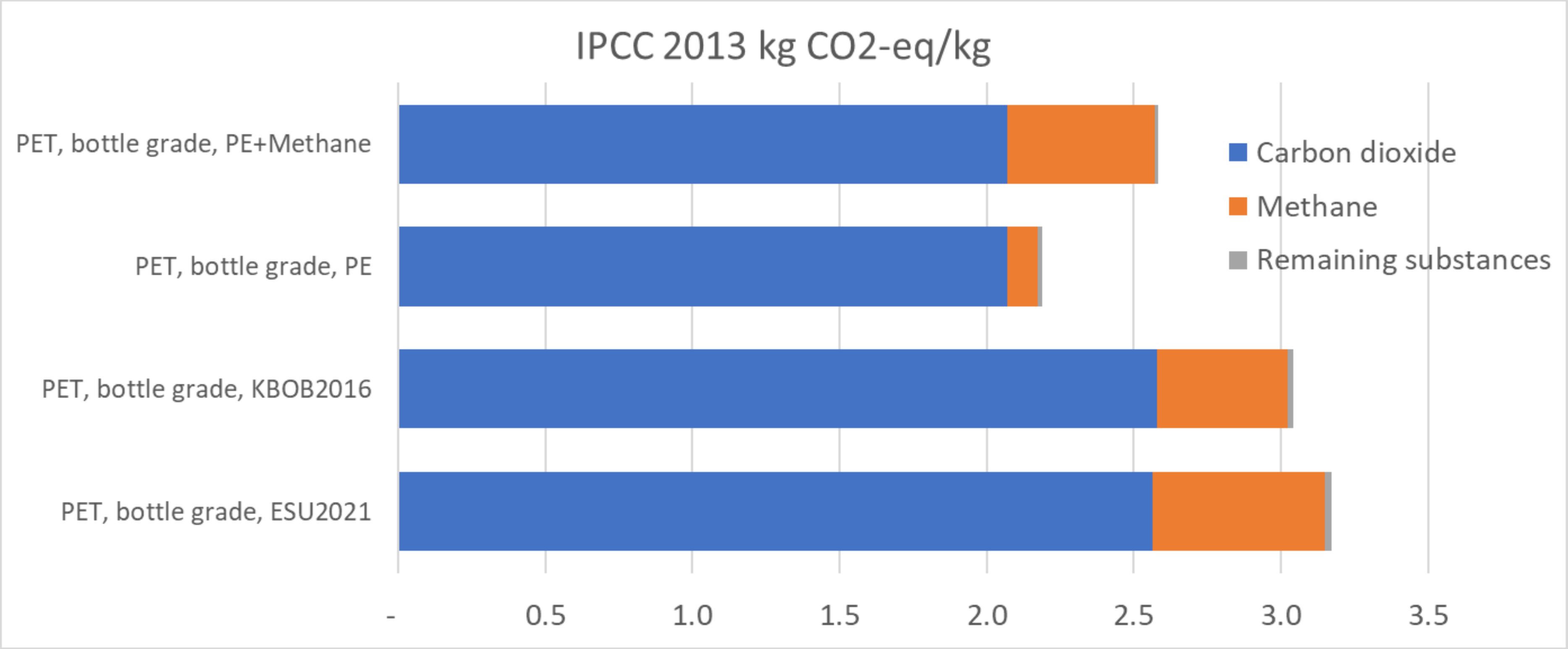
# What is the contribution for plastics?

- Bias for system processes needs to be avoided
- Estimation of surplus methane release based on LCI for crude oil and natural gas resource use

methane, fossil/kg = oil, crude in ground/kg * 0.0135 kg/kg + gas, natural/$m^3$ * 0.0089 kg/$m^3$

- Integrated in system processes provided by Plastics Europe and imported to ESU-database 2022

# Results for plastics, example PET




ESU 2021 – Unit processes with CH4
PE – system processes

KBOB 2016 – Unit processes without CH4
PE+Methane – including methane

- Increase “at gate” due to methane 15-30%
- Effect of methane less pronounced due to further CO2 emissions from fossil fuels
- Data for several plastics integrated in ESU database 2021

Last update published 2018

# PRODUCTION OF OIL PRODUCTS IN REFINERIES

# Updates: Refineries

- Petrol and diesel modelled with low-sulphur (10 ppm) only
- Update of product properties, e.g. carbon and energy content (must be considered for datasets using products!)
- Update for internal energy use and emissions
- Change of allocation for crude input (energy content instead of mass)

# Change of results: oil refinery

- Products with a larger heating value have higher impacts than these with a lower energy content due to allocation based now for more flows on the heating value of the products.
- Increase on renewable energy due to introduction of biogenic fuels in Europe and Switzerland used in the life cycle

# Change of results: oil refinery

| Increase or decrease of indicator results compared to KBOB database | reference value | primary energy factor, total [MJ-eq] | primary energy factor,fossil [MJ-eq] | primary energy factor, nuklear [MJ-eq] | primary energy factor, renewable [MJ-eq] | CO2 equivalents [kg CO2-eq] | eco-points [eco-points 2013] |
|---|---|---|---|---|---|---|---|
| bitumen/RER | 0 | -3.3% | -3.9% | 41.7% | 68.5% | 28.3% | -14.2% |
| diesel/CH | 0 | 4.1% | 3.7% | 44.0% | 66.6% | 54.8% | 21.5% |
| diesel/RER | 0 | 0.1% | -0.3% | 40.7% | 72.6% | 34.7% | -10.7% |
| heavy fuel oil/RER | 0 | -4.3% | -4.8% | 38.2% | 66.7% | 27.9% | -15.1% |
| kerosene/CH | 0 | 4.0% | 3.6% | 40.5% | 64.2% | 52.5% | 20.8% |
| kerosene/RER | 0 | 0.4% | 0.0% | 39.4% | 72.5% | 32.2% | -11.2% |
| light fuel oil/CH | 0 | 3.5% | 3.0% | 43.2% | 65.6% | 51.8% | 20.3% |
| light fuel oil/RER | 0 | -0.3% | -0.8% | 39.9% | 71.7% | 31.6% | -11.7% |
| naphtha/CH | 0 | 8.1% | 7.3% | 67.0% | 82.9% | 60.7% | 25.6% |
| naphtha/RER | 0 | 4.9% | 4.3% | 52.2% | 77.9% | 42.7% | -5.8% |
| petrol/CH | 0 | 0.5% | -0.1% | 46.7% | 60.2% | 26.1% | 12.7% |
| petrol/RER | 0 | -3.8% | -4.4% | 38.1% | 61.7% | 7.5% | -17.9% |
| propane/ butane/CH | 0 | 10.7% | 10.0% | 61.7% | 77.9% | 54.4% | 26.5% |
| propane/ butane/RER | 0 | 6.2% | 5.6% | 48.3% | 73.1% | 30.7% | -7.5% |
| refinery gas/CH | 0 | 14.7% | 14.3% | 57.4% | 80.5% | 51.8% | 28.6% |
| refinery gas/RER | 0 | 9.2% | 8.7% | 49.5% | 81.8% | 23.4% | -8.4% |

- Products with a larger heating value show higher impacts
- Increase on renewable energy due to introduction of biogenic fuels in Europe and Switzerland used in the life cycle

# Interpretation

- Increase of eco-points for CH products and a decrease for EU products due to harmonization of assumptions
- Increase of the GWP for all products due to new data for methane emissions during crude oil extraction
- No clear trend for the fossil energy demand. Changes due to new allocation factors
- European products have slightly higher energy demand than products of the Swiss refinery. This is mainly due to the higher internal energy use

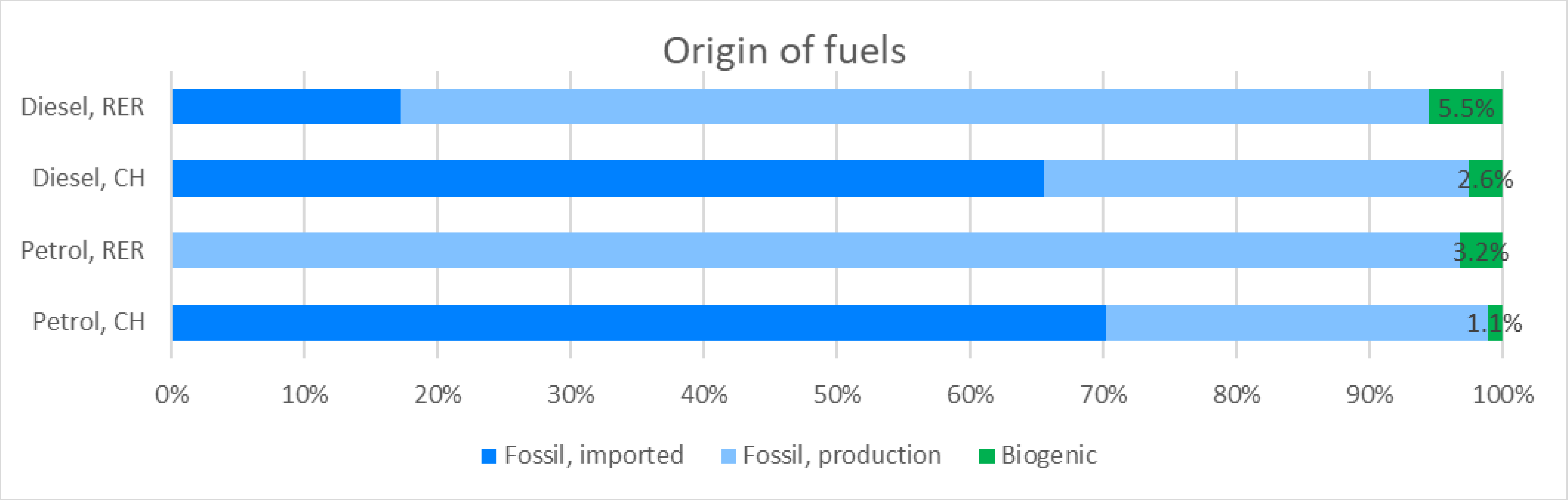
Last update published 2018

# DISTRIBUTION OF OIL PRODUCTS

# Updates: storage and distribution of oil products

- Share of biofuels in transportation fuels modelled at this stage
- Update of fugitive emissions
- Update on transport distances
- No investigation of specific products like E10/85 as not relevant anymore

# Blending with biofuels




- Share of import and domestic biofuels considered
- Biomass feedstocks considered
- Assumption all fuels are blended (average supply of petrol and diesel) and no set a side for “green” fuels sold separately
- Credit for biogenic carbon content to correct the inventories which use these fuel inputs

# Results: storage and distribution

| Refinery products | reference value | primary energy factor, total | primary energy factor,fossil | primary energy factor, nuklear | primary energy factor, renewable | CO2 equivalents | eco-points | primary energy factor,fossil | Lower heating value |
|---|---|---|---|---|---|---|---|---|---|
| | | MJ-eq | MJ-eq | MJ-eq | MJ-eq | kg CO2-eq | eco-points 2013 | MJ-eq/MJ | MJ-eq/kg |
| diesel/CH | kg | 54.8 | 53.8 | 0.74 | 0.25 | 0.79 | 1'312 | 1.25 | 43.0 |
| diesel/RER | kg | 56.6 | 53.1 | 0.96 | 2.34 | 0.79 | 1'587 | 1.24 | 43.0 |
| heavy fuel oil/CH | kg | 52.8 | 51.5 | 1.03 | 0.29 | 0.77 | 1'256 | 1.25 | 41.2 |
| heavy fuel oil/RER | kg | 52.5 | 51.4 | 0.84 | 0.28 | 0.76 | 1'209 | 1.25 | 41.2 |
| kerosene/CH | kg | 55.9 | 54.5 | 1.02 | 0.32 | 0.84 | 1'306 | 1.26 | 43.2 |
| kerosene/RER | kg | 55.7 | 54.6 | 0.80 | 0.27 | 0.85 | 1'292 | 1.26 | 43.2 |
| light fuel oil/CH | kg | 55.8 | 54.4 | 1.03 | 0.31 | 0.85 | 1'327 | 1.27 | 42.9 |
| light fuel oil/RER | kg | 55.7 | 54.6 | 0.82 | 0.28 | 0.86 | 1'308 | 1.27 | 42.9 |
| naphtha/CH | kg | 57.7 | 56.1 | 1.27 | 0.37 | 0.83 | 1'361 | 1.25 | 45.0 |
| naphtha/RER | kg | 57.5 | 56.2 | 1.03 | 0.34 | 0.84 | 1'341 | 1.25 | 45.0 |
| petrol/CH | kg | 56.9 | 54.5 | 1.28 | 1.08 | 0.88 | 1'412 | 1.28 | 42.6 |
| petrol/RER | kg | 57.1 | 54.1 | 1.09 | 1.85 | 0.86 | 1'546 | 1.27 | 42.6 |

- Most changes explained by changes until refinery and due to oil extraction
- Biofuels used for blending are very relevant for eco-points and renewable energy → Higher eco-points for European fuels with agricultural biomass

Last update published 2018

# HEATING WITH OIL PRODUCTS

# Updates: Heating with light fuel oil

- Update of key air emissions and efficiencies with new data
- Renaming of main datasets to “average” in order to reflect today average technology
- Better explanation of efficiency and temperature levels
- Keep differences between “burned in” and “heat, at” in ESU-database to allow the easy change of working conditions and efficiency of heating

# Results: oil heatings

| technology | reference value | primary energy factor, total | | eco-points | | CO2 equivalents | |
|---|---|---|---|---|---|---|---|
| | | MJ-eq | | eco-points | | kg CO2-equivalents | |
| light fuel oil, 10kW, non-modulating | MJ | 1.42 | 1.44 | 75.8 | 78.1 | 0.096 | 0.101 |
| light fuel oil, 10kW condensing, non-modulating | MJ | 1.34 | 1.36 | 71.7 | 73.6 | 0.090 | 0.095 |
| light fuel oil, 100kW, non-modulating | MJ | 1.39 | 1.41 | 73.8 | 75.8 | 0.095 | 0.100 |
| light fuel oil, 100kW condensing, non-modulating | MJ | 1.31 | 1.32 | 69.8 | 71.4 | 0.090 | 0.094 |
| light fuel oil, 1MW, CH | MJ | 1.36 | 1.38 | 77.2 | 70.5 | 0.094 | 0.099 |
| light fuel oil,1MW, RER | MJ | 1.37 | 1.37 | 79.5 | 70.2 | 0.094 | 0.099 |
| heavy fuel oil, 1MW, CH | MJ | 1.39 | 1.36 | 85.8 | 83.4 | 0.098 | 0.101 |
| heavy fuel oil, 1MW, RER | MJ | 1.43 | 1.35 | 111.4 | 83.1 | 0.098 | 0.101 |
| **Source** | | KBOB v2.2: 2016 | This study | KBOB v2.2: 2016 | This study | KBOB v2.2: 2016 | This study |

- Lower eco-points for European heavy fuel oil burned in industrial furnace due to lowered air emission factors and reduced emissions in the production
- Increase in GWP due to higher venting rates found for crude oil extraction

# CHALLENGES FOR UPDATES IN 2016-22 COMPARED TO 1994-2003

# First version in 1996 Ökoinventare von Energiesystemen

- Estimates often 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

# Updates 2000-2003
# ecoinvent v1 and v2

- More 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 had to be combined for an estimate

# Updates in 2016-22 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 in literature on main air pollutants like CO, $NO_X$, SOx, NMOVC
- No current information found for specific pollutants (heavy metals, single NMVOC, water pollutants) reported in former versions

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# Archetype models for LCI based on global statistics

| | B | F | G | J | K | L | P | Q | R | V | W | X | AB | AC | AD | AE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 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 | combine d gas and oil productio n offshore | combine d gas and oil productio n onshore | Data for this scenario | Explanation for Data entry | D |
| 4 | | Location | | | | US_obs | US_obs | US_obs | US_obs | US_obs | US_obs | US_obs | US_obs | US_obs | US_obs | | |
| 5 | | InfrastructureProcess | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2016_obsolete | | |
| 6 | | Unit | | | | a | kg | Nm3 | a | kg | Nm3 | a | kg OE | kg OE | kg OE | | |
| 14 | 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) | 4 |
| 15 | | 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. | |
| 16 | | 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 c | 3 |
| 17 | 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 | |
| 18 | | 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 | |
| 19 | | 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) | |
| 20 | 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 | |
| 21 | | 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 | |
| 22 | | 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) | |
| 23 | | 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 of | |
| 24 | | 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 or | |
| 25 | 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 | |
| 26 | | 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 | |
| 27 | | 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) | |
| 28 | | 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) /1 | |
| 29 | 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 | |
| 30 | | 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 | |
| 31 | 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 | |
| 32 | | 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 imports

# Publication

- Life cycle inventory analysis (LCI) and not a full LCA
- All reports and data until 2021 edition are available on https://esu-services.ch/data/public-lci-reports/
- Full SimaPro library based on UVEK 2018 with latest updates offered by ESU-services https://www.esu-services.ch/fileadmin/download/tender/ESU-background-databases.pdf
- Integration in ecoinvent v3.9 (only extraction and mixes) ongoing (to be announced by ecoinvent)

# Outlook/Suggestion

- Huge changes due to Russian war on mixes and flaring
- 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 extending LCI models to further countries and products

# Conclusions

- Full methane emissions need to be accounted for all products from oil and gas. Industry data do not show the full picture
- Mainly relevant for cradle-to-gate analysis
- This changes relative comparisons between fossil-based products with biobased products and other alternative products
- Regular updates of mix and emissions necessary

# Thank you very much for your attention!

Contact:

jungbluth@esu-services.ch

meili@esu-services.ch

bussa@esu-services.ch

Website:

https://www.esu-services.ch

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Here we present only our own personal conclusions

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**In case of any questions, please contact:**

**Dr. Niels Jungbluth, CEO - Chief Executive Officer**
**ESU-services Ltd. - fair consulting in sustainability**
**Vorstadt 10**
**CH-8200 Schaffhausen**
**https://www.esu-services.ch**
**tel +41 44 940 61 32**
**jungbluth@esu-services.ch**