Spatial and Temporal Representativeness of the Ecoinvent Datasets and it's Impact on Global Warming Potential

EXLPORING ELECTRICITY DATASETS USED IN LCA

Abeer Ali Khan, Fraunhofer Institute for Solar Energy Systems ISE
13-14th March, 2023
LCA Methodology Harmonization Workshop, Brussels.

Organized by

LIÈGE université   Fraunhofer ISE   TNO innovation for life   UNIVERSITÀ DI SIENA 1240

LCA Methodology Harmonization Workshop, Brussels, 2023
Overview of Electricity Mix

The electricity mix is defined as the share of different energy generating technologies used to produce electricity for specific location and year. The more the share of renewable energy in an electricity mix, the less is its Global Warming Potential (GWP) as renewable energy technologies produce less GHG emissions.

The electricity used in production can have up to **62.7%** and **51.6%** of the GWP impact respectively for a glass-backsheet module produced in China and glass-glass module produced in Europe [1].

Figure: GWP of different electricity producing technologies sourced from LCIA documentation of Ecoinvent 3.9 available in _Ecoquery_. Red and green points signify the maximum and minimum GWP values respectively, as shown by Ecoinvent for each technology.
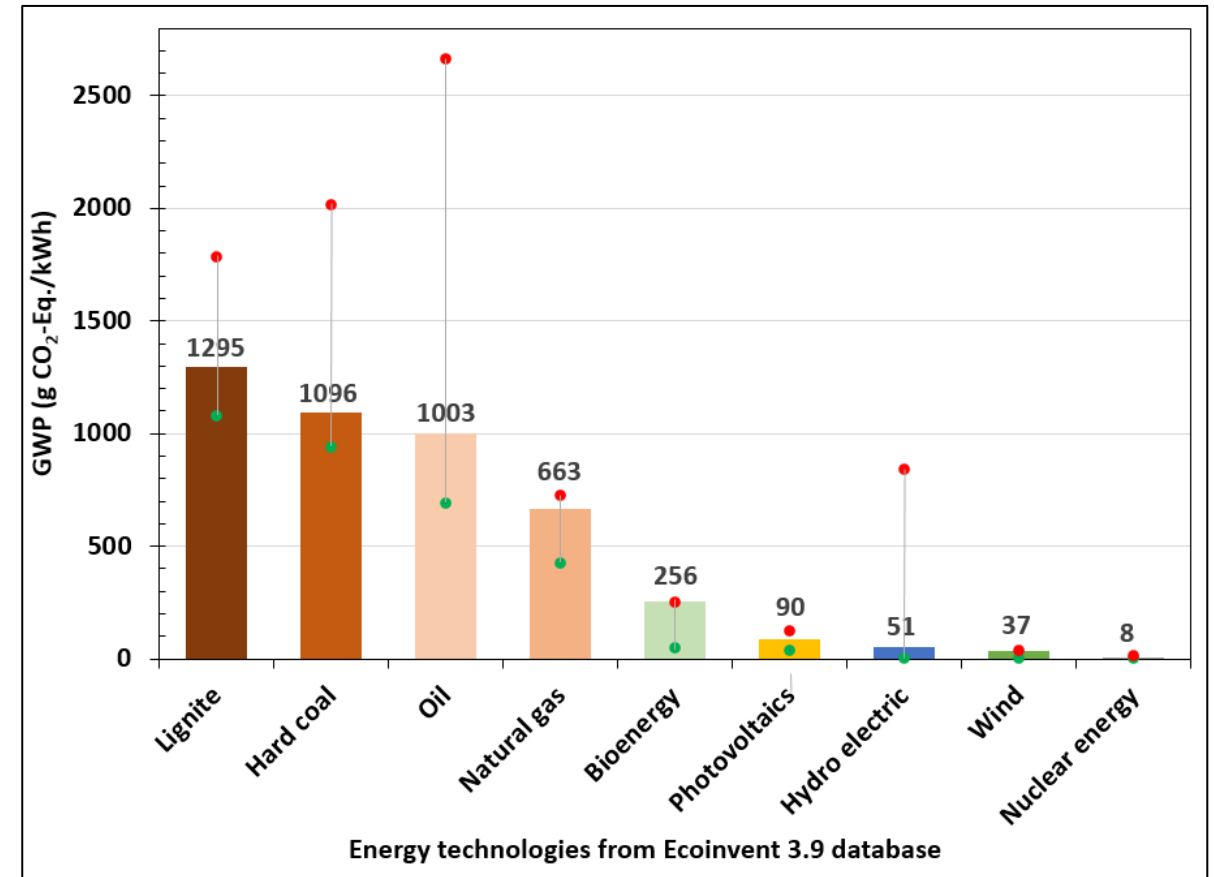
1. Müller A, Friedrich L, Reichel C, Herceg S, Mittag M, Neuhaus DH (2021) A comparative life cycle assessment of silicon PV modules: Impact of module design, manufacturing location and inventory. Solar Energy Materials and Solar Cells 230:111277. doi:10.1016/j.solmat.2021.111277

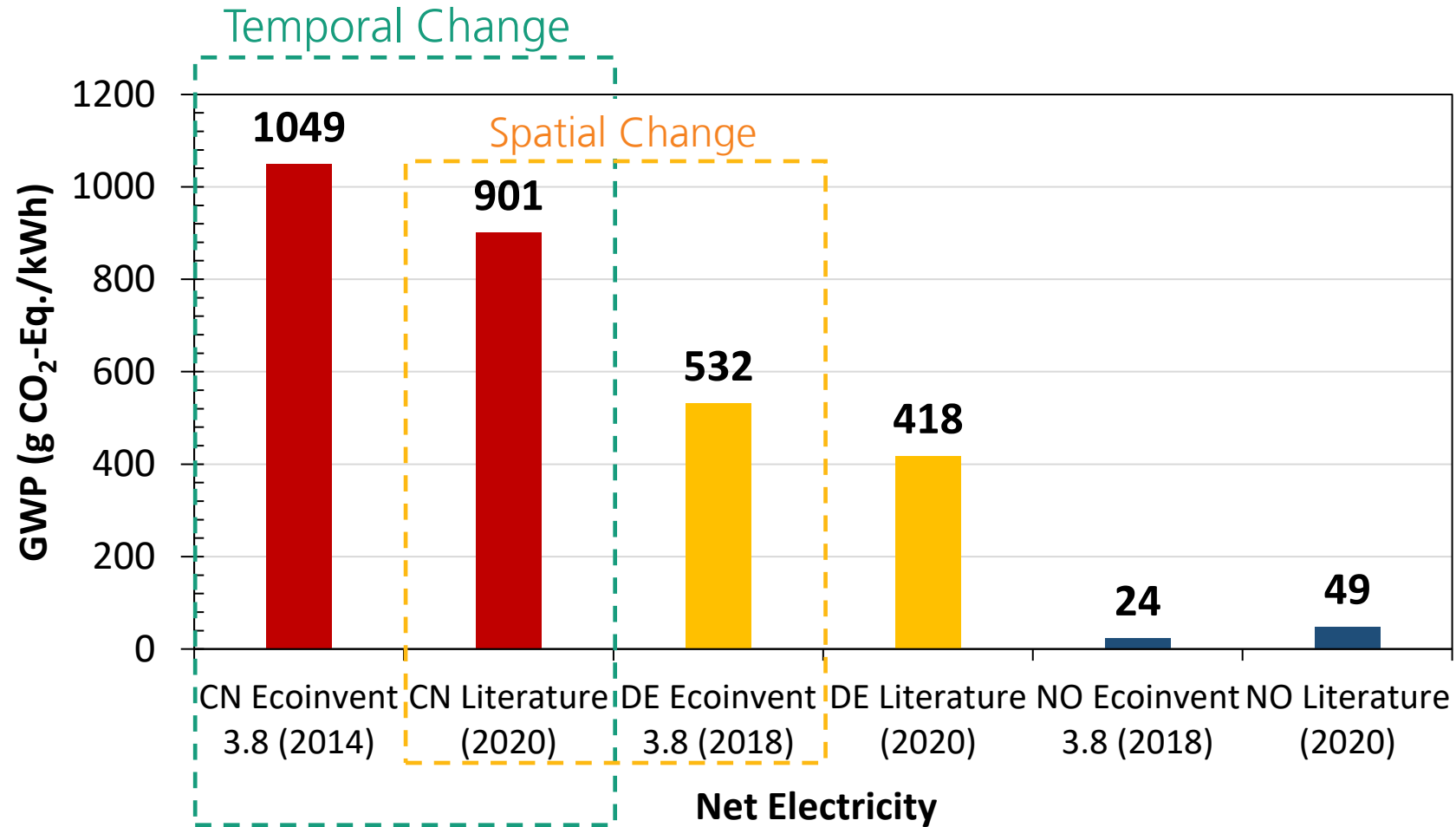# LCA Methodology Harmonization Workshop, Brussels, 2023

Sensitivity of the Electricity Mix to Temporal and Spatial Changes
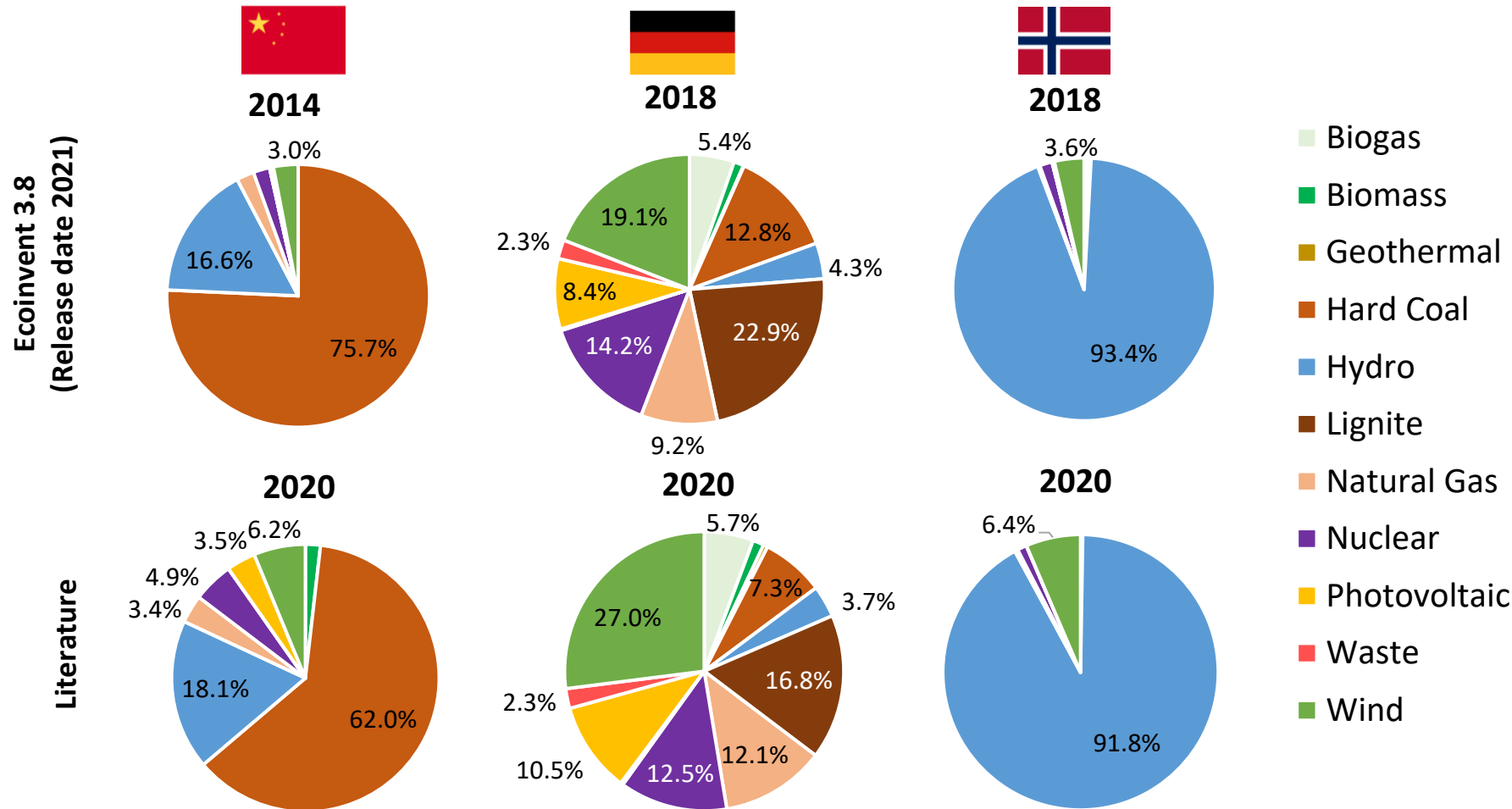
Net electricity mixes are modelled based on the electricity activities of Ecoinvent 3.8 and literature shares for the year 2020. Sources are provided in slide 8.

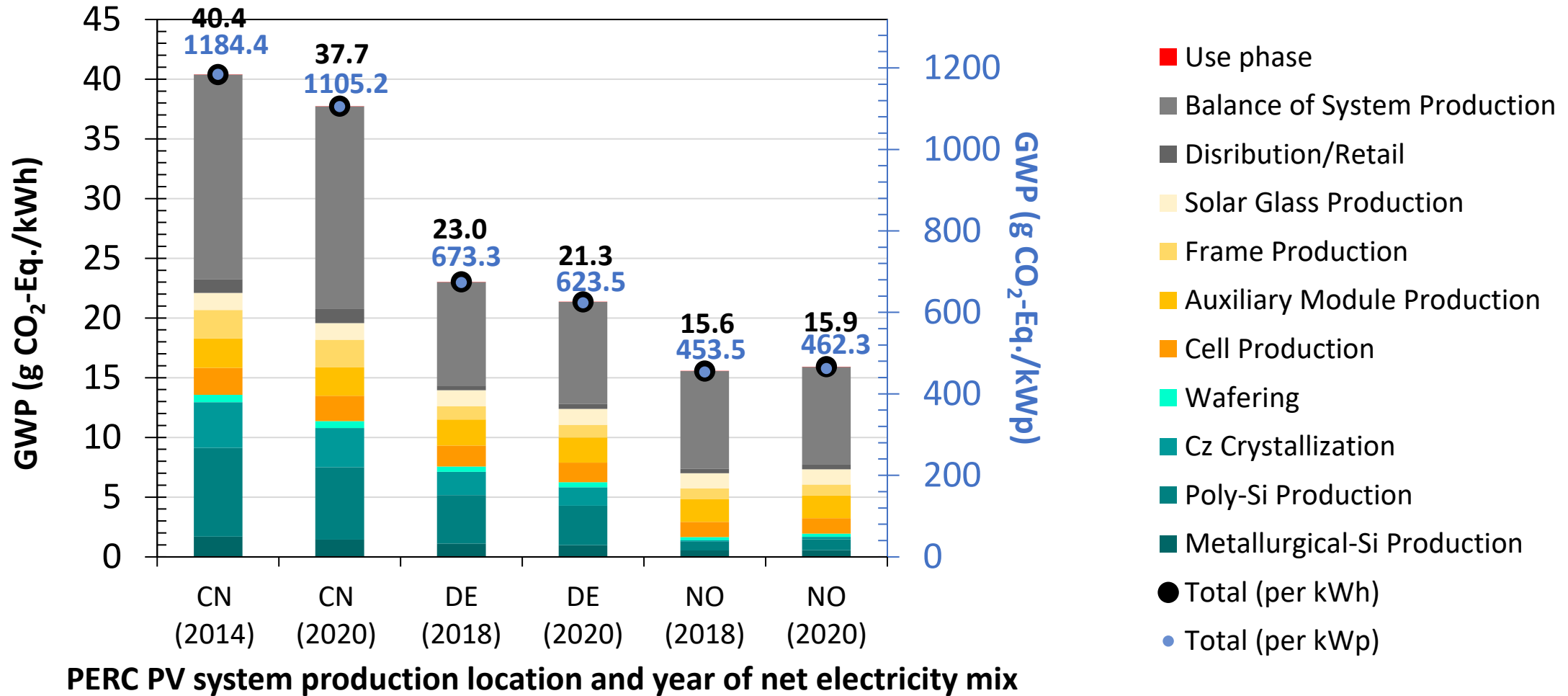# LCA Methodology Harmonization Workshop, Brussels, 2023
Consequent Impact on the GWP of PV LCA

PERC PV system production location and year of net electricity mix

Legend:
- Use phase
- Balance of System Production
- Disribution/Retail
- Solar Glass Production
- Frame Production
- Auxiliary Module Production
- Cell Production
- Wafering
- Cz Crystallization
- Poly-Si Production
- Metallurgical-Si Production
- ● Total (per kWh)
- • Total (per kWp)

LCA Methodology Harmonization Workshop, Brussels, 2023
Discussion: Temporal Representativeness of Electricity Datasets of Ecoinvent Database

Dataset Identification Ecoinvent 3.8

Activity name	market for electricity, low voltage
Geography	DE (Germany)
Time period	2014-01-01 to 2021-12-31 - Valid for the entire period
ISIC rev.4 ecoinvent	3510: Electric power generation, transmission and distribution
Reference product	electricity, low voltage
CPC classification	17100: Electrical energy
Dataset type	Market activity
Technology level	
Version - system model	3.8 - Allocation, cut-off

Dataset Identification Ecoinvent 3.9.1

Activity name	market for electricity, low voltage
Geography	Germany
Time period	2014-01-01 to 2022-12-31 - Valid for the entire period
ISIC rev.4 ecoinvent	3510: Electric power generation, transmission and distribution
Reference product	electricity, low voltage
CPC classification	17100: Electrical energy
Dataset type	Market activity
Technology level	Undefined
Version - system model	3.9.1 - Allocation, cut-off

The shares of electricity technologies on this market are **valid for the year 2018**.

Extrapolations: This dataset has been extrapolated from year 2017 to the year of the calculation (2021). The uncertainty has been adjusted accordingly.

LCIA Method: IPCC 2013, GWP 100a
Score: **516 kg CO$_2$-Eq./MWh**

Extrapolations: Assumptions for the amount of transmission network per kWh transported and emissions per kWh are based on Swiss data. Electricity losses data are based on IEA data and on data from Switzerland.

LCIA Method: IPCC 2021, GWP 100a
Score: **440 kg CO$_2$-Eq./MWh**

LIÈGE université   Fraunhofer ISE   TNO innovation for life   UNIVERSITÀ DI SIENA 1240

Kontact

Abeer Ali Khan
abeer.ali.khan@ise.fraunhofer.de

LCA Methodology Harmonization Workshop, Brussels, 2023
Sources

1. Ecoinvent 3.8 China: National Bereau of Statistics of China (2015) China Statistical Yearbook. http://www.stats.gov.cn/tjsj/ndsj/2015/indexeh.htm. Accessed 14 Jul 2022

2. Ecoinvent 3.8 Norway and Germany: (2017-) IEA World Energy Statistics and Balances. OECD

3. Literature shares China 2020: CEC Statistics and Data Center. (2021) List of basic data of electricity statistics in 2020. CEC Statistics and Data Center. https://www.cec.org.cn/detail/index.html?3-305140. Accessed 14 Jul 2022

4. Literature shares Germany 2020: Bruno Burger (2021) Public Net Electricity Generation in Germany 2020: Share from Renewables Exceeds 50 percent

5. Literature shares Norway 2020: Statistics Norway, SSB (2022) Generation and consumption of electricity. GWh. Statistics Norway, SSB. https://www.ssb.no/en/energi-og-industri/energi/statistikk/elektrisitet. Accessed 14 Jul 2022

6. Methodology for modelling *net electricity*: Itten, René, Rolf Frischknecht and Matthias Stucki. (ed) (2014) Life Cycle Inventories of Electricity Mixes and Grid.

7. Ecoinvent 3.8 activities used:
   - Electricity, low voltage [CN, DE, NO]
   - Electricity, medium voltage [CN, DE, NO]
   - Electricity, high voltage [CN, DE, NO]