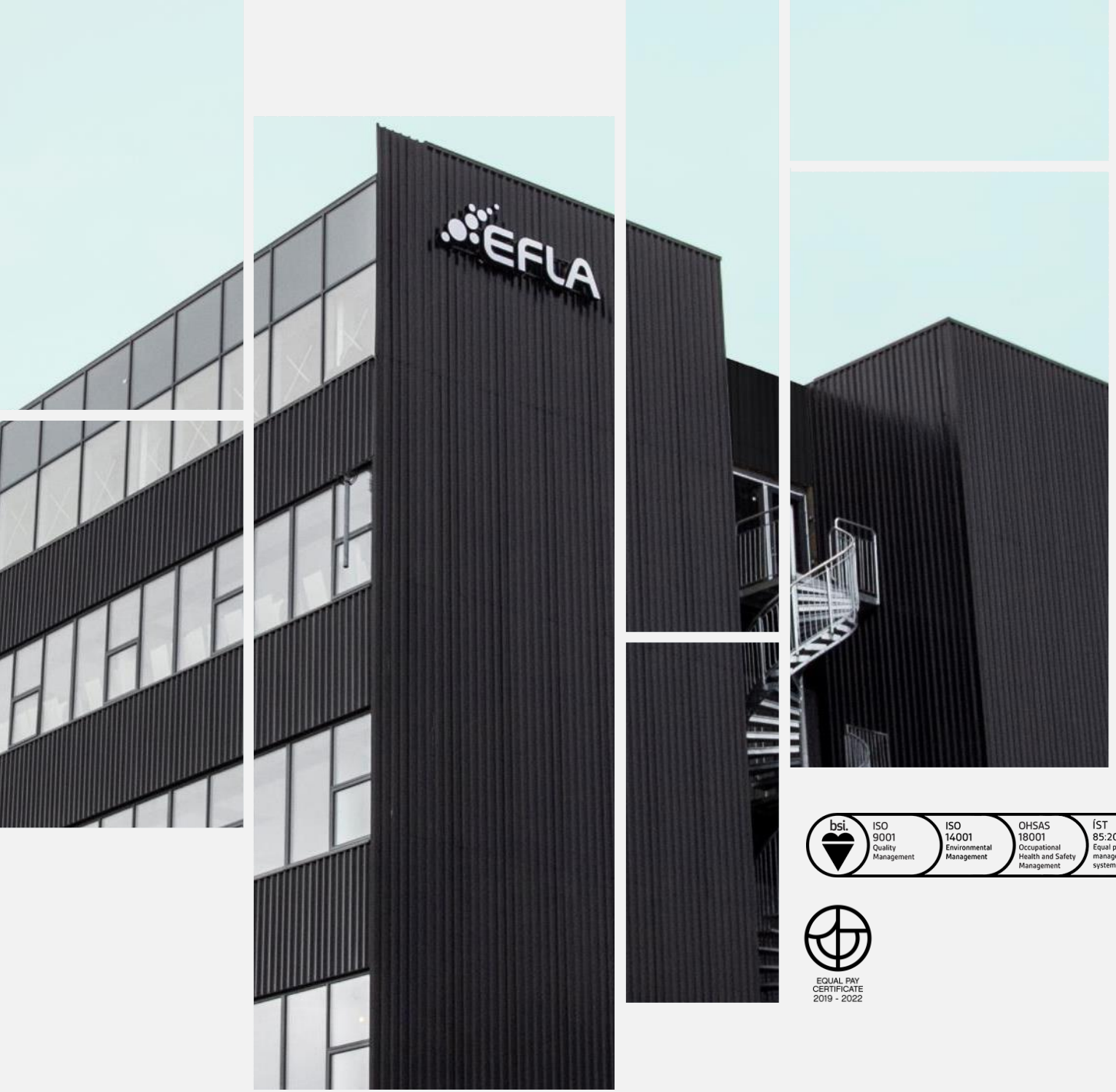
25.10.2019

Effect of geothermal district heating on the carbon footprint of buildings in Iceland

Alexandra Kjeld

Environmental Engineer, M.Sc.

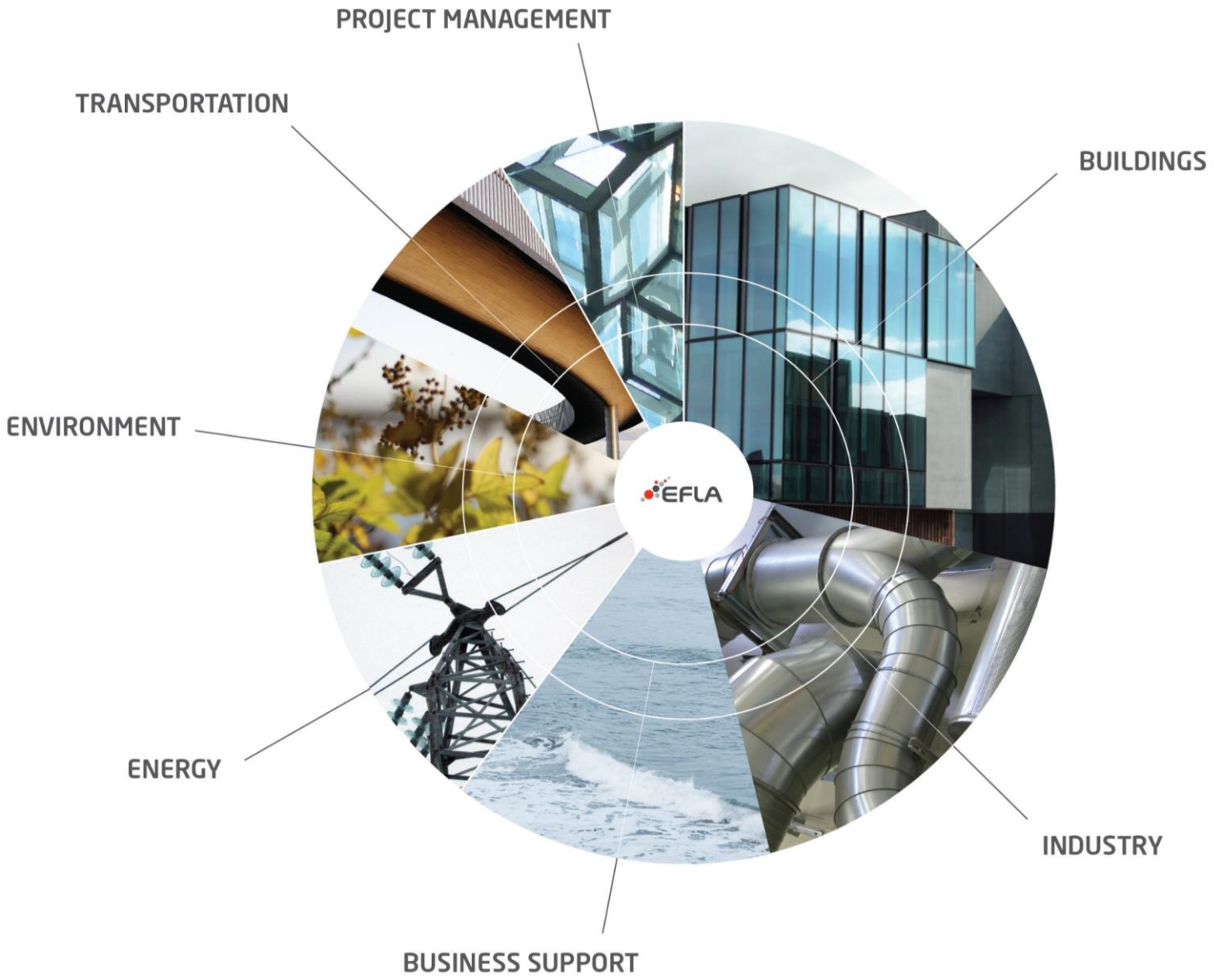


EFLA Consulting Engineers

- A general engineering and consulting company providing high quality solutions worldwide
- About 400 employees
- 40 year history
- Operates on a professional basis according to certified management system:
  - ISO9001 Quality Management
  - ISO14001 Environmental Management
  - OHSAS18001 Safety Management
  - ÍST 85 Equal Pay Management

bsi. ISO 9001 Quality Management | ISO 14001 Environmental Management | OHSAS 18001 Occupational Health and Safety Management | ÍST 85:2012 Equal pay management system

EQUAL PAY CERTIFICATE 2019 - 2022



EFLA's structure

- **Marketing divisions**
  - Buildings
  - Industry
  - Energy
  - Environment
  - Transportation
  - Project Management
- Business support

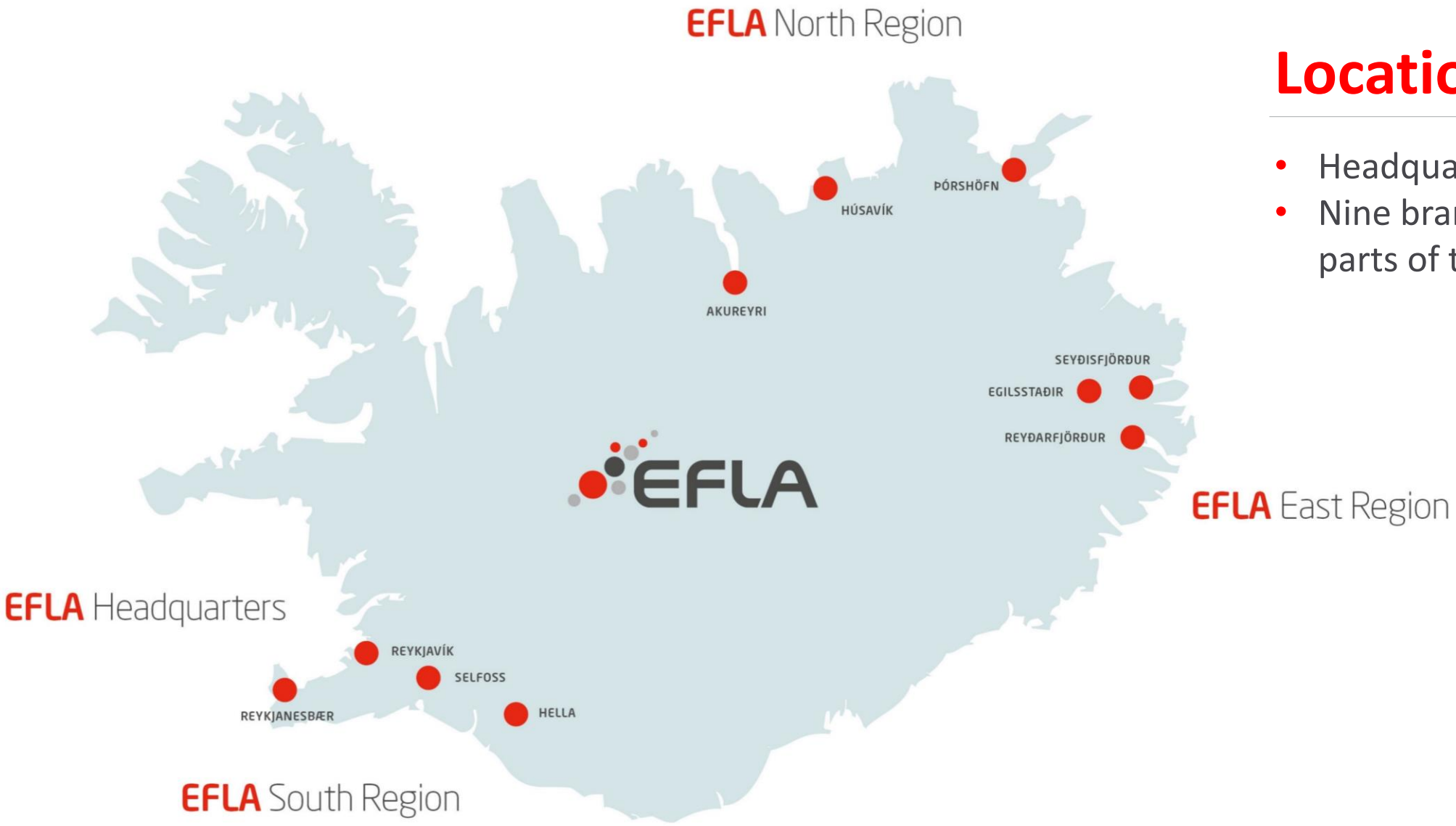
Various projects worldwide focusing on

- Energy and utilities
- Transportation
- Industry automation

Locations overseas

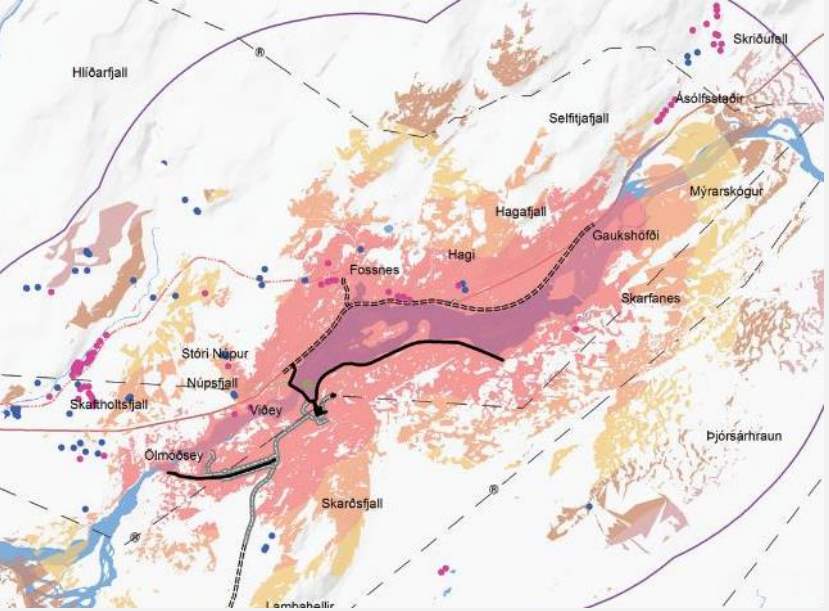
Offices and affiliated companies

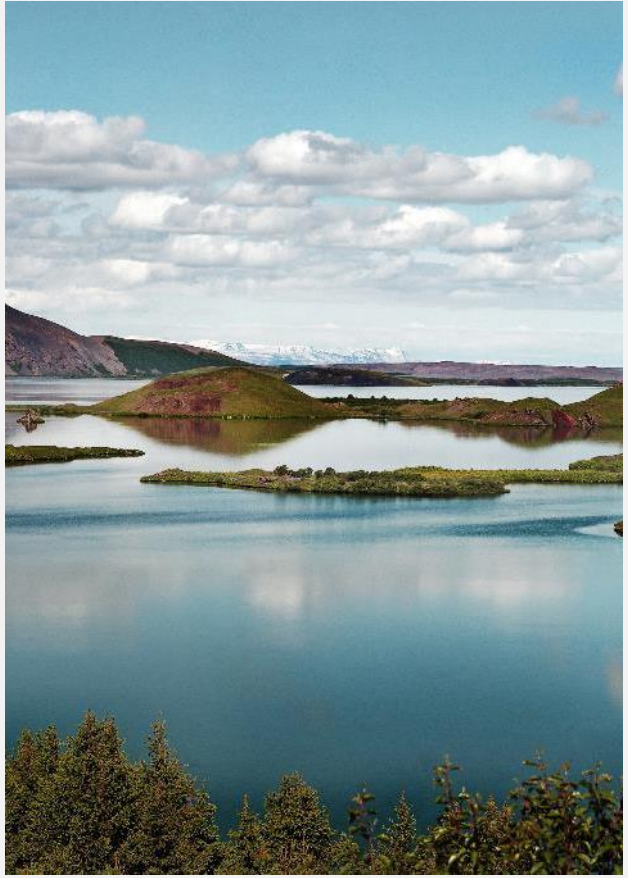
Norway | Sweden | Germany | France
Poland | Turkey | Scotland



Locations

- Headquarters in Reykjavík
- Nine branches in other parts of the country



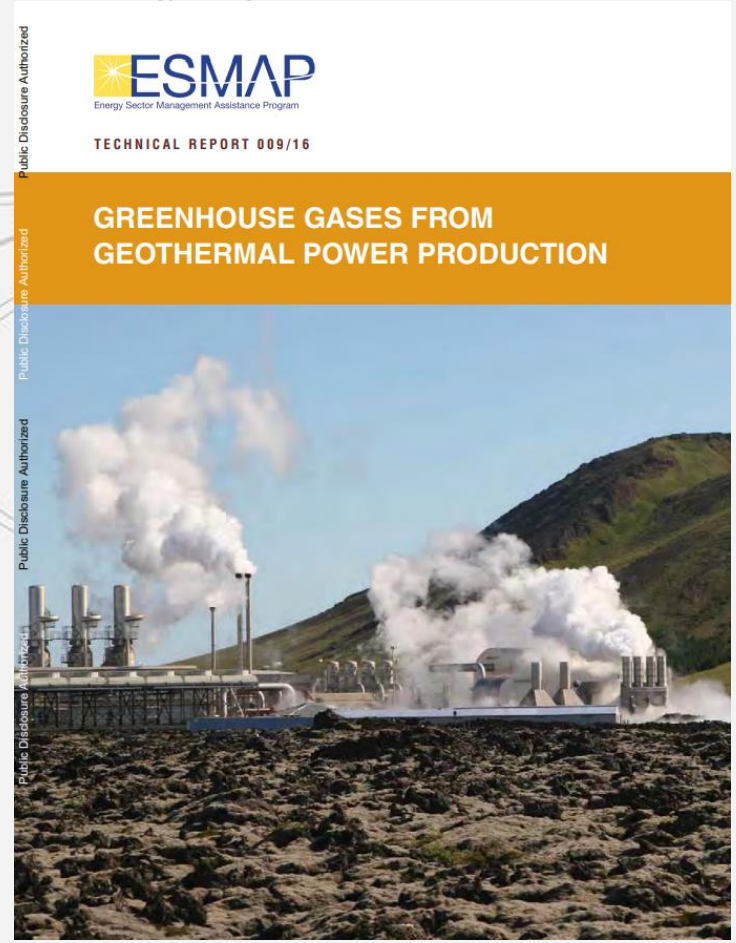


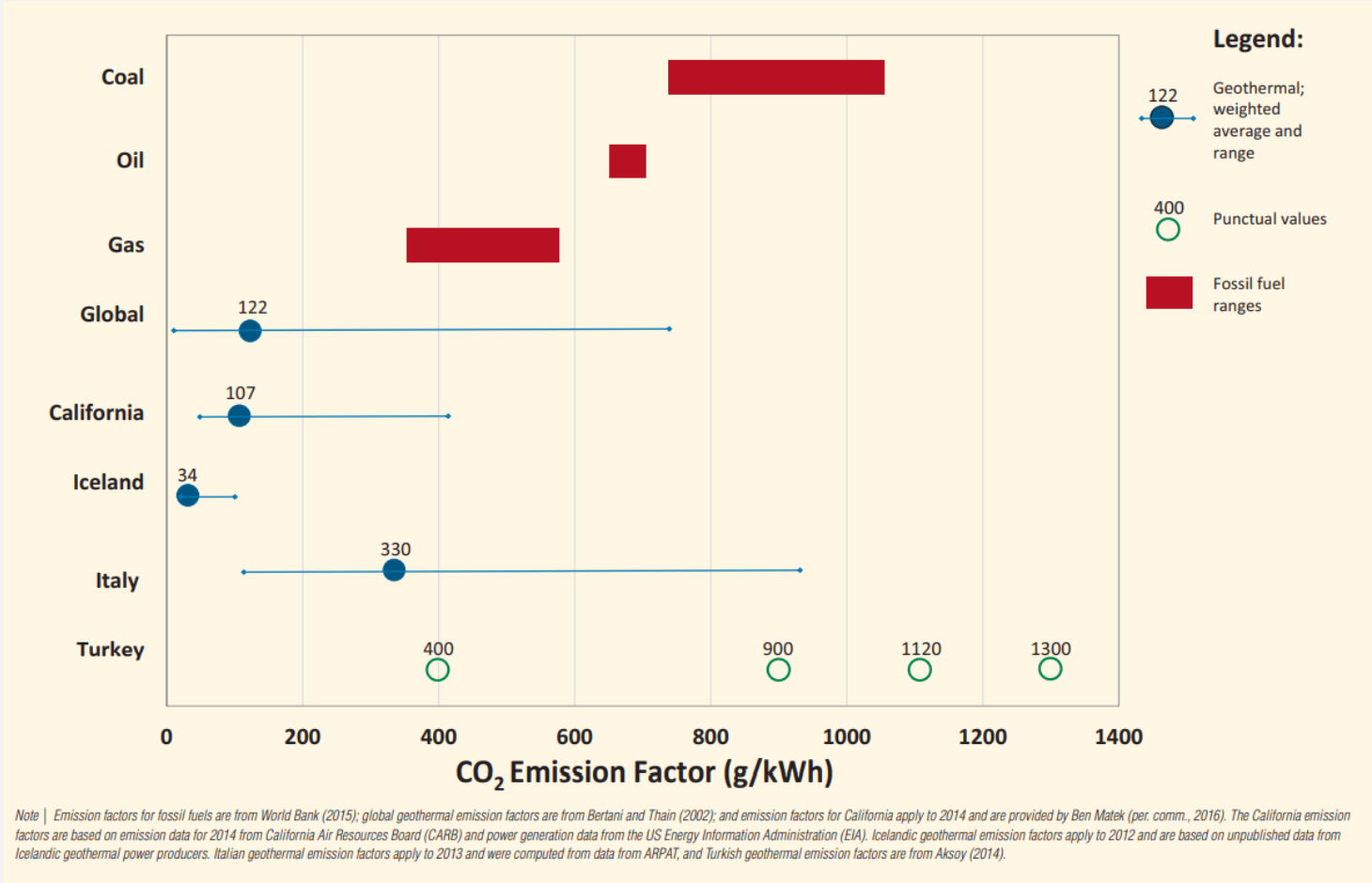
Built environment

- EFLA has been at the forefront in Iceland regarding environmental issues, both in its consultation and its own operation
- Provides professional consulting on the full spectrum of environmental concerns above and below ground
- EIA, wastewater management, GIS, LCA, carbon footprint and environmental management
- Sustainable design of buildings and infrastructure projects, as well as sustainability certifications, in accordance with BREEAM

Carbon footprint of buildings and the impact of geothermal utilisation

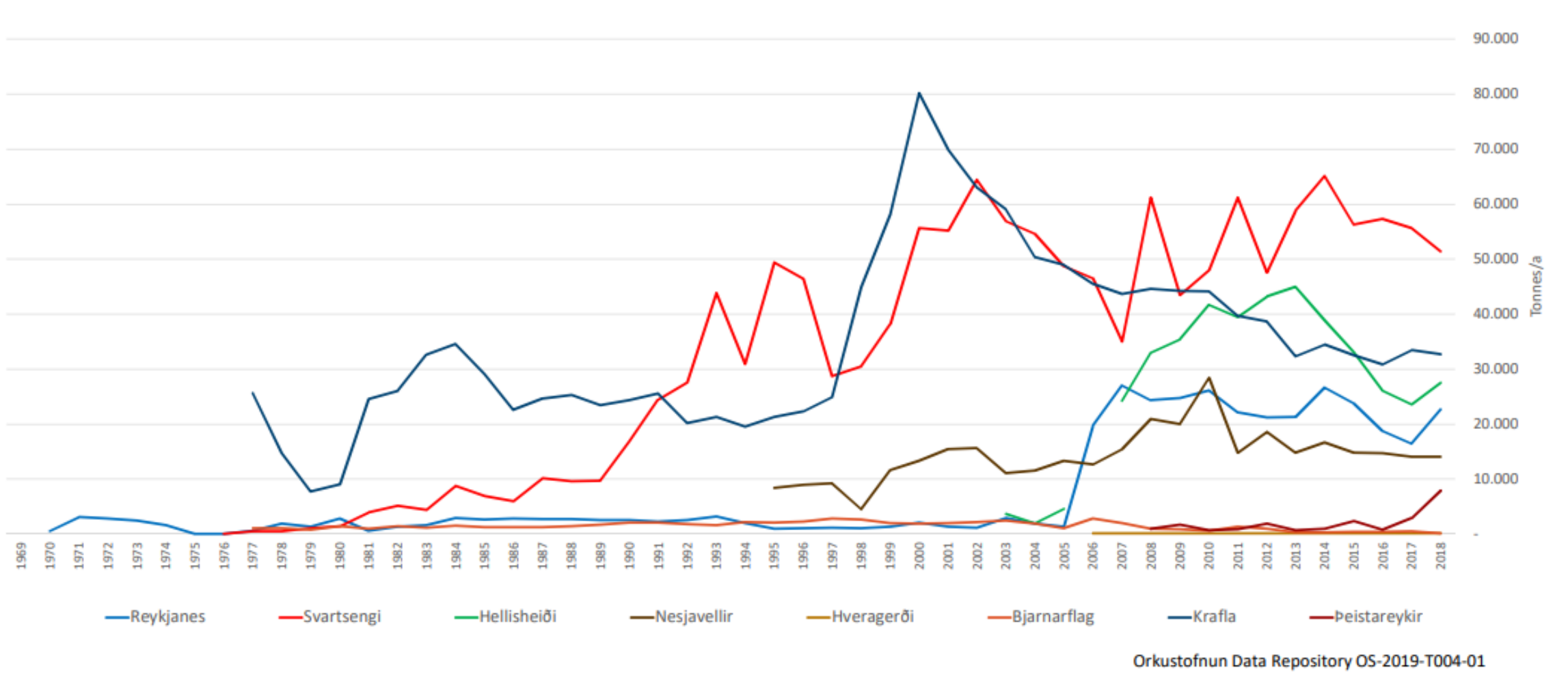
Emission Factors of Geothermal Power Compared to Fossil Fuel





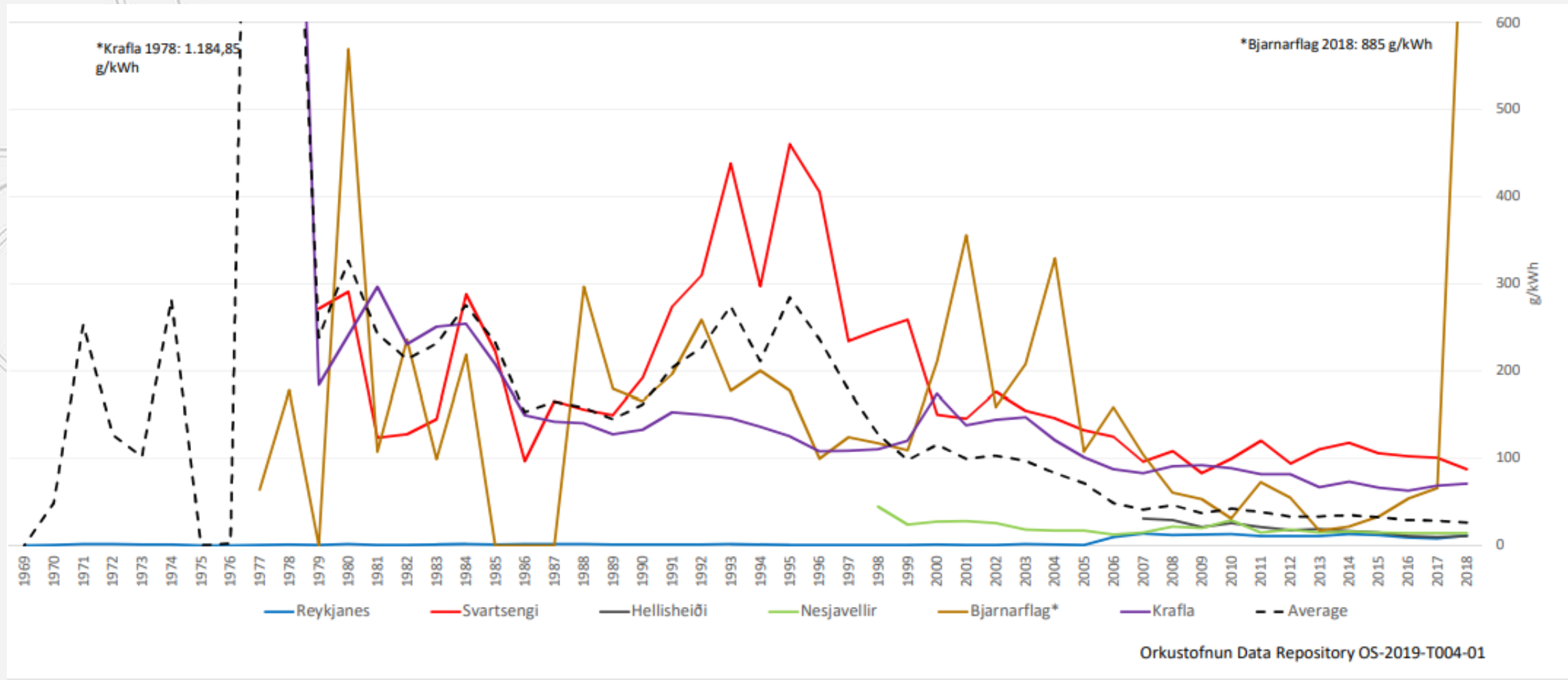
Note | Emission factors for fossil fuels are from World Bank (2015); global geothermal emission factors are from Bertani and Thain (2002); and emission factors for California apply to 2014 and are provided by Ben Matek (per. comm., 2016). The California emission factors are based on emission data for 2014 from California Air Resources Board (CARB) and power generation data from the US Energy Information Administration (EIA). Icelandic geothermal emission factors apply to 2012 and are based on unpublished data from Icelandic geothermal power producers. Italian geothermal emission factors apply to 2013 and were computed from data from ARPAT, and Turkish geothermal emission factors are from Aksoy (2014).

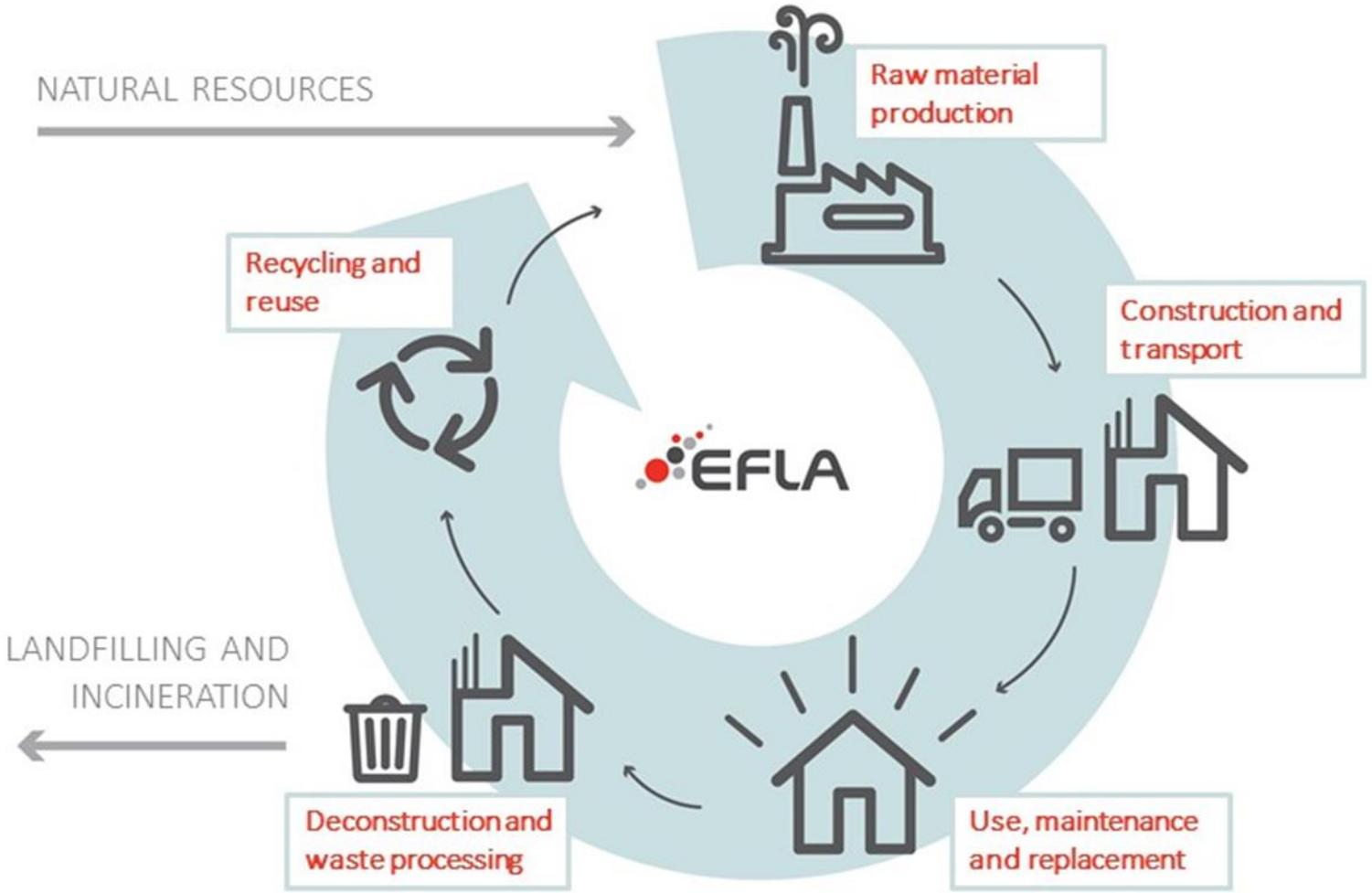
CO_2 emissions from geothermal power plants and heat plants 1969-2018



Orkustofnun Data Repository OS-2019-T004-01

CO_2 emissions per kWh 1969-2018





Building life cycle

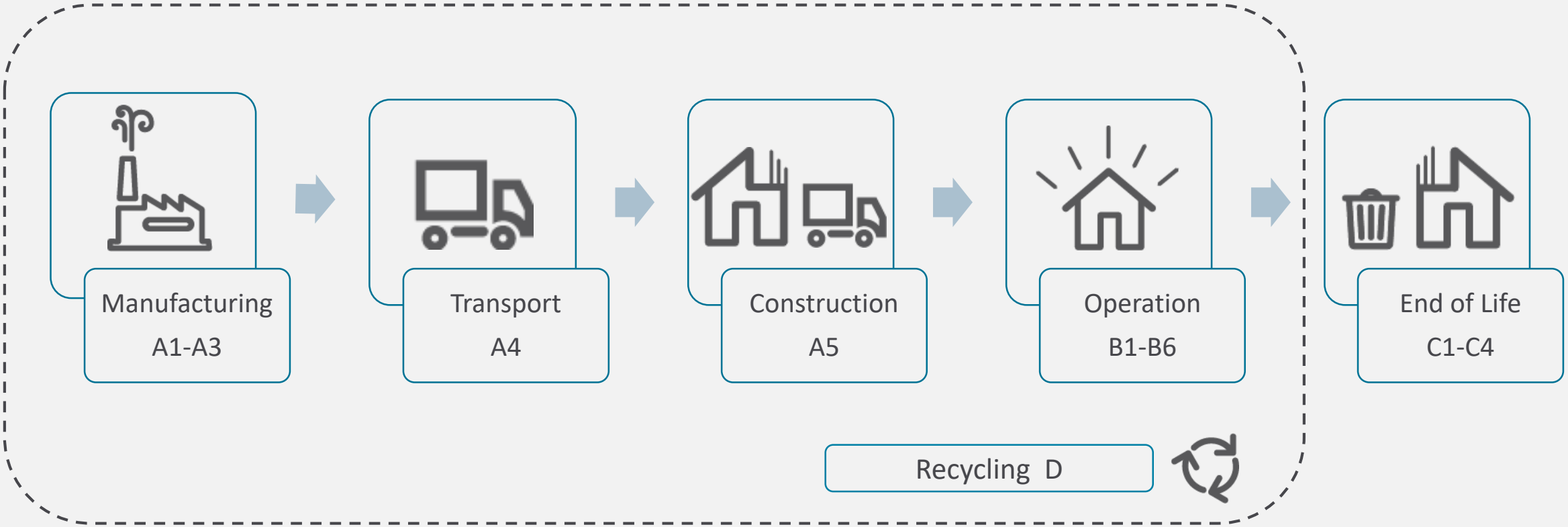
- Life cycle inclusive
- Where do the main impacts lie?
- Information used to reduce impacts
- Important step in eco-design and sustainable construction

Where and how do we use LCA results?

- During planning and design stages and to compare alternatives and scenarios
- During product development
- Providing environmental information:
  - Carbon footprint, eco-footprint
  - Certification schemes for products
  - Sustainable building certificates
  - Environmental product declarations (EPD)

LCAs carried out by EFLA

Typical system boundaries




Urban arkitektar

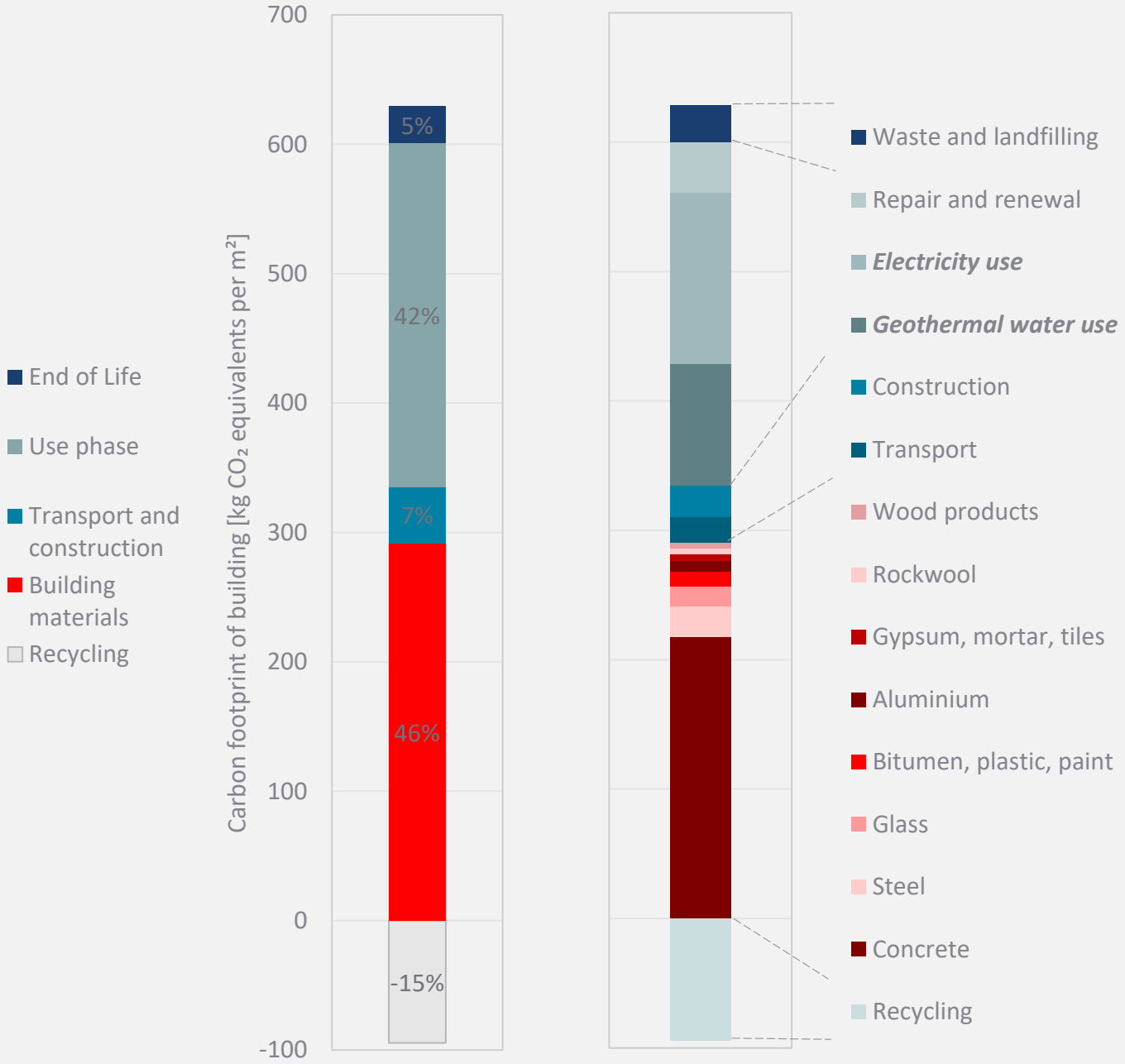
Nursing home in Árborg

Scope

- Floor space: 3.810 m²
- Functional unit:
  1 m² of floor space
- Lifetime: 60 years
- System boundaries: Cradle to grave

Building elements

- *Footings and columns*
- *Floor slab*
- *Floor tiles*
- *Ceiling*
- *Roof*
- *External walls*
- *Internal walls*
- *Doors*
- *Windows*
- *Beams*
- *Stairs*
- *Indoor paint*



Nursing home in Árborg

Carbon footprint

- Carbon footprint
  - Building: 2.400 t CO_2
  - Per m^2: 630 kg CO_2/m^2
- Use phase: 42%
  - Geothermal water use: 15%
  - Electricity use: 21%

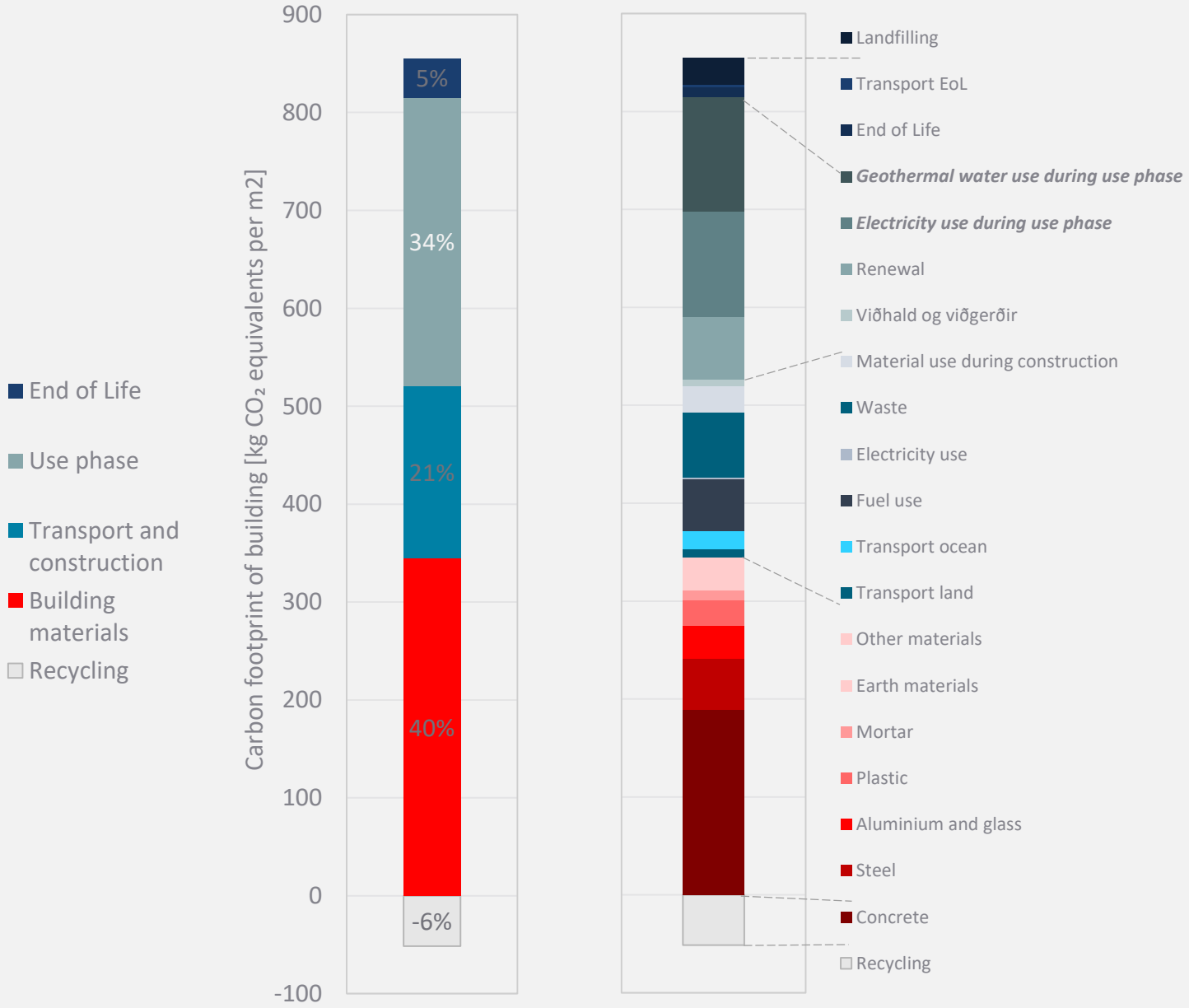
Annex building to Sundhöll Reykjavíkur

Scope

- Floor space: 710 m^2
- Functional unit:
  1 m^2 of floor space
- Lifetime: 60 years
- System boundaries: Cradle to grave
- Annex building, outdoor changing rooms and sauna

Building elements

- *Slab*
- *Floors*
- *Flooring materials*
- *Ceiling*
- *Roof*
- *Exterior walls*
- *Interior walls*
- *Doors*
- *Windows*
- *Columns*
- *Stairs*
- *Indoor paint*
- *Piping*
- *Wells and drains*
- *Filling*



Annex building to Sundhöll Reykjavíkur

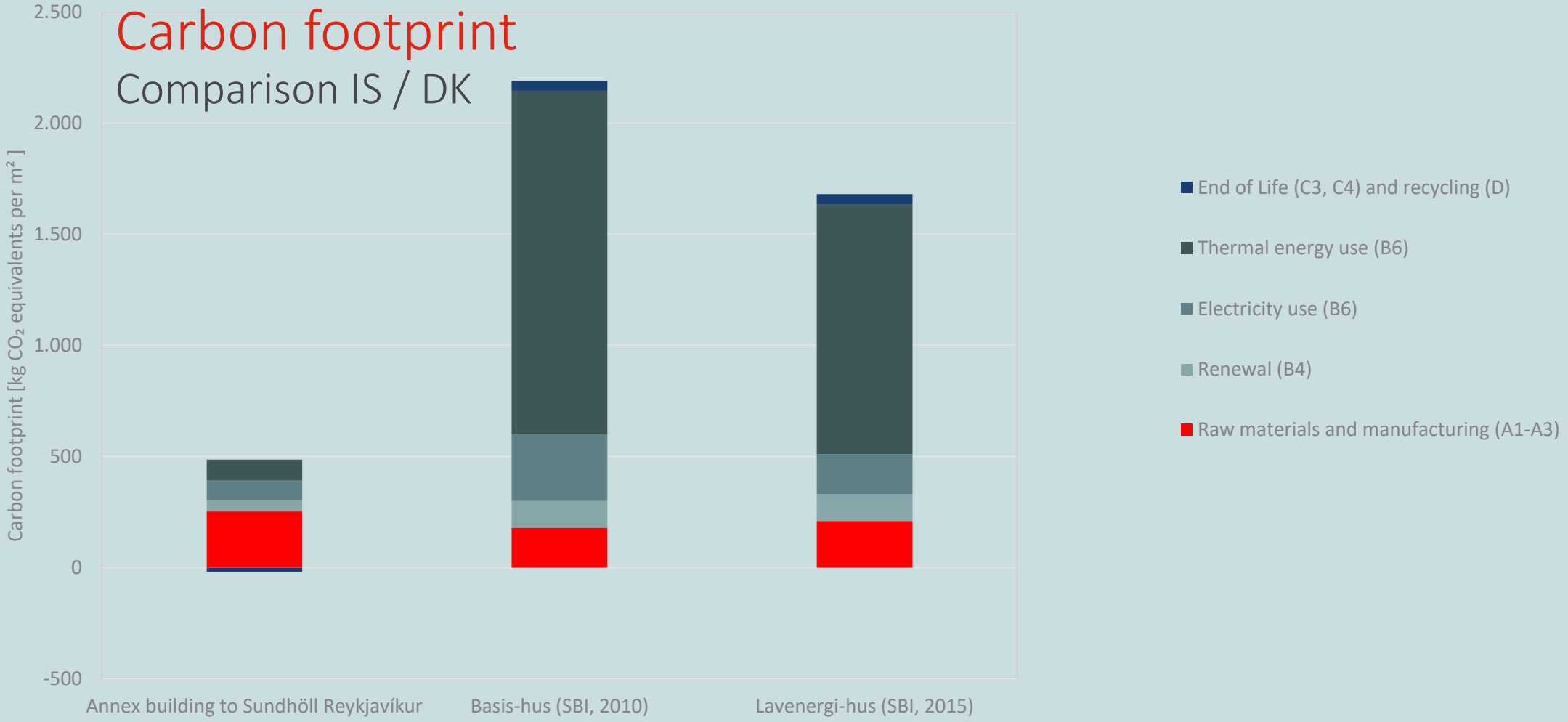
Carbon footprint

- Carbon footprint
  - Entire building: 610 t CO_2
  - Per m^2: 860 kg CO_2/m^2
- Use phase: 34%
  - Geothermal water use: 13%
  - Electricity use: 7%

Building materials:	**52%**	8%	13%
Use phase:	48%	**90%**	**85%**
EoL and recycling:	-4%	2%	3%

Carbon footprint

Comparison IS / DK



For comparison purposes, transport, construction, EoL and some building elements were omitted


Thank you