SVENSKA ARALSJÖSÄLLSKAPET

Swedish Aral Sea Society

3. Energy

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Master Course on Sustainable Development and Sustainability Science
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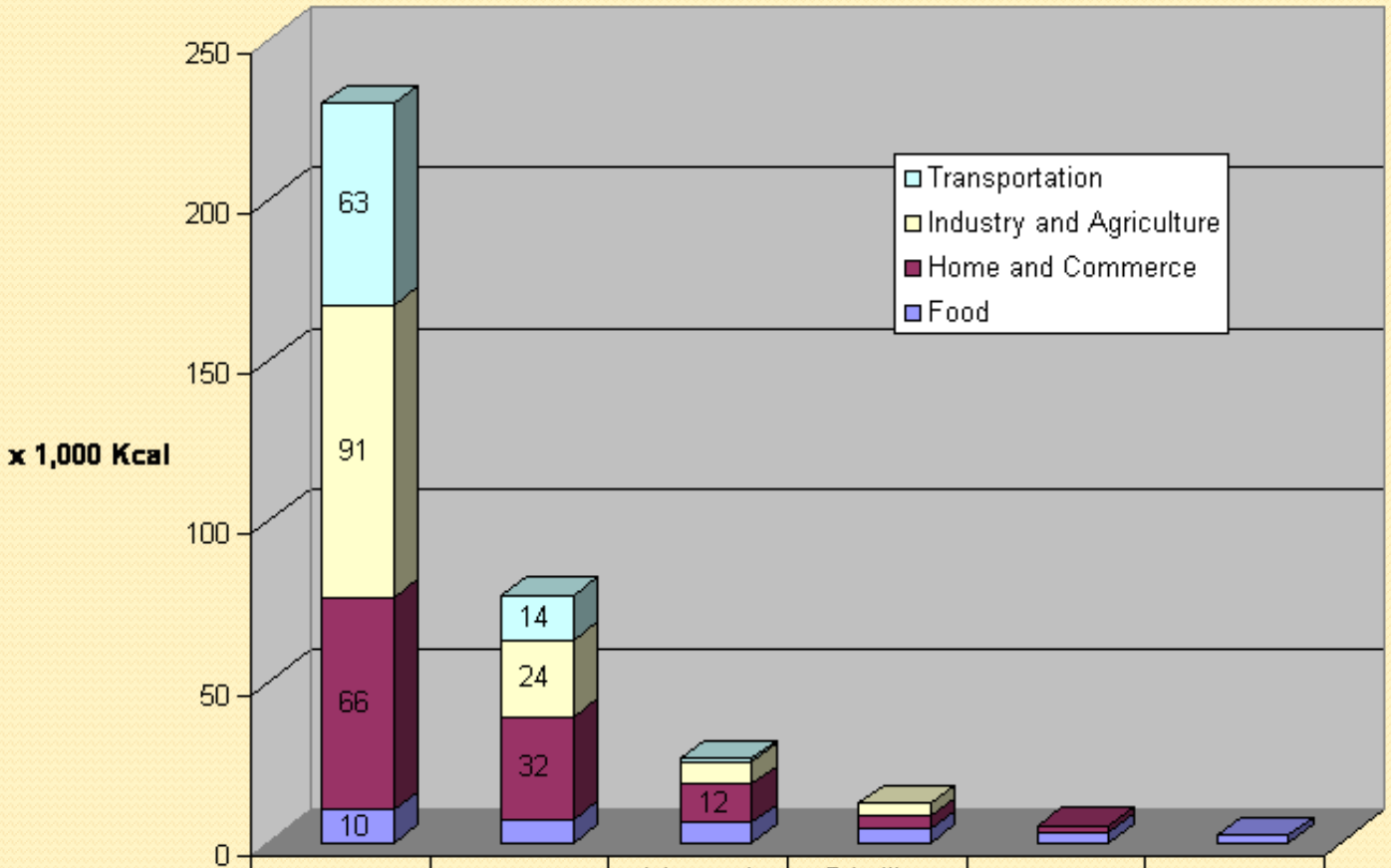
Energy supply and use

Energy use per capita in different societies

• Biological	2.4	kWh/day
• Gatherers, hunters	10	kWh/day
• Agriculture	25-50	kWh/day
• Industrial society	50-100	kWh/day
• Contemporary	250	kWh/day

Daily Consumption of Energy Per Capita



	Technological Man	Industrial Man	Advanced Agricultural Man	Primitive Agricultural Man	Hunting Man	Primitive Man
Transportation	63	14	1			
Industry and Agriculture	91	24	7	4		
Home and Commerce	66	32	12	4	2	
Food	10	7	6	4	3	2

Two different kinds of energy

- **Non-renewable (fossil) energy resources**
  - Coal
  - Oil
  - Gas

- **Renewable – flowing - energy resources**
  - Biomass and other forms of bioenergy
  - Hydropower
  - Wind power
  - Solar power

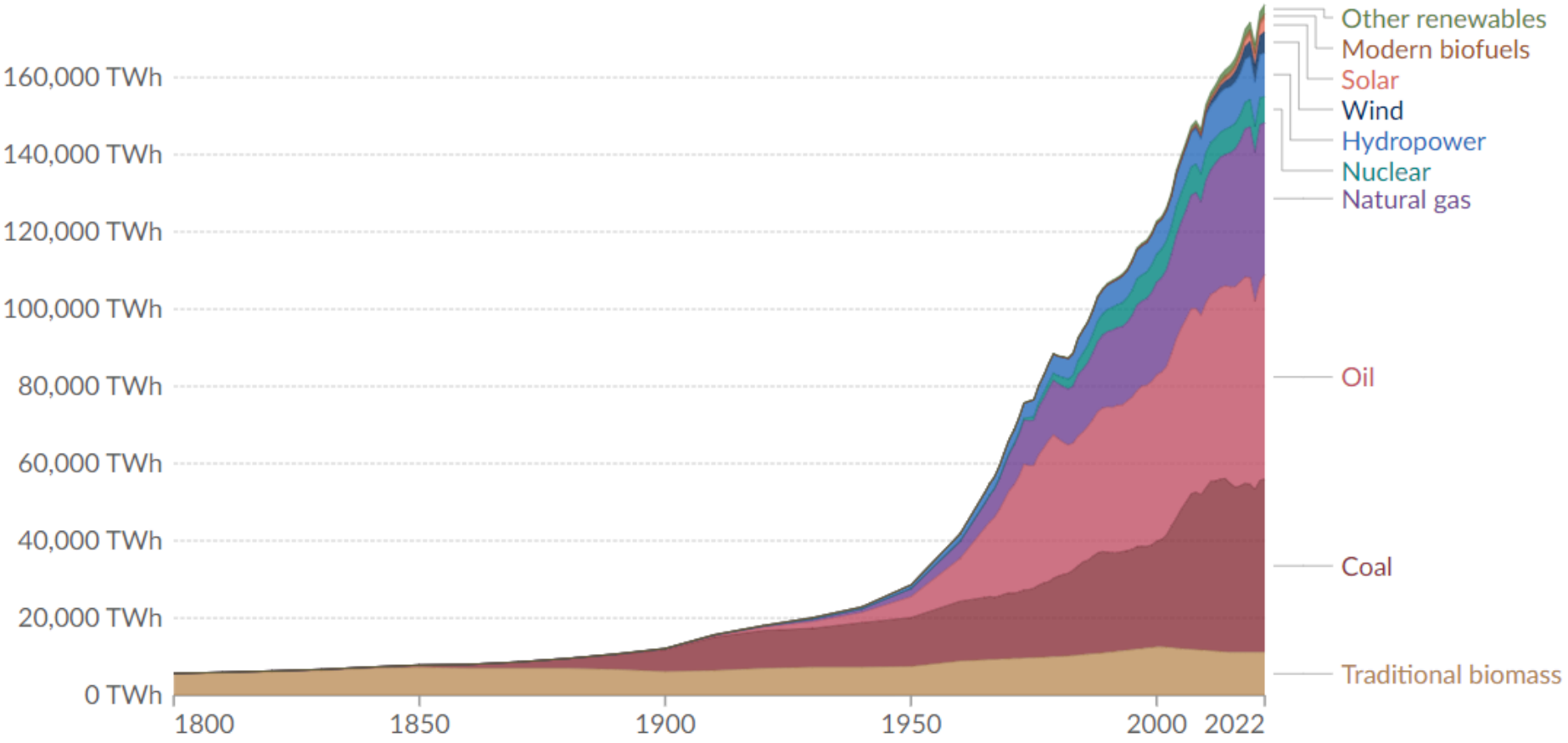
Global primary energy consumption by source

Primary energy is based on the substitution method and measured in terawatt-hours.

Our World in Data

Table | Chart

Settings

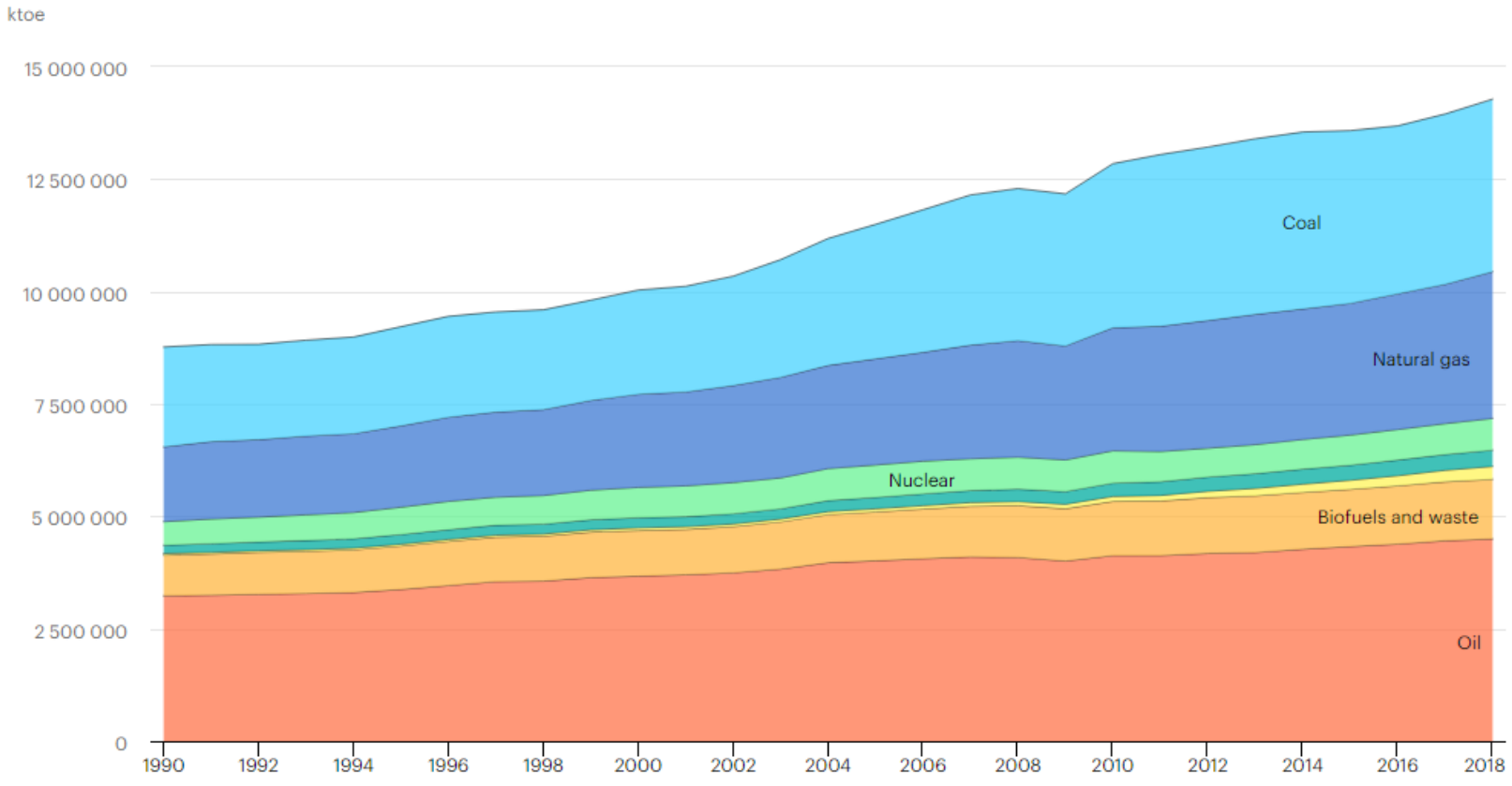


1800 2022

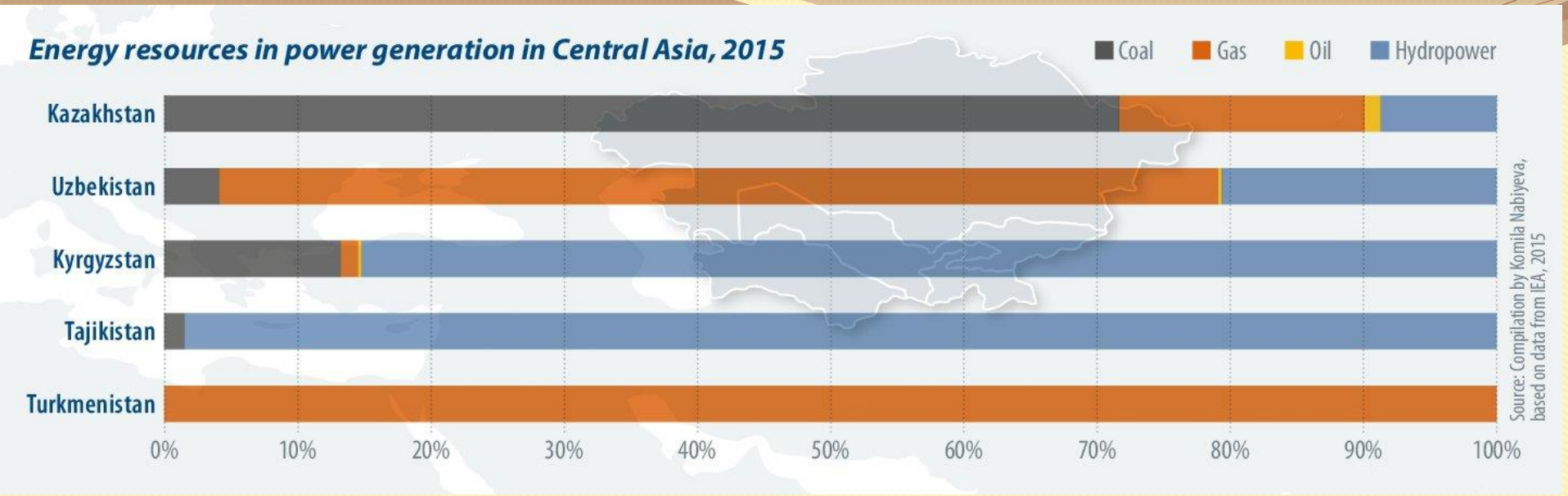
Data source: Energy Institute - Statistical Review of World Energy (2023); Smil (2017) – Learn more about this data

Note: In the absence of more recent data, traditional biomass is assumed constant since 2015.

World Energy Outlook 2020 – Analysis – International Energy Agency, IEA



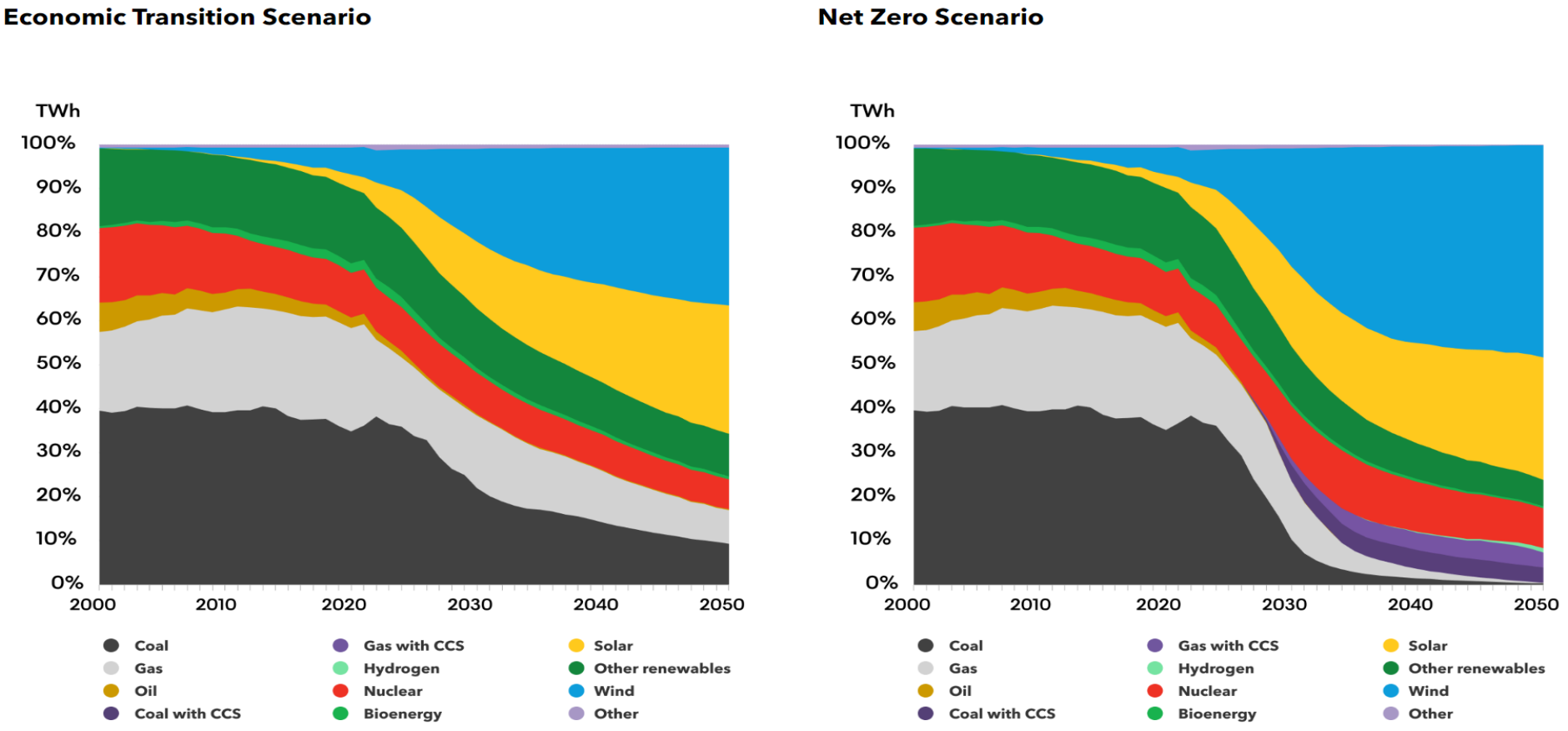
https://www.iea.org/data-and-statistics?country=WORLD&fuel=Energy%20supply&indicator=TPESbySource



https://energytransition.org/2018/06/central-asias-green-horizons/

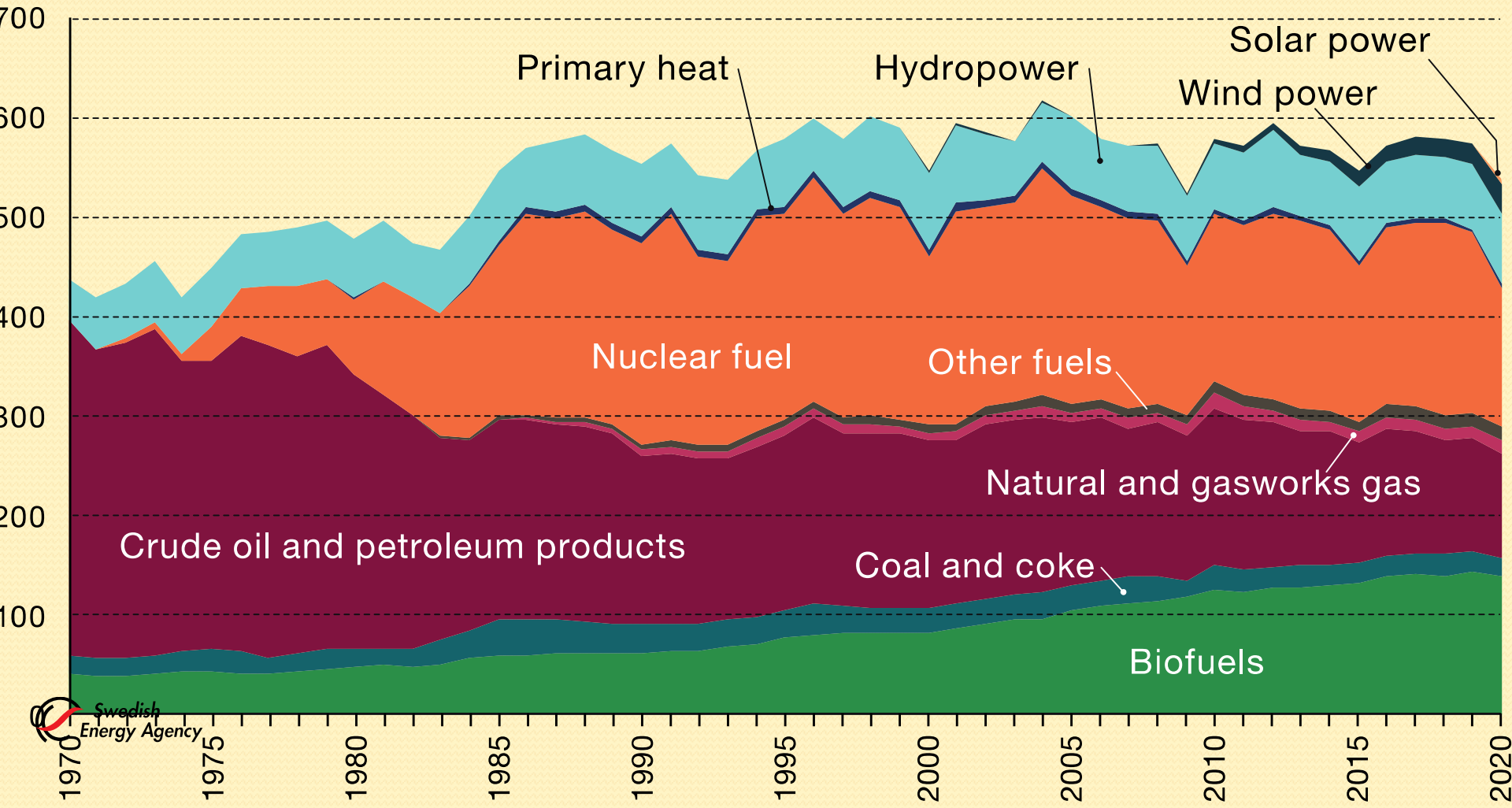
Sun and wind power dominates investments today, and will dominate in the future

Electricity generation by technology, by scenario



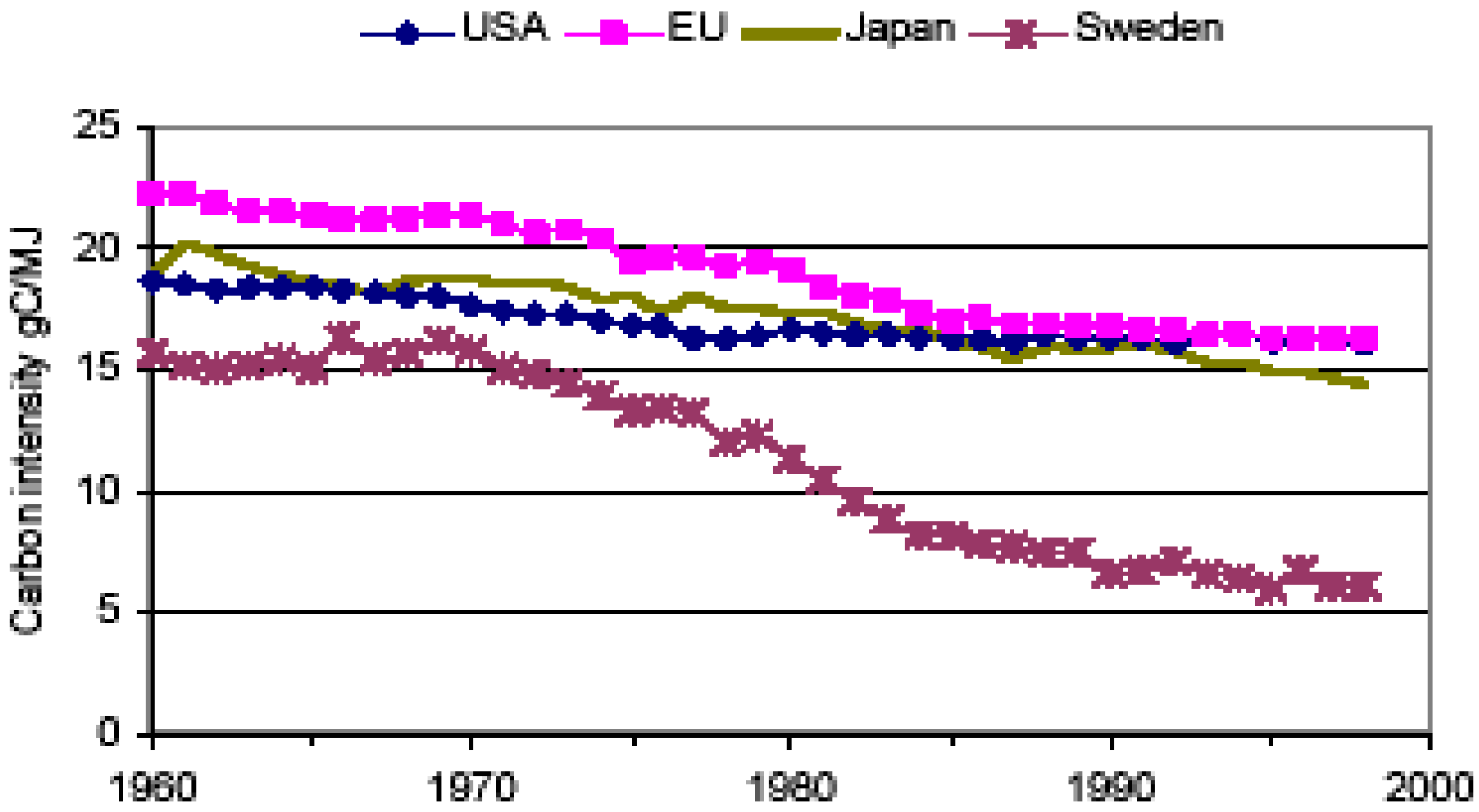
Source: The 2022 New Energy Outlook (NEO) Bloomberg New Energy Finance

Sweden - Total supplied energy 1970–2020, TWh

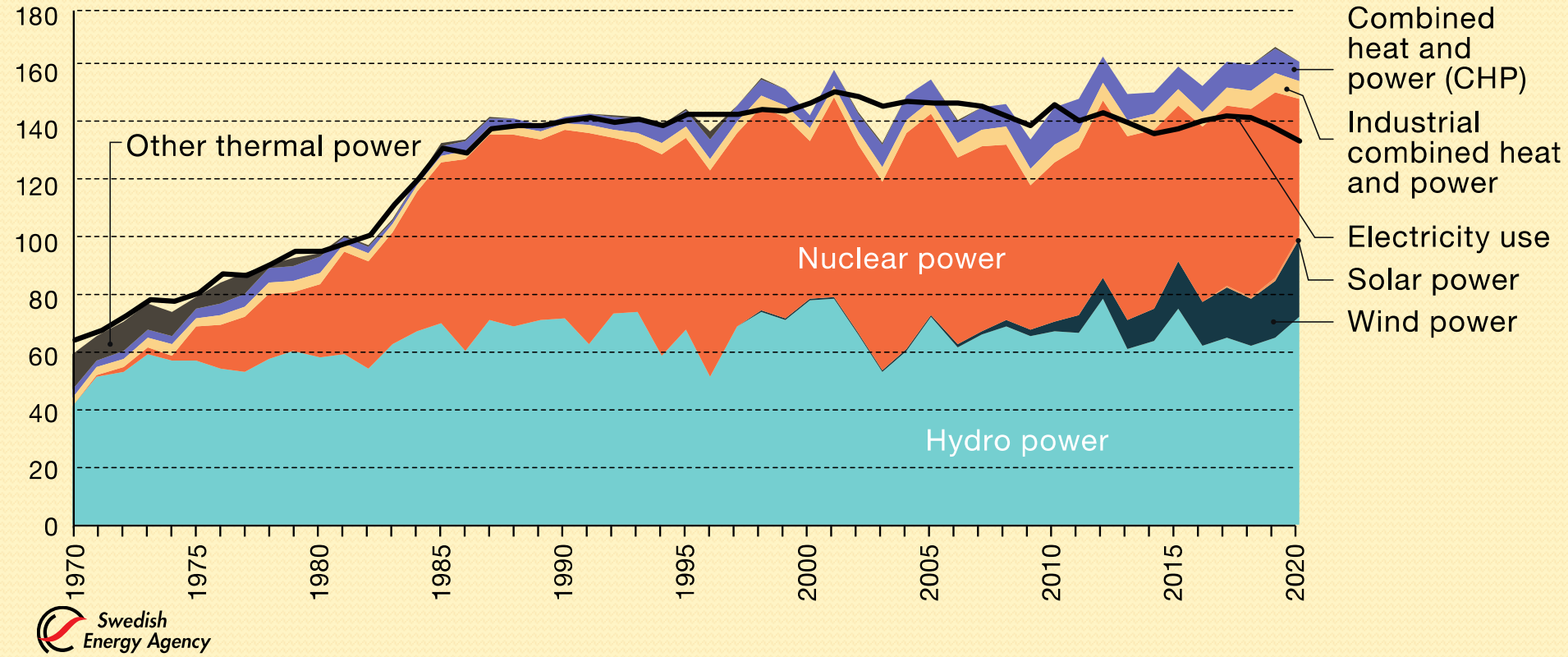


Carbon content of energy

From *Decoupling*, Azar, Holmberg and Karlsson, Chalmers University of Technology, 2002 based on IEA statistics

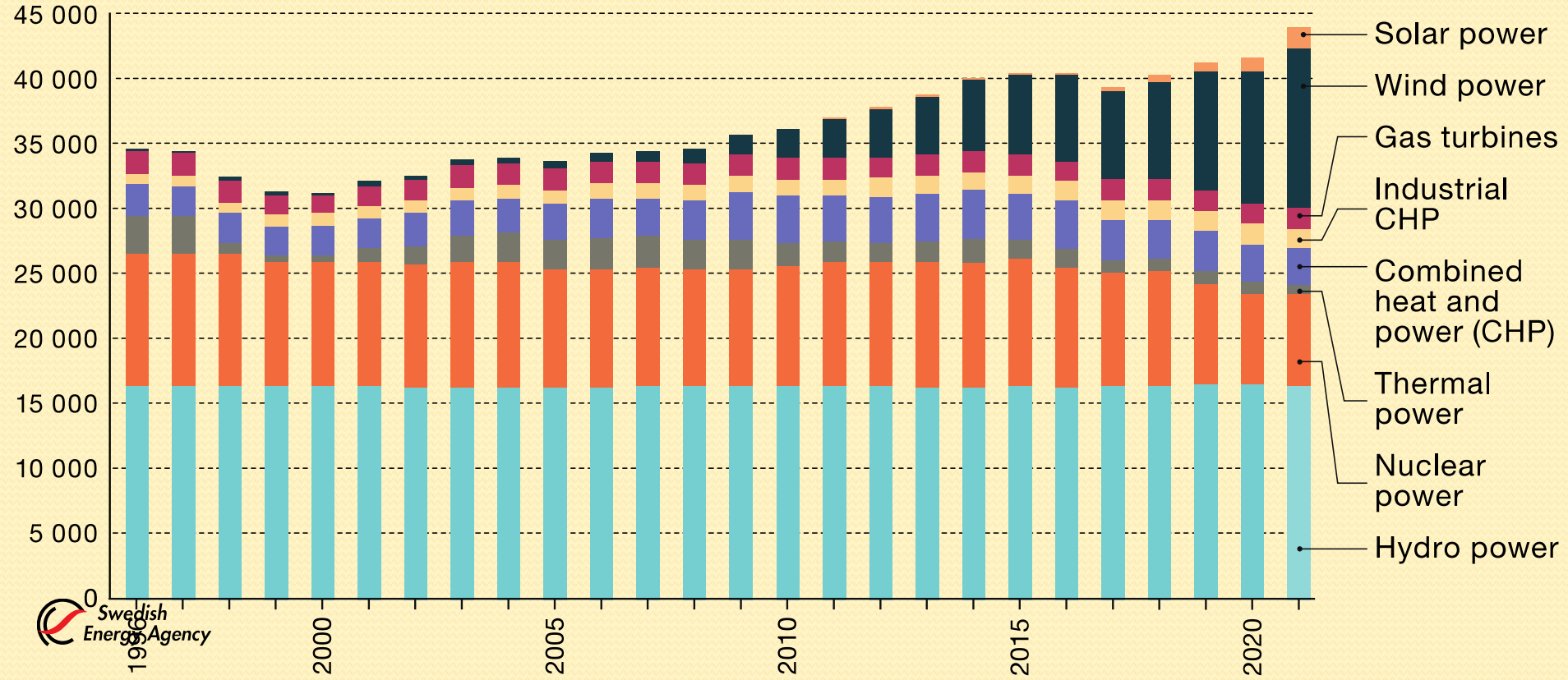


Electricity use and electricity generation per type of power 1970–2020, TWh

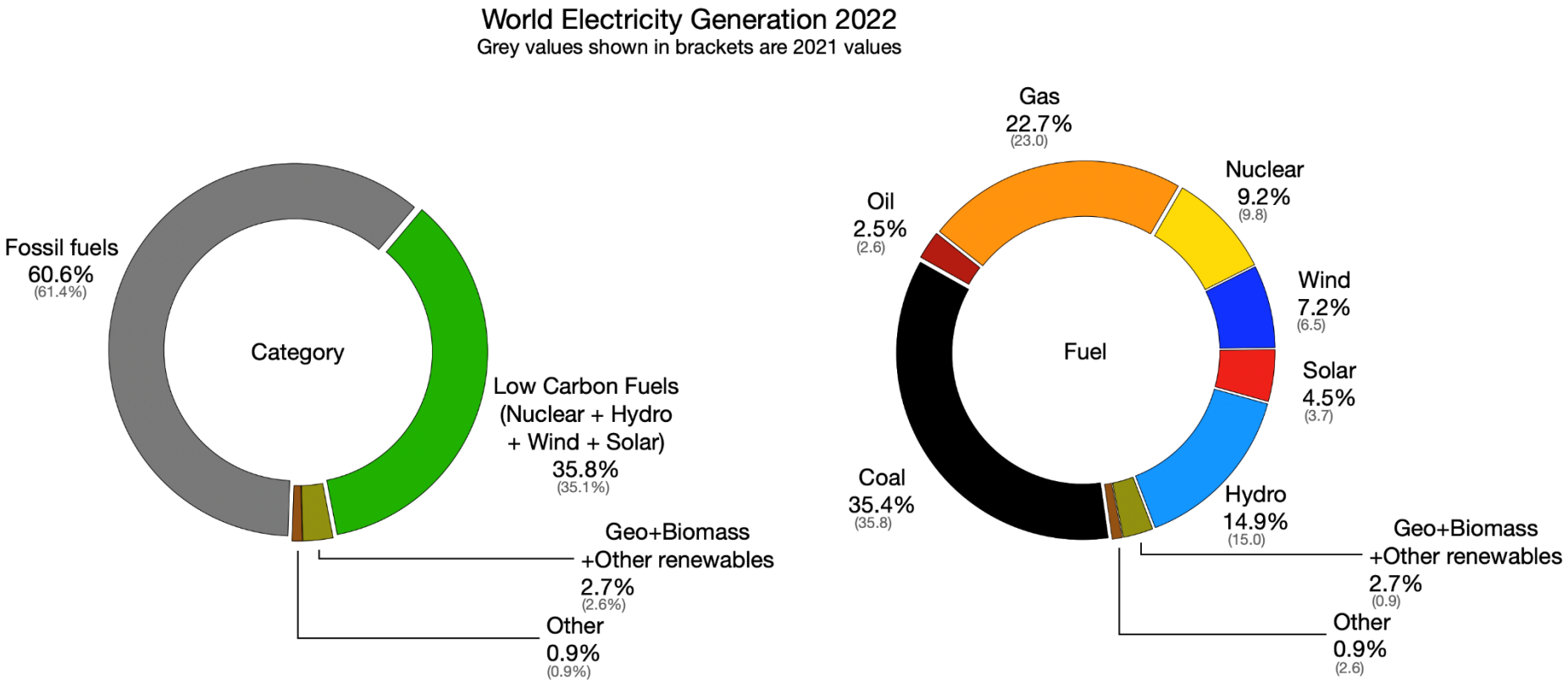


Swedish Energy Agency

Installed electricity generation capacity by type of power 1996–2021, MW

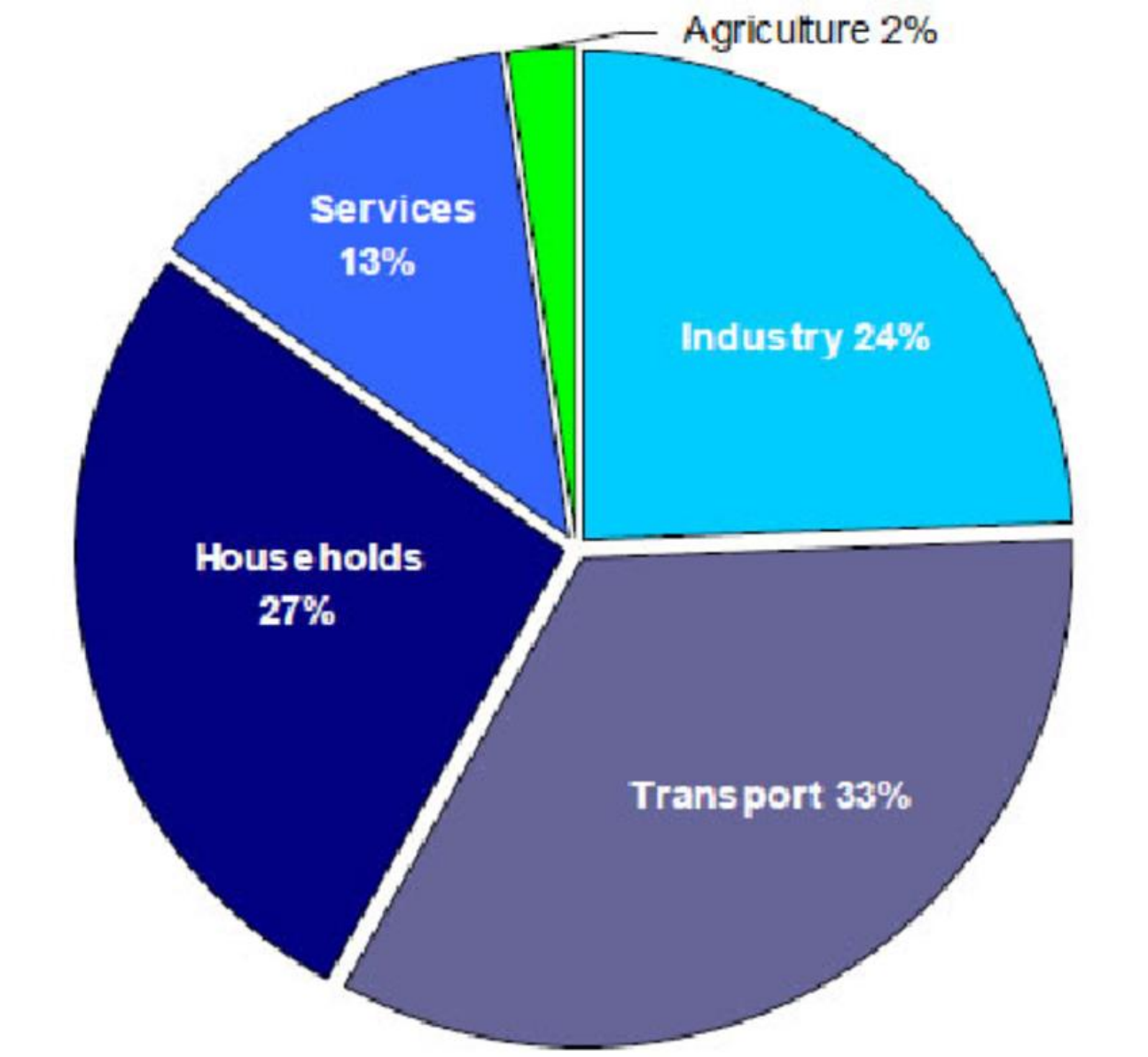


World Electricity Generation 2022

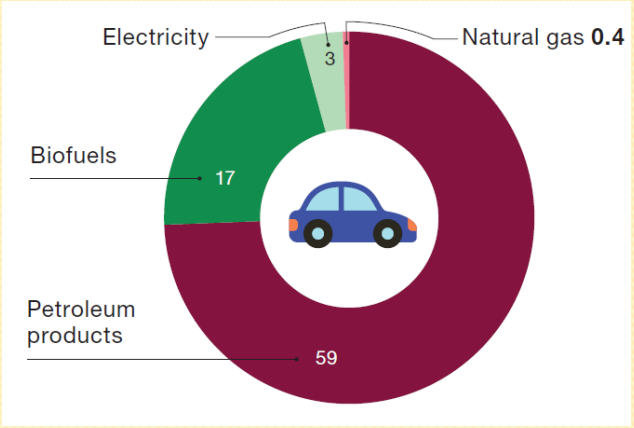


https://www.worldenergydata.org/world-electricity-generation/

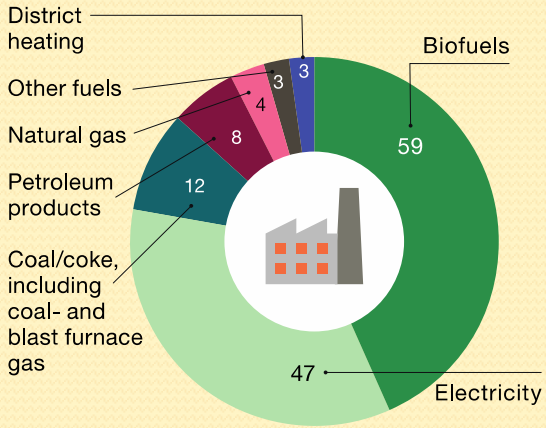
Energy use


Agriculture 2%
Services 13%
Industry 24%
Households 27%
Transport 33%

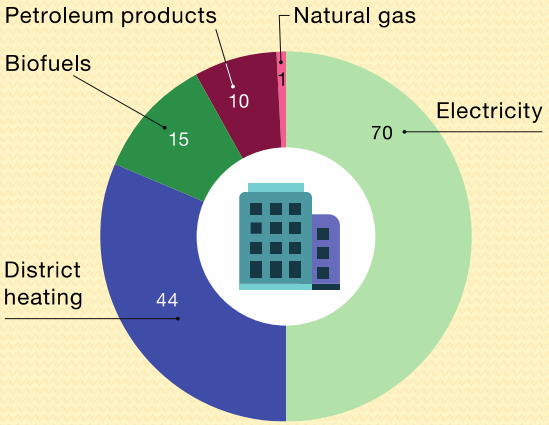
Final energy use in the different sectors 2020, TWh



Transport



Industry



Households and business

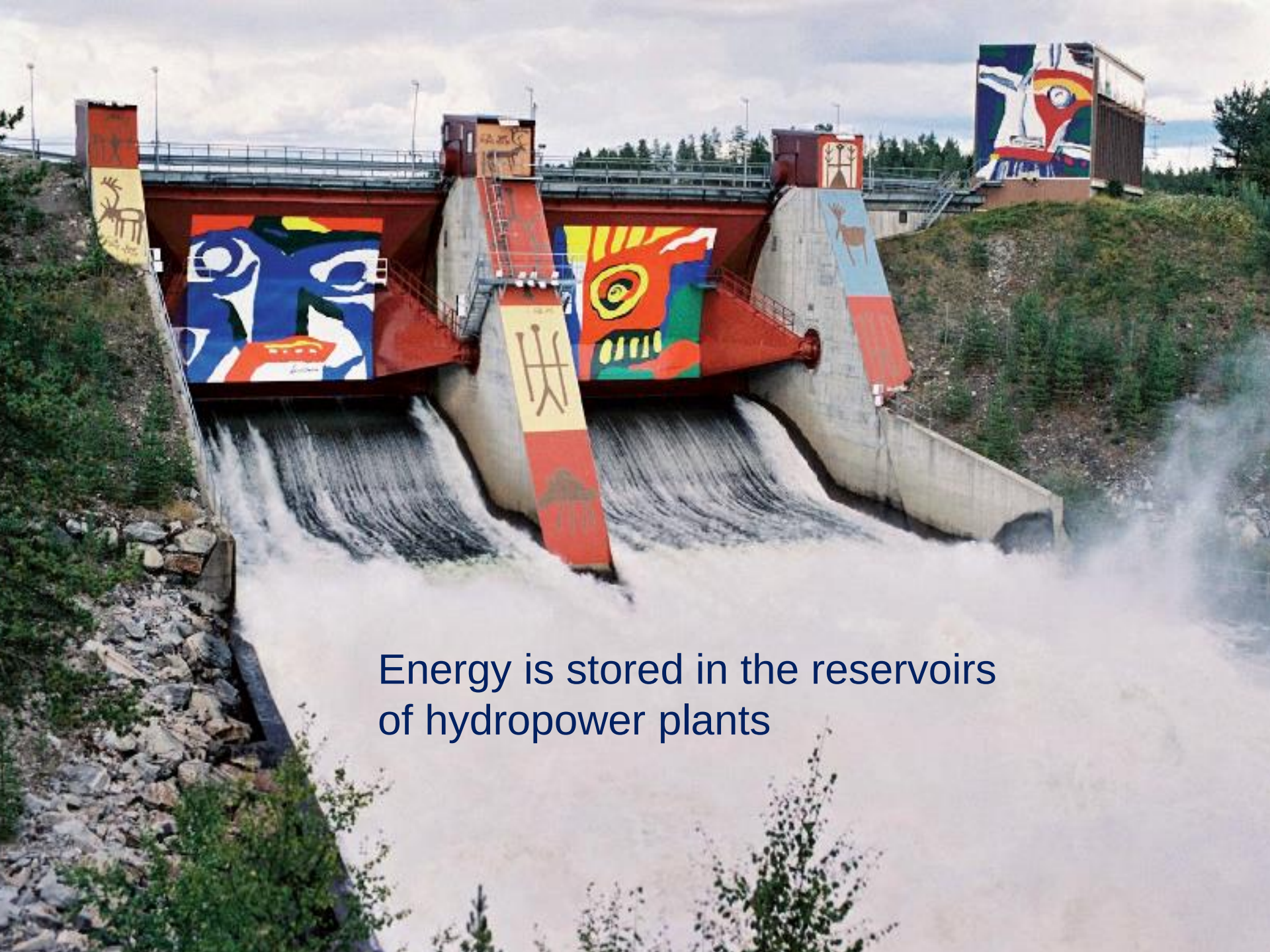
Swedish Energy Agency

Energy intensity (J/h)	Activity	Happiness
Very low (zero)	Sex	4,7
	Socialising	4,0
	Relaxing	3,9
	Praying/meditating	3,8
	Eating	3,8
	Exercising	3,8
	Watching TV	3,6
Use of appliances: medium high	Shopping	3,2
	Preparing food	3,2
	Talking in phone	3,1
	Taking care of children	3,0
	Computer/internet	3,0
	Housework	3,0
	Working	2,7
Commuting: high	Commuting	2,6

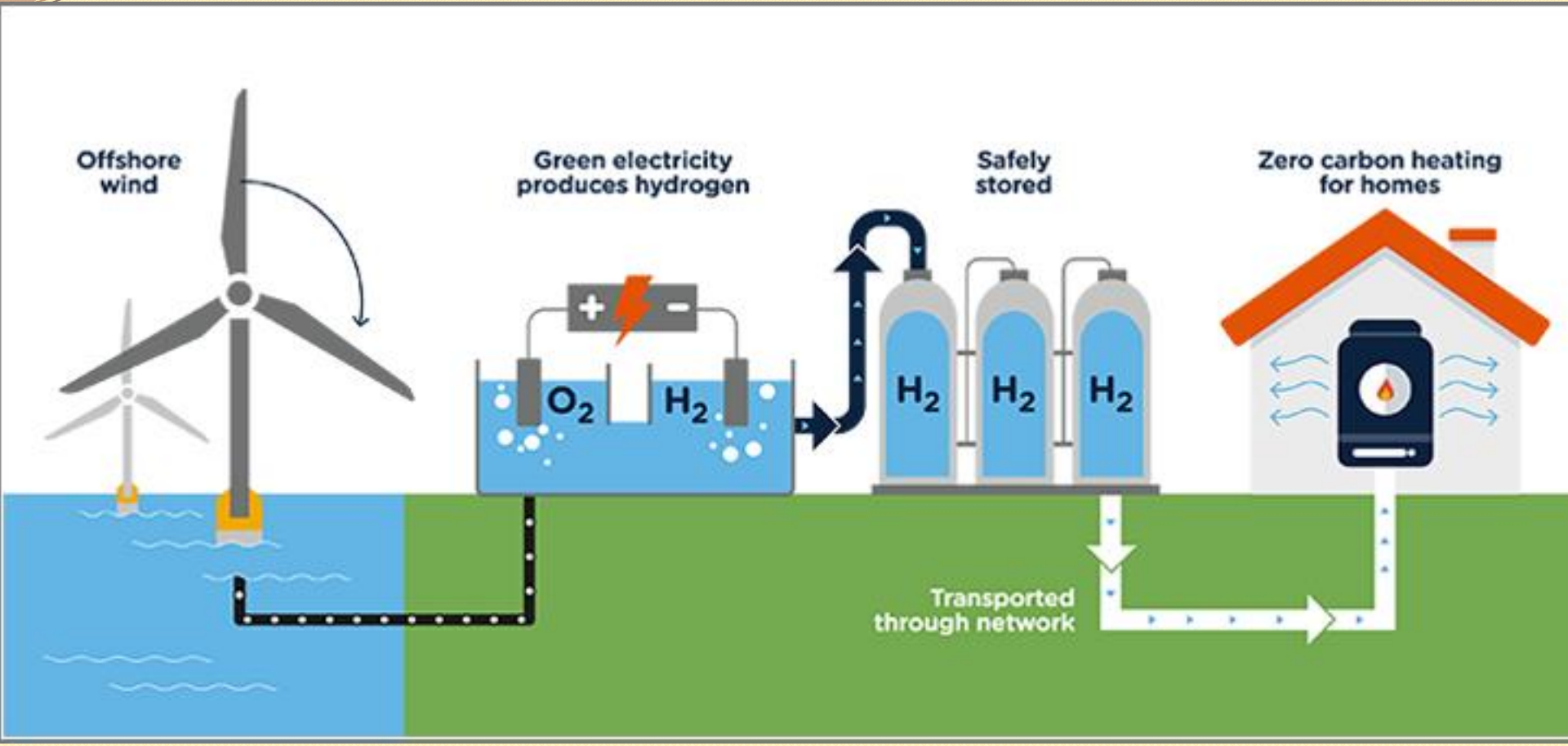
Storage of energy

Enormous amounts of energy is stored in biomass

How can we best harvest the biomass?

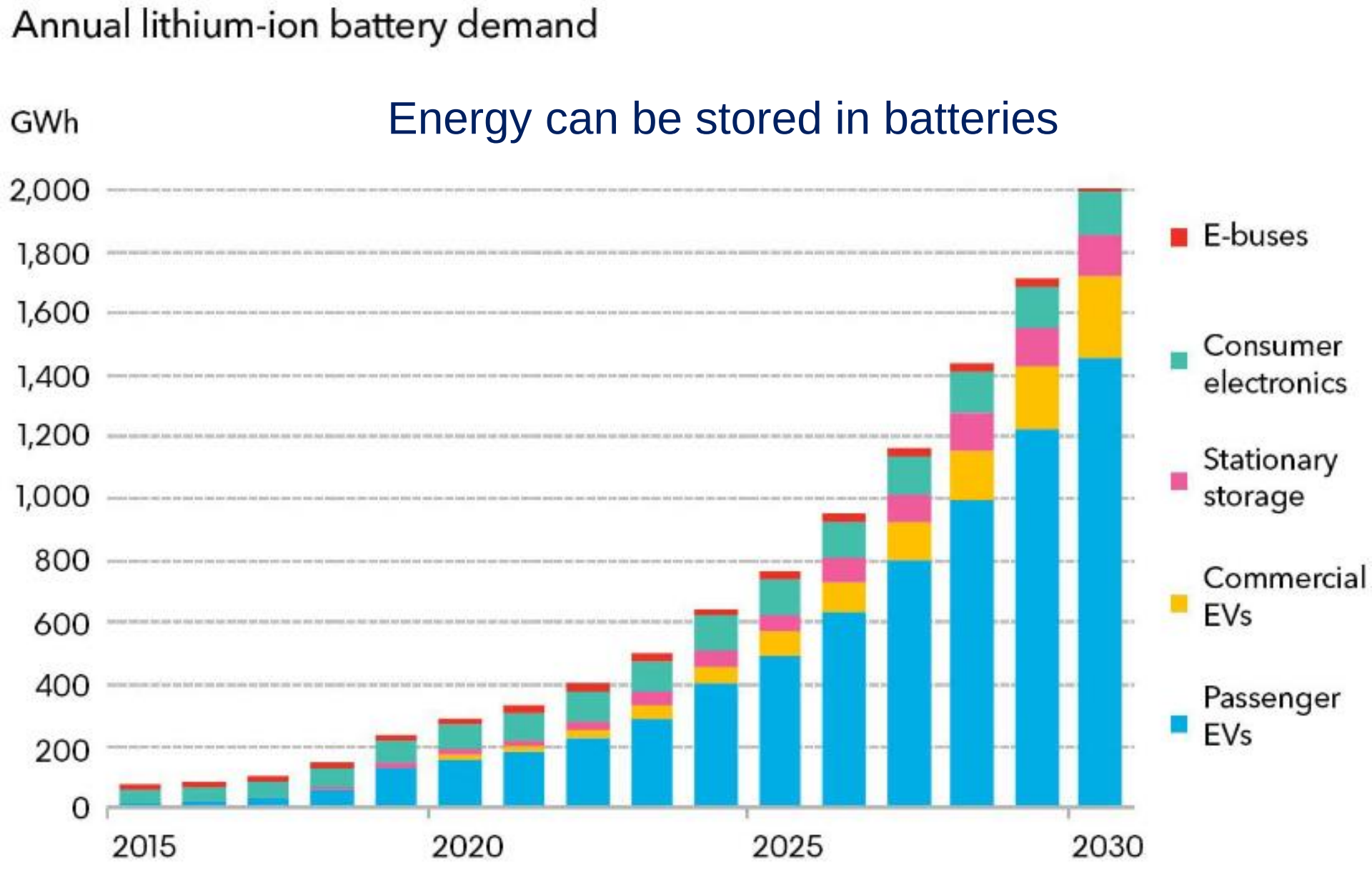


Energy is stored in the reservoirs of hydropower plants



Energy can be stored as hydrogen gas

Energy can be stored in batteries



Source: Bloomberg NEF 2019 Electric Vehicle Outlook

Energy efficiency

Energy conservation: Insulation of pipes and covers on containers

Building a passive energy house

A passive energy house

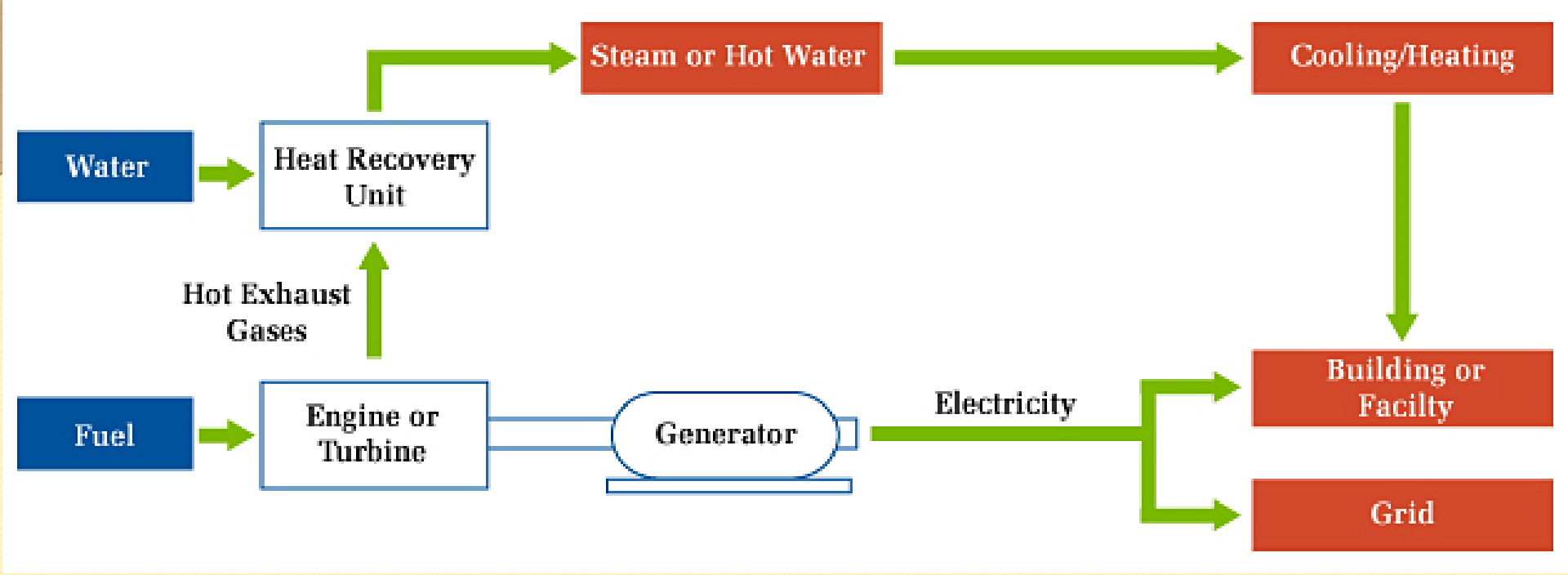
Improved technology

Torraca, Italy, has LED for all street lights

Improved technology

Electric cars

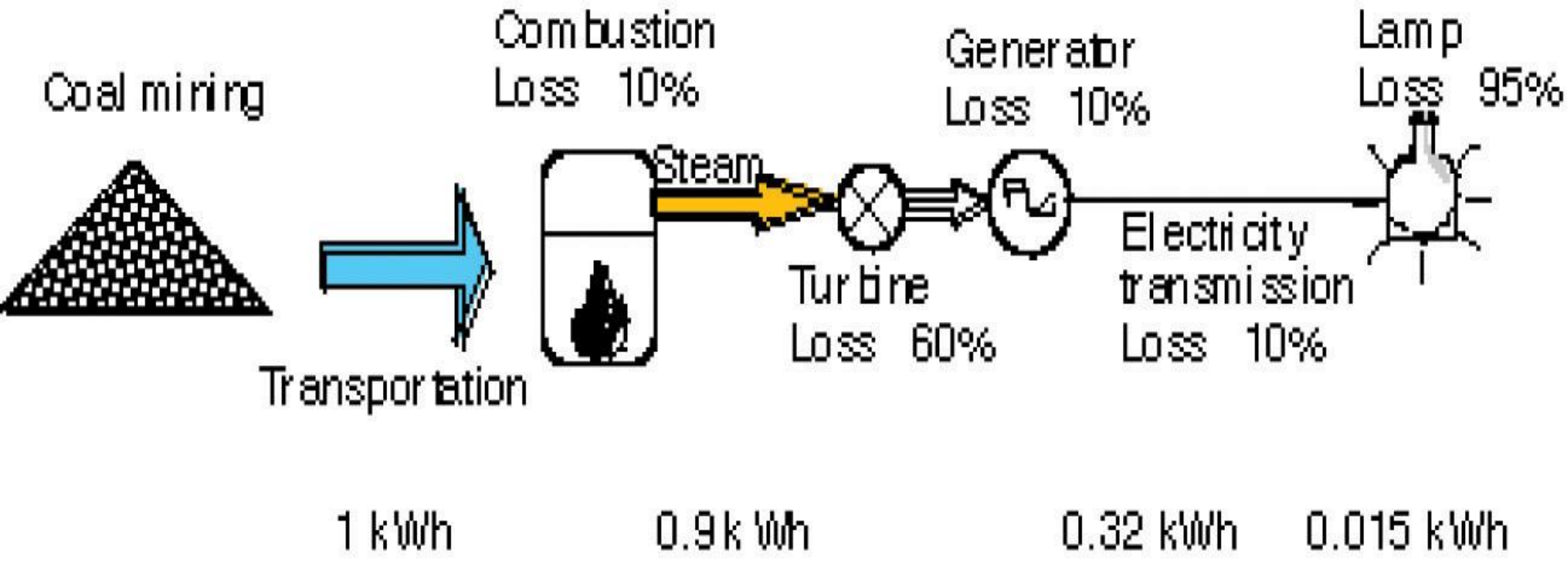
Combustion engine: 15 % of energy comes to the wheels
Electric engine: 90 % of the energy comes to the wheels



Power stations

Careful use of energy:
Combined heat and power - cogeneration

Why demand management is better than increased production



PFE - Energy Efficiency in Large Companies

Swedish Energy Authority

- 100 companies took part
- All made a complete energy use mapping
- All introduced a certified energy management system
- 1247 projects and 1.47 TWh less electricity annually
- 708 MSEK in investments
- 400 MSEK less energy costs annually
- Average return of investments 1.5 year
- Tax reductions 150 MSEK annually

Mapping Energy use, project proposals

1. Background
2. Photos
3. Energy efficiency proposals
4. Drawbacks of each
5. Calculations – kWh, Investments, Return on investements

52 projects during 2 years

Primary improvements

- Temperature adjustments
- Heat recovery
- New valves
- Insulation
- Changed routines
- New lighting
- Toilets

Secondary improvements

- Reduced water use
- Decreased fire risks
- Less air pollutants
- Less noise

Results after 2 years

- Accomplished 19 304 MWh /year
- Under planning 32 942 MWh /year

Increased use of renewable resources

- promoting local development
- creates new jobs
- combats climate change
- requires competence
- creates social capital
- promotes sustainable development


The power plant in Enköping produces heat and electricity to the town using forest rest Products.
Yield: ca 90 %
Emissions: 2,99 g CO2/kwh
https://www.enae.se/
© Henrik von Klopp

Biofuel - waste

Uppsala biogas station use organic waste, including food waste from households etc to produce biogas, methane.

All citybuses in Uppsala are running on locally produced Biogas.

Similar in many Swedish cities.

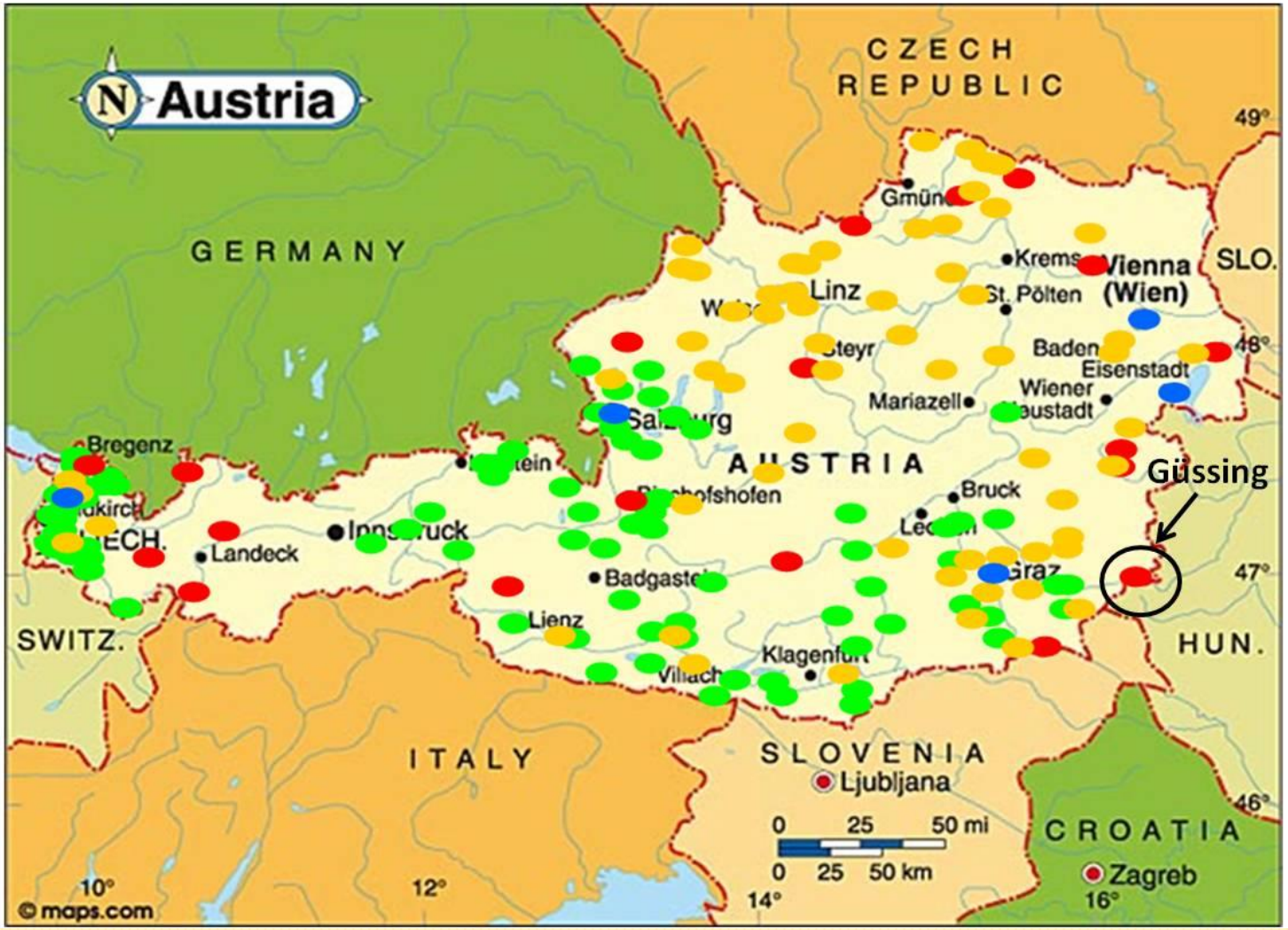
Güssing, Austria

From 1992 and in 11 years, Güssing became self-sufficient in electricity, heating, and transports. In the process 60 new companies with more than 1,500 new "green jobs" were created and commuting decreased to 40 %. On top of this Güssing now sells green energy outside the municipality to $28 million yearly and emissions of CO_2 decreased by more than 80%.

https://www.100-percent.org/gussing-austria/

Energy Independence
Growing on Regional Level

Regions Independent in Electricity, Heat and/or Transportation **E-Mobility Pilot Projects**
Regions with growing Energy Independence **Regions with high Energy Efficiency standards**



Networks of fossil-free municipalities in the world

- ***Post carbon cities***, USA based
- ***Local Renewables Initiative*** run by ICLEI (local authorities for sustainability)
- ***Solar Cities*** network Australia
- ***52 cities in Japan*** develops energy autonomy
- ***Transition Towns*** A network for munciplities with local transition initiatives to tackle the double challenge of peak oil and climate change.
- And many more!

To read

- Energy and Climate. Chapter 1 *Energy and Sustainable Development*. pp 11-22.

- Energy and Climate. Chapter 2 *How much energy do we use – energy statistics*. pp 23-34.

30 minutes

- Discuss which kind of energy you use
- Discuss which kind of energy your university uses
- Discuss how can you save energy

After 10 minutes we meet and talk together!