

May 2023

XI International School on
Nuclear Power

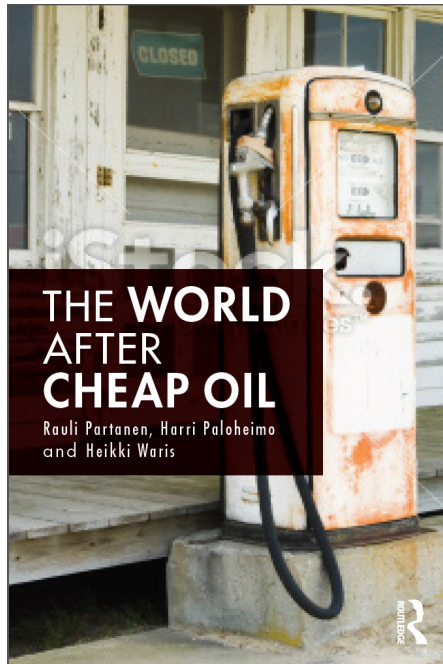
**NUCLEAR POWER IN THE CLEAN
ENERGY MIX**

RAULI PARTANEN

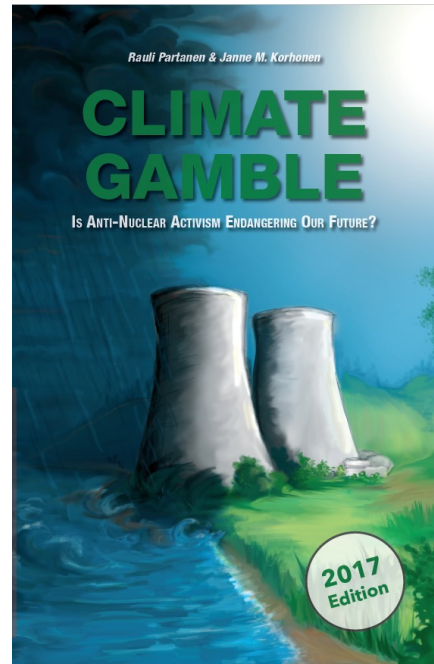
THINK ATOM

RAULI WHO?

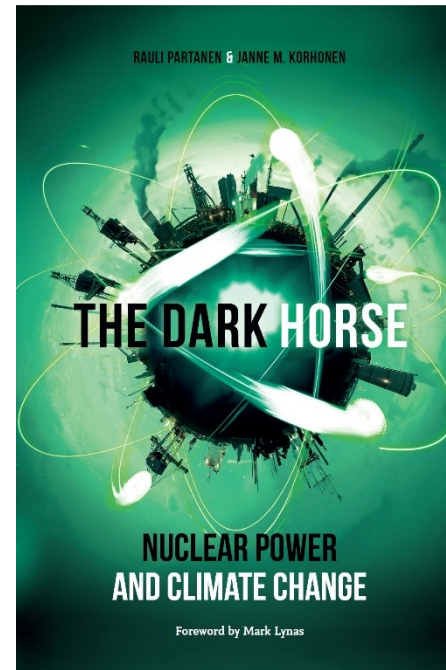
- 🌀 Award-winning science writer, analyst, and communicator
- 🌀 Environmental activist (Ecomodernist Society of Finland, RePlanet)
- 🌀 Co-founder & CEO of Think Atom (Thinkatom.net/publications)



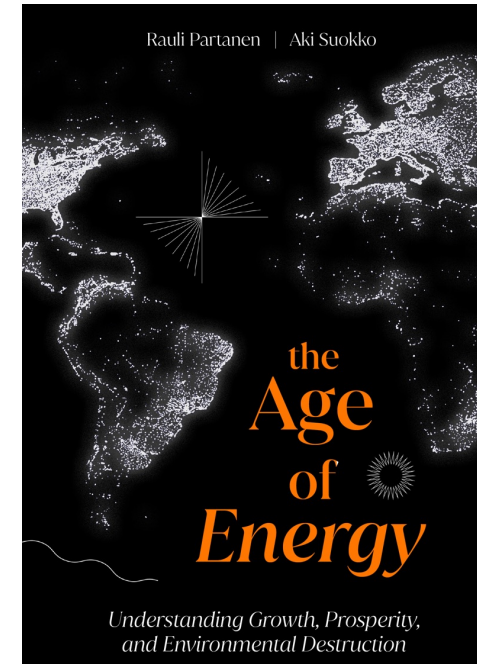
2014



2015

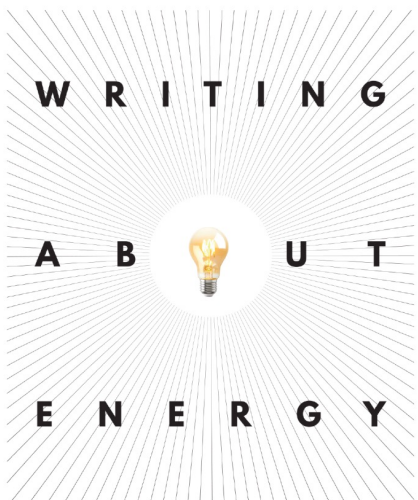


2020

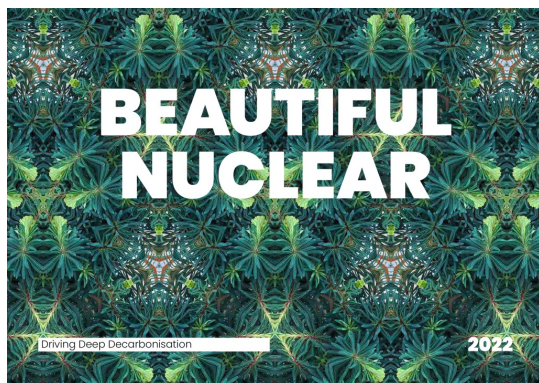


2022

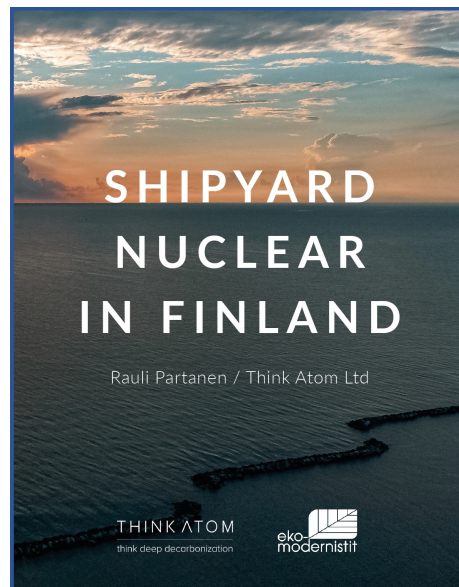
THINK ATOM



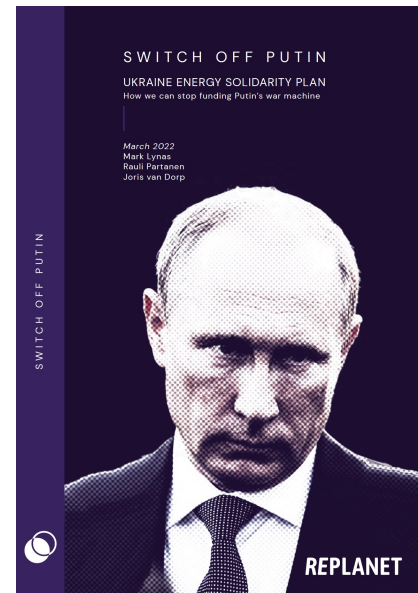
2023



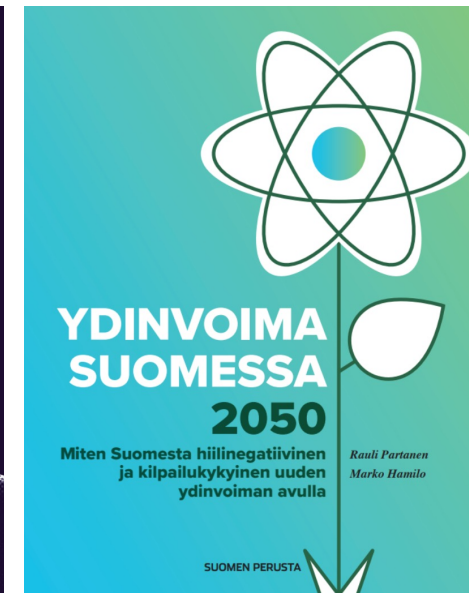
2022



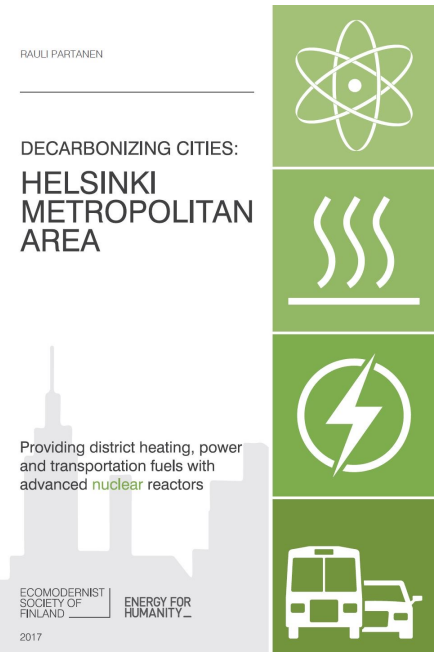
2022



2022



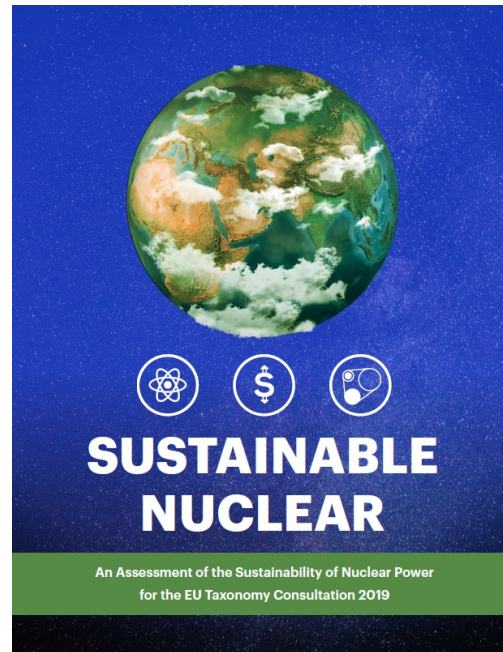
2021



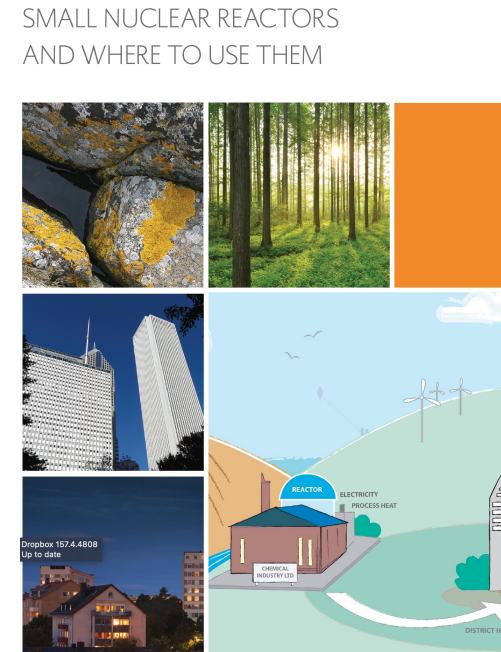
2017



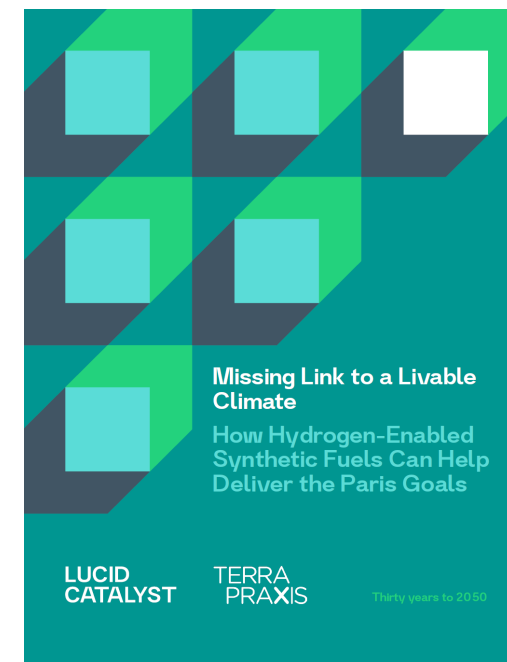
2019



2019

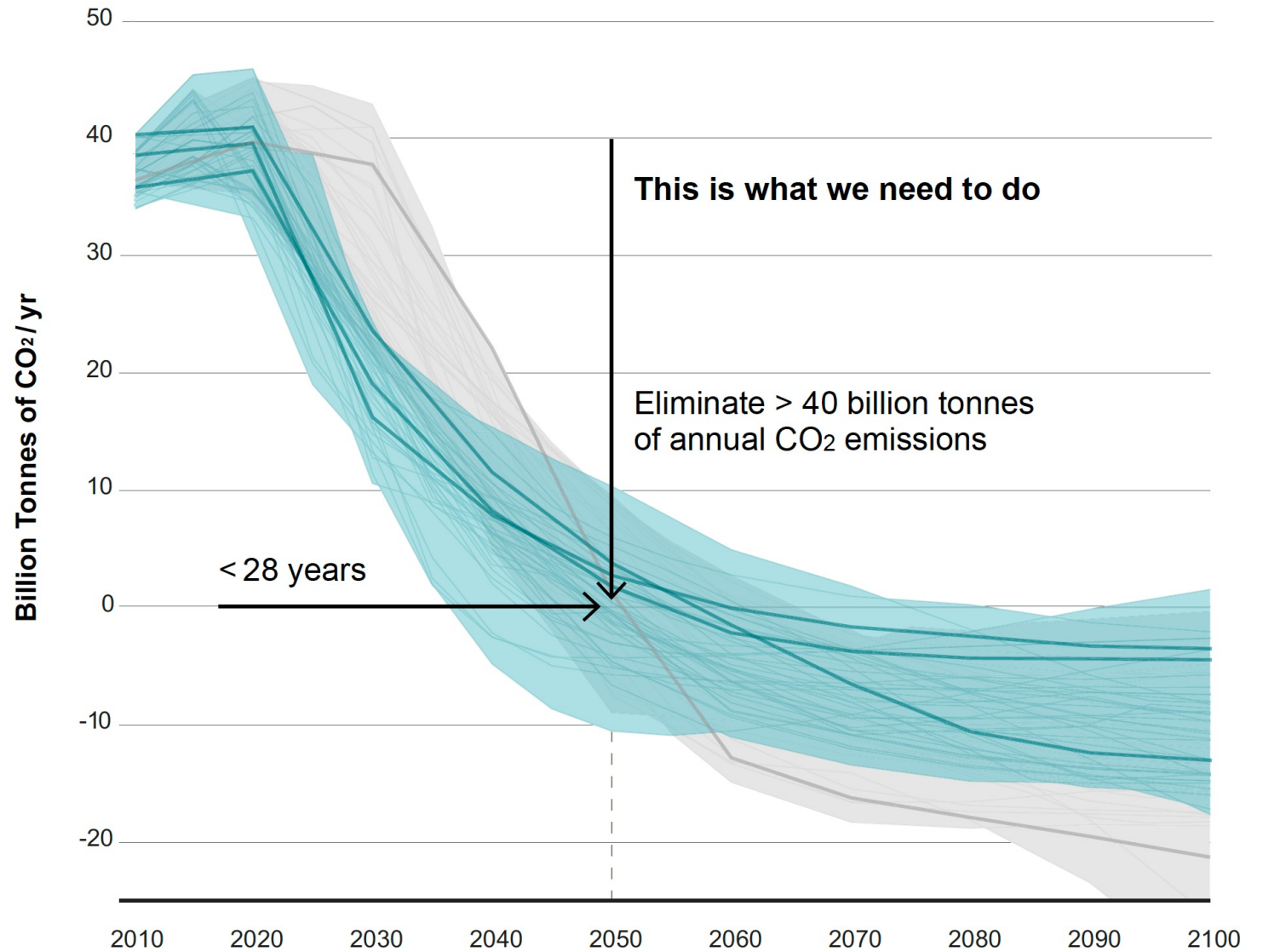


2020



2020

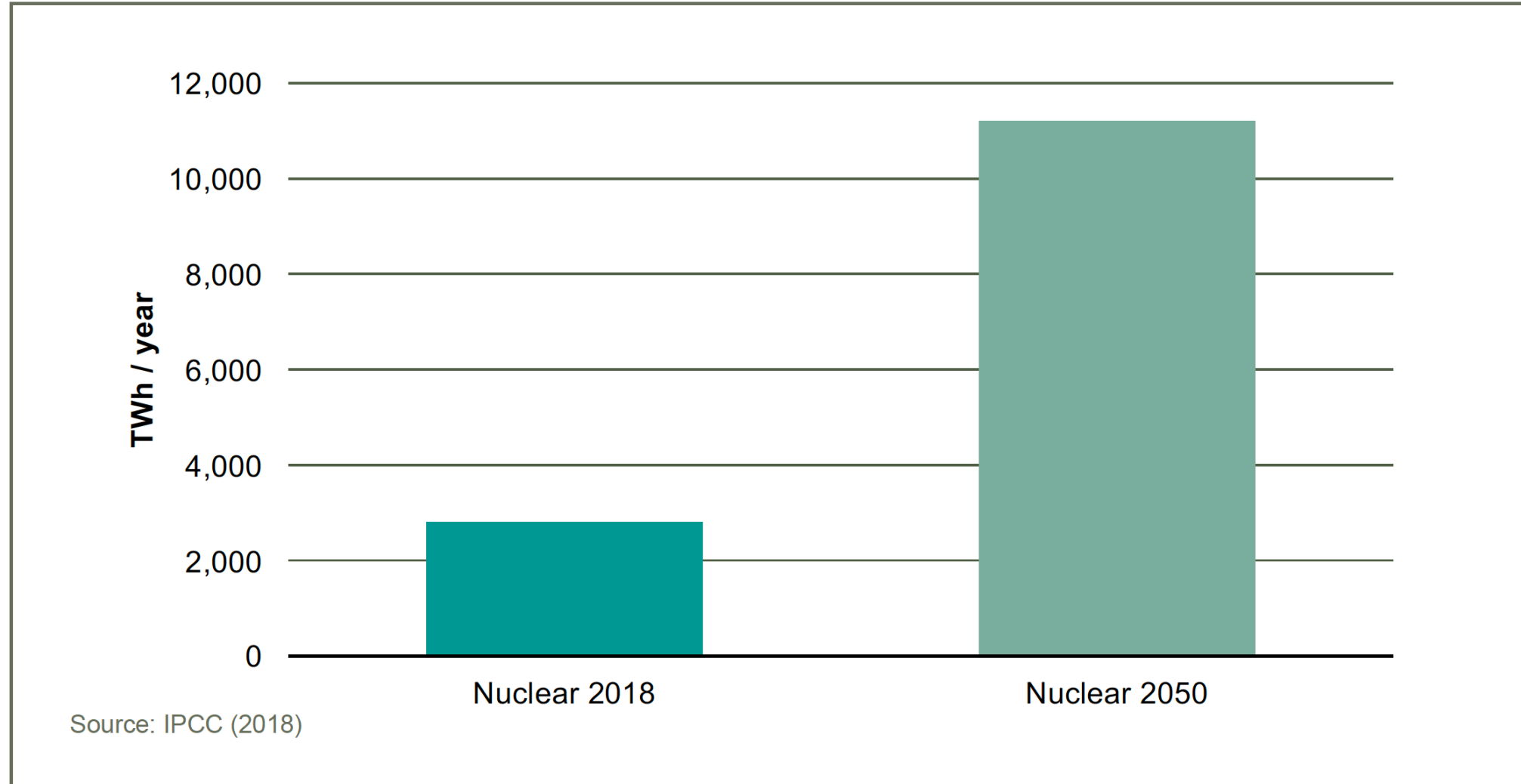
Part 1. Scale and Urgency



Source: IPCC (2018)

Figure 2. Projections of global net CO₂ emissions

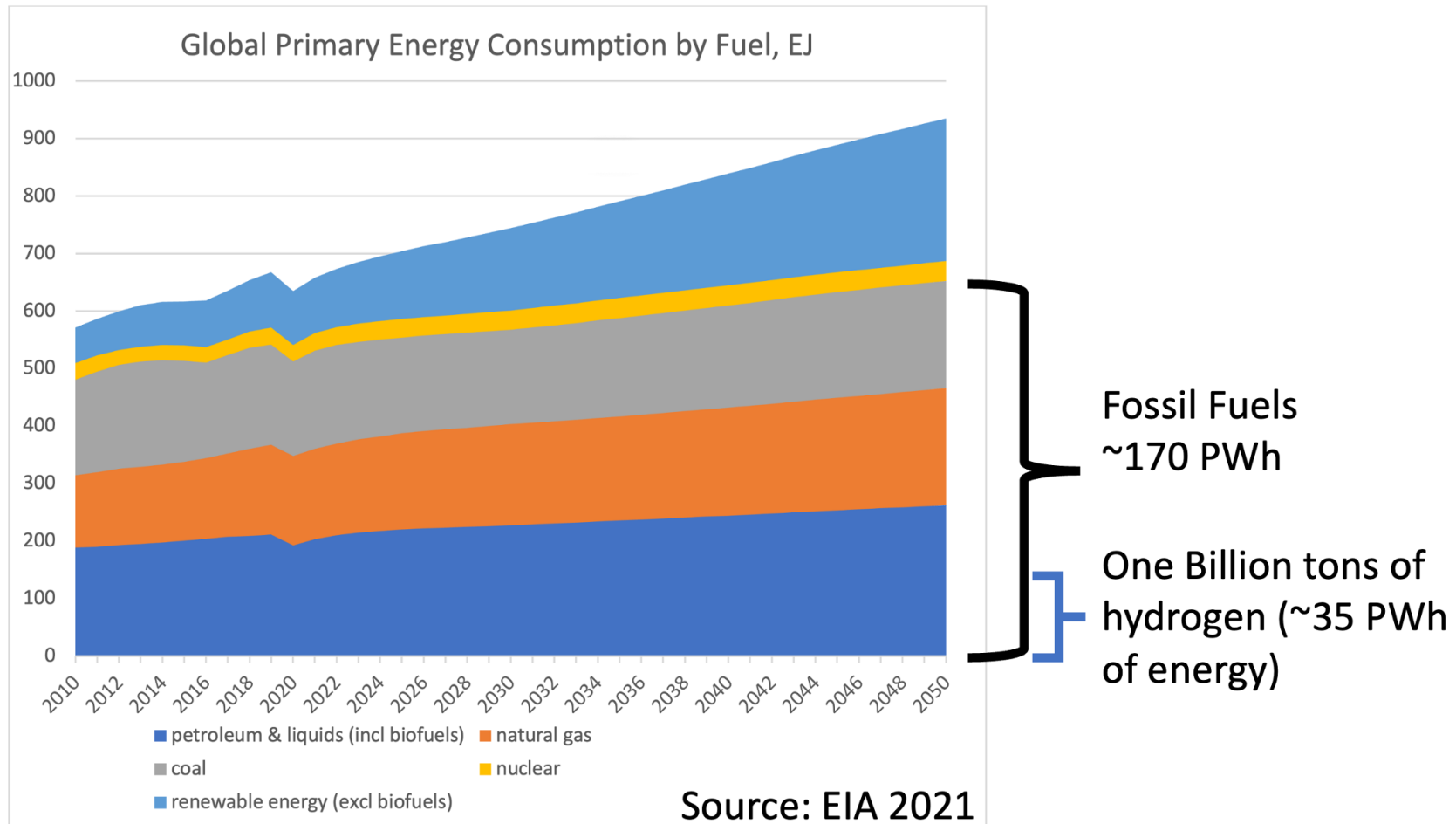
IPCC on the need for more nuclear



Source: IPCC (2018)

Figure 6. Nuclear generation in 2018 v. 2050 (2050 is IPCC average of four main scenarios)

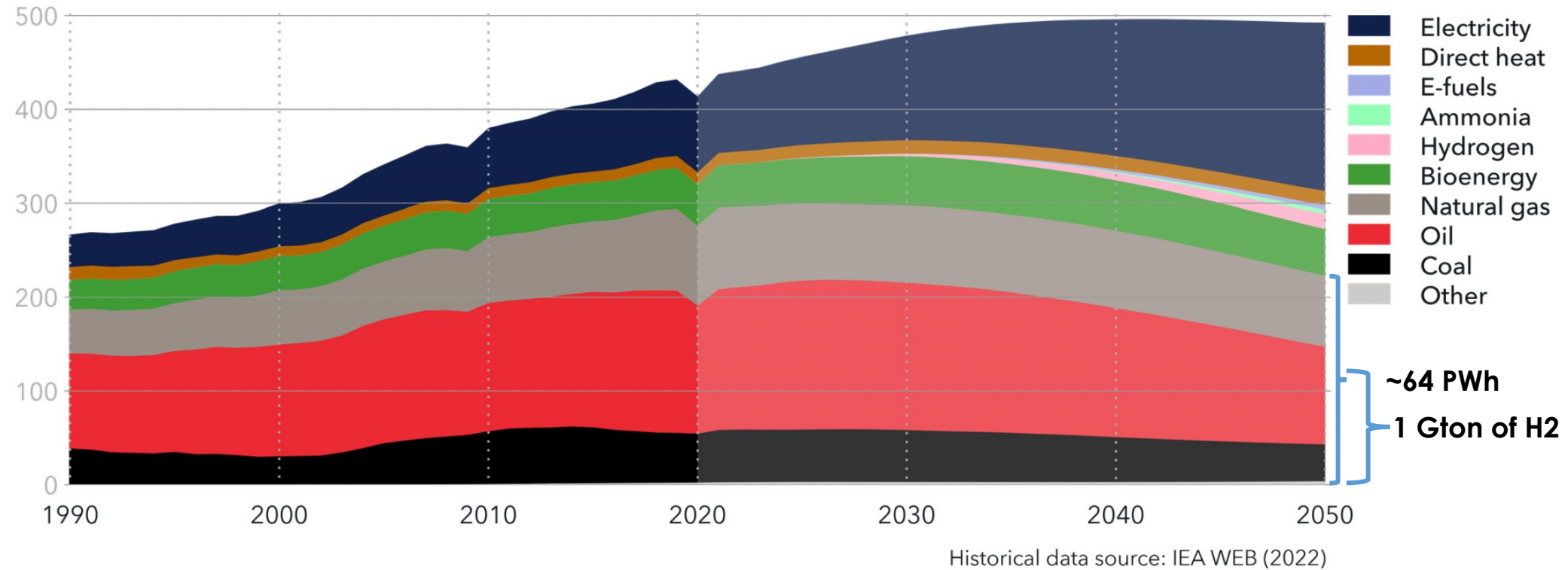
THE GLOBAL GAP ON CLEAN FUELS



THE GLOBAL GAP ON CLEAN FUELS

World final energy demand by carrier

Units: EJ/yr

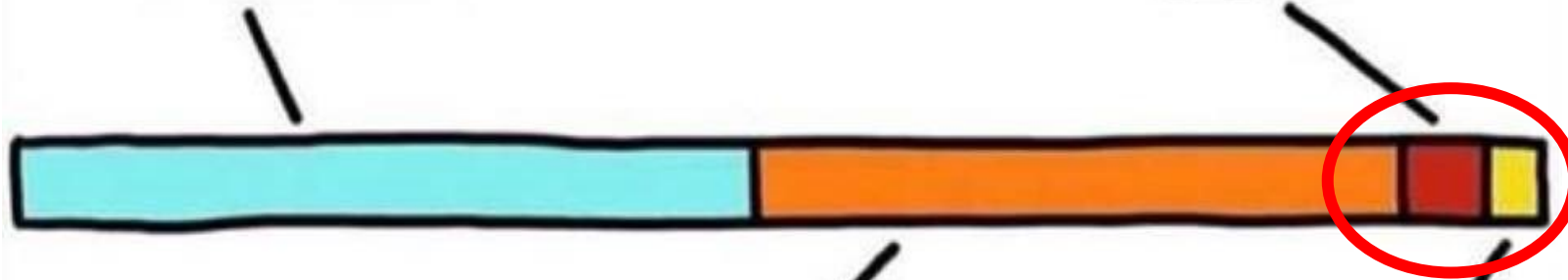


CLIMATE CHANGE

A TIMELINE

©SEMI-RAD

"NUCLEAR POWER IS
MORE DANGEROUS
THAN FOSSIL FUELS"



OOPS

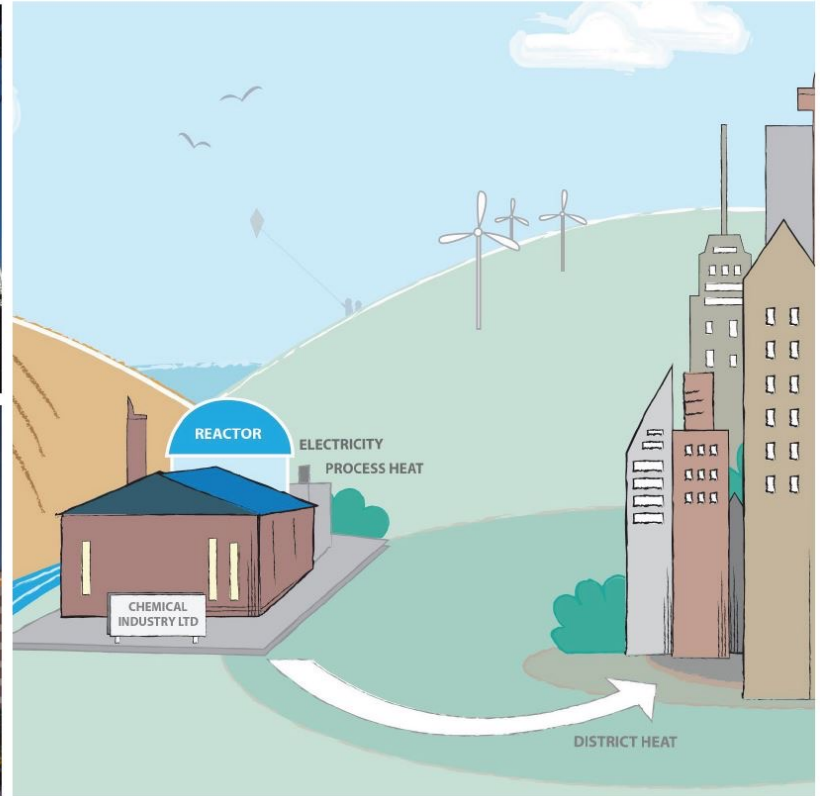
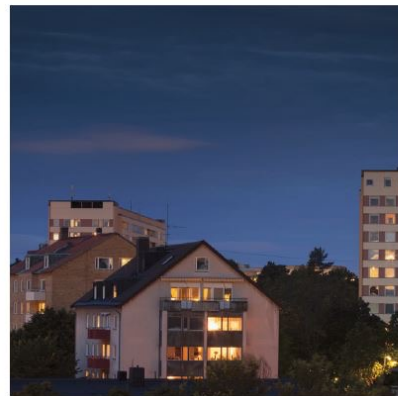
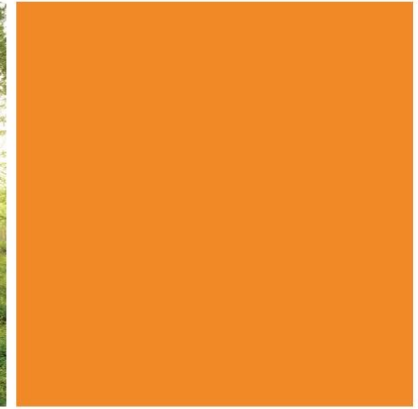
WE ARE
HERE...

"OK, IT IS NOT. BUT IT
IS NOT PROFITABLE IN
A LIBERALIZED ENERGY
MARKET"

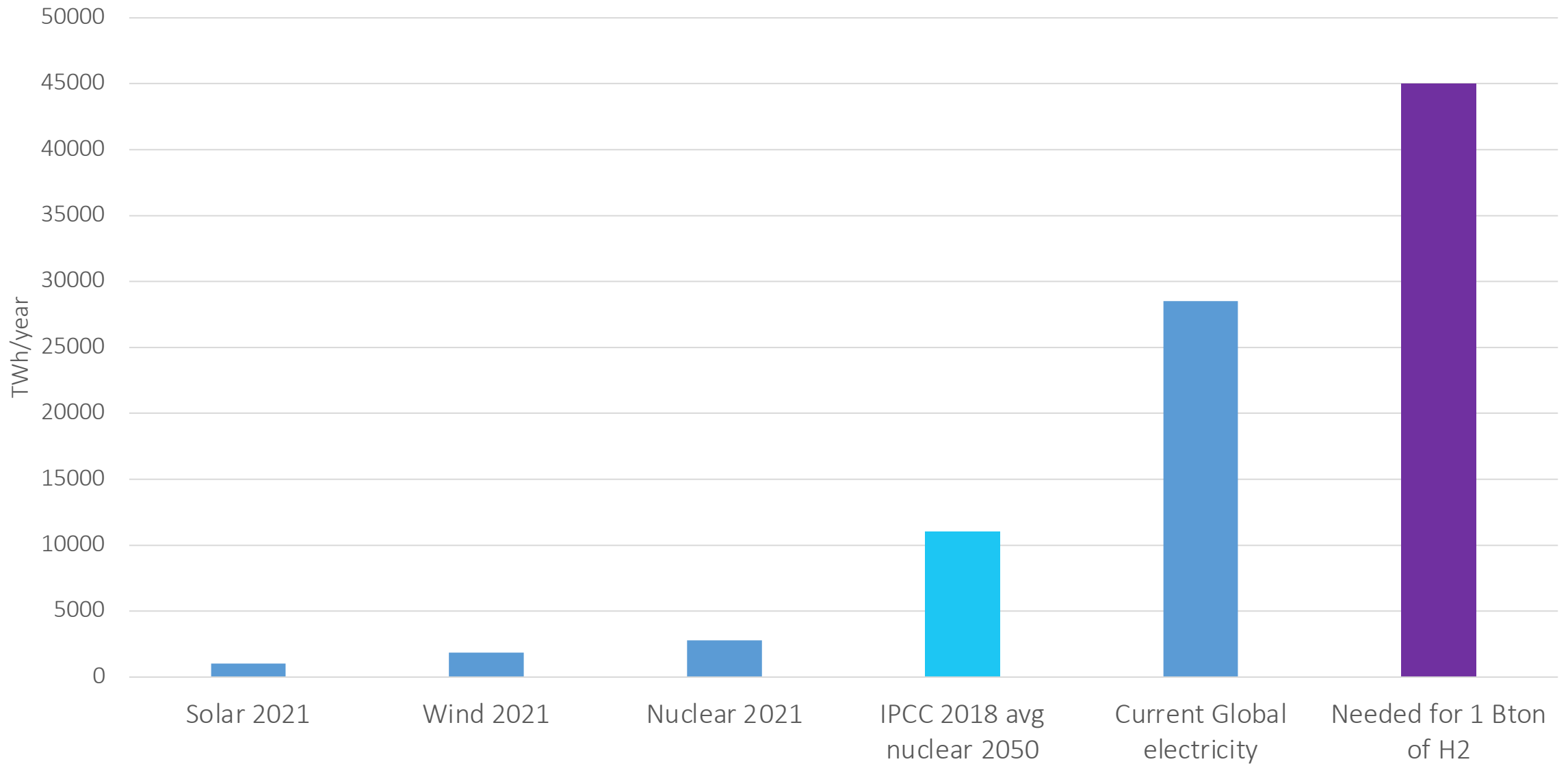
FUCK

SMALL NUCLEAR REACTORS AND WHERE TO USE THEM

Part 2. The Case for Nuclear



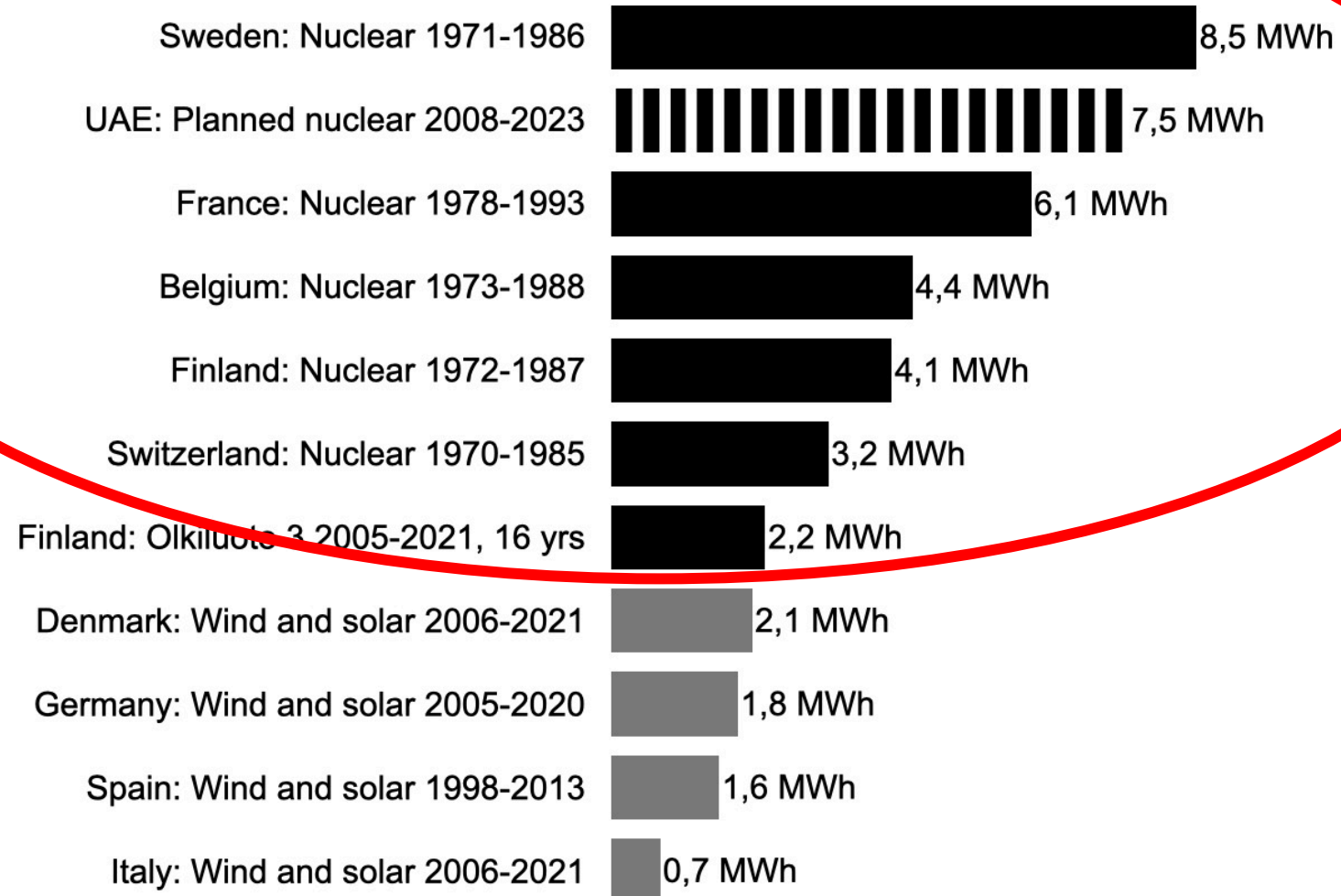
IT'S ABOUT SCALE



“No other carbon-neutral electricity source has been expanded anywhere near as fast as nuclear.”

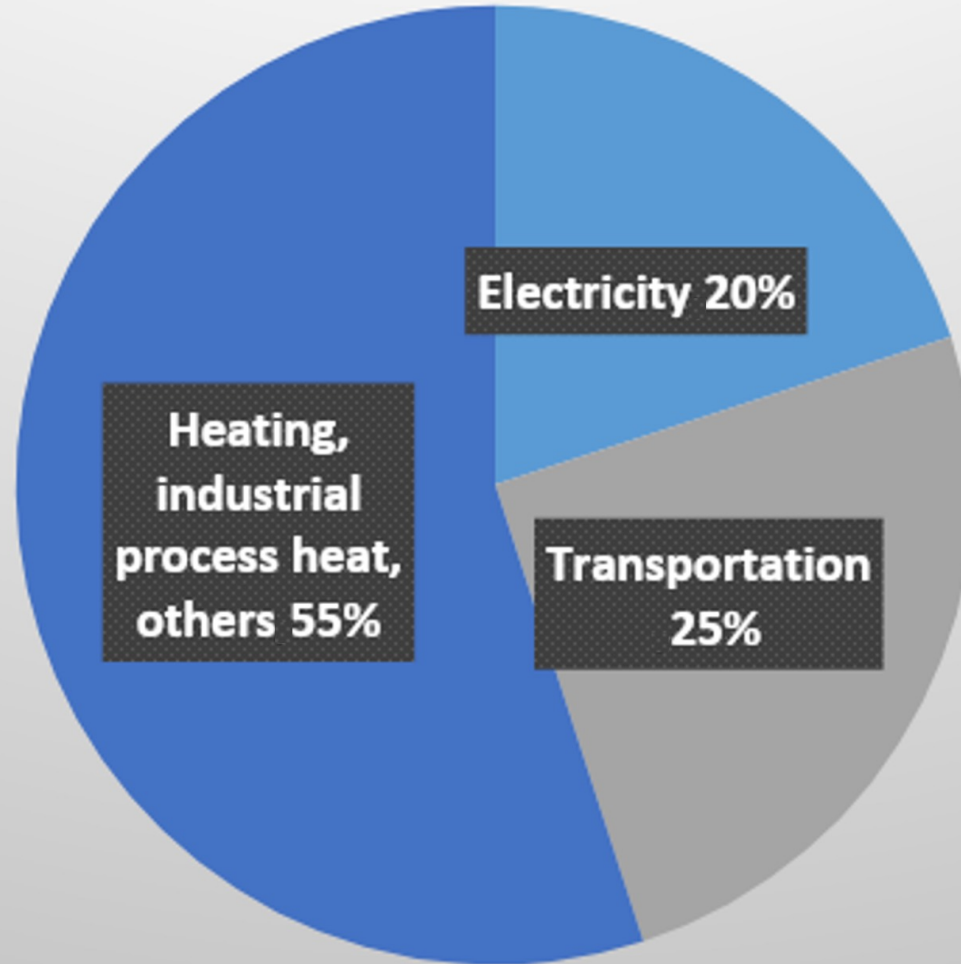
Barry Brook & Staffan Qvist

Best increase in electricity generation per capita over 15-year period

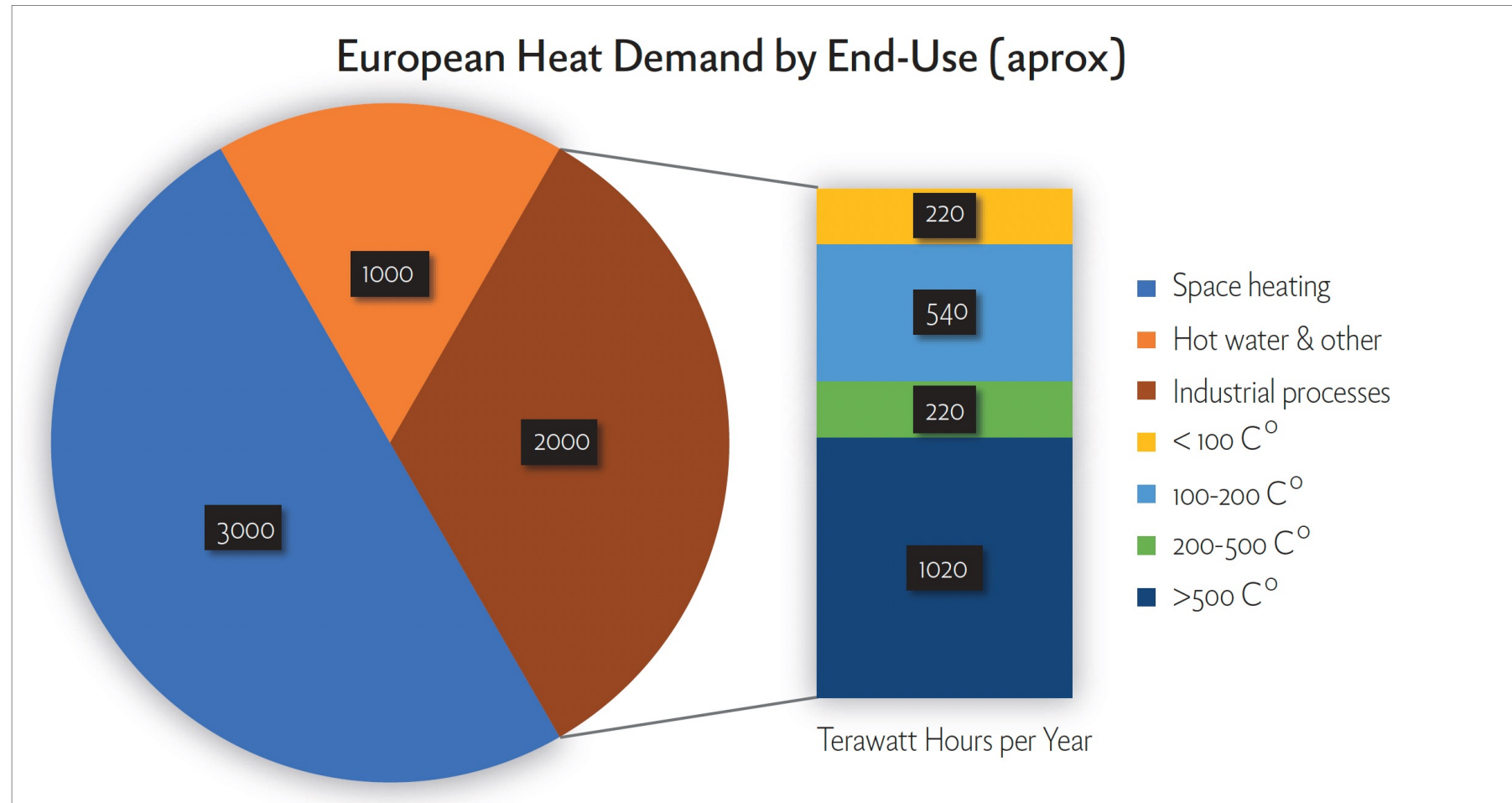


WHAT WE
USE WHEN
WE USE
ENERGY?

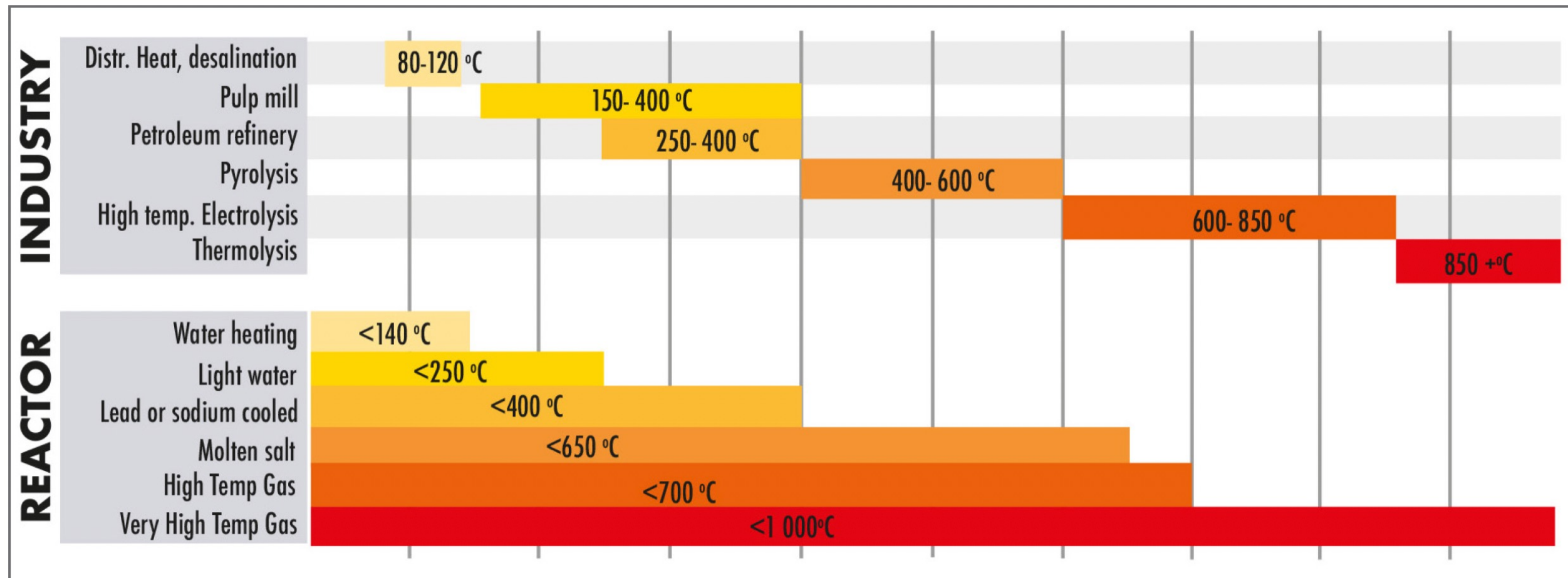
Shares of end energy use (global)



HEAT & STEAM IN EUROPE



Roughly half of energy is used as heat. In Europe, the total heat use is roughly 6,000 TWh/year. It is split for different use-cases and temperatures as seen on the graph.

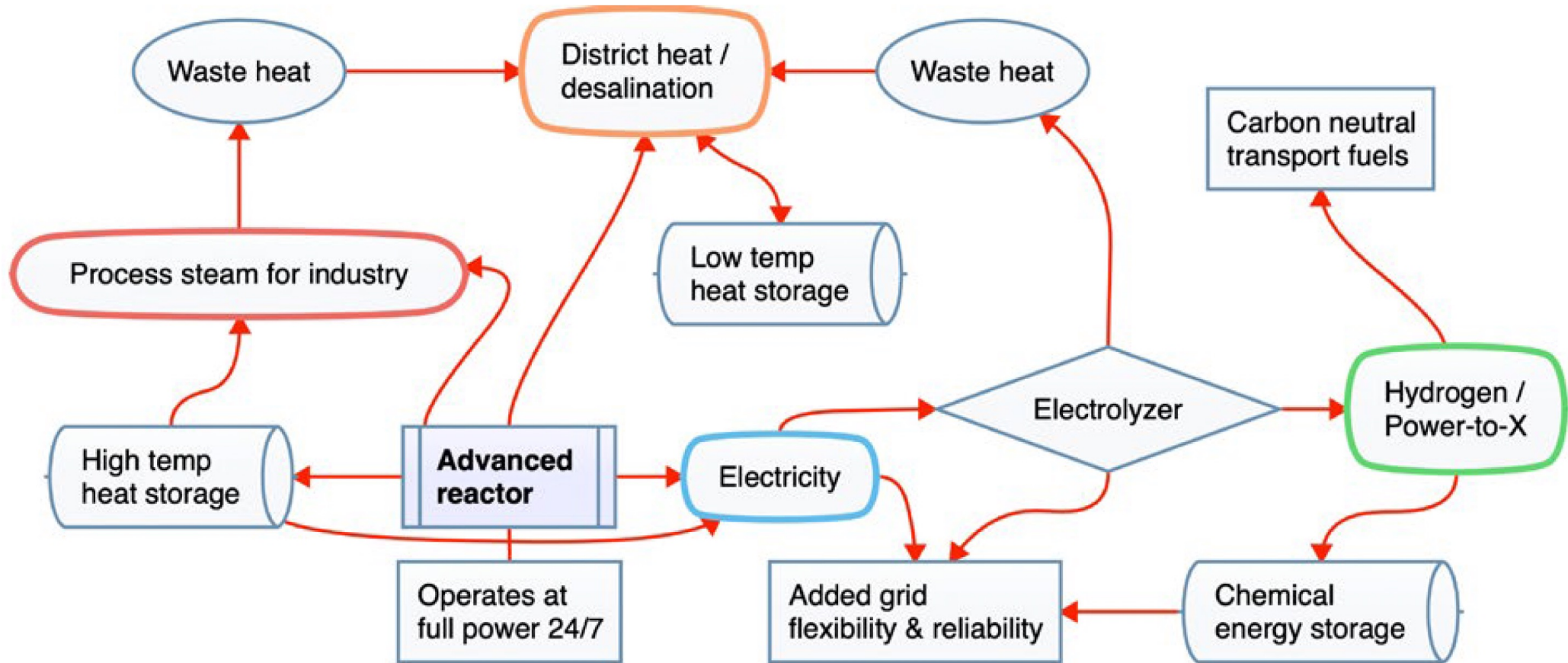


Temperature ranges used in various industries compared with temperature ranges produced by different types of reactors.

NUCLEAR CAN PRODUCE...

- Low-q heat for district heat & desalination
- High-q steam for industry processes
- Electricity (baseload and flexible)
- Hydrogen (both electrolysis & steam electrolysis)

AN ADVANCED REACTOR IN A HYBRID ENERGY SYSTEM



Part 3. Nuclear and Sustainability



SUSTAINABLE DEVELOPMENT

- Nuclear technology contributes, in some way, to **EVERY SINGLE ONE** of the 17 UN Sustainable Development Goals (UNECE 2021).

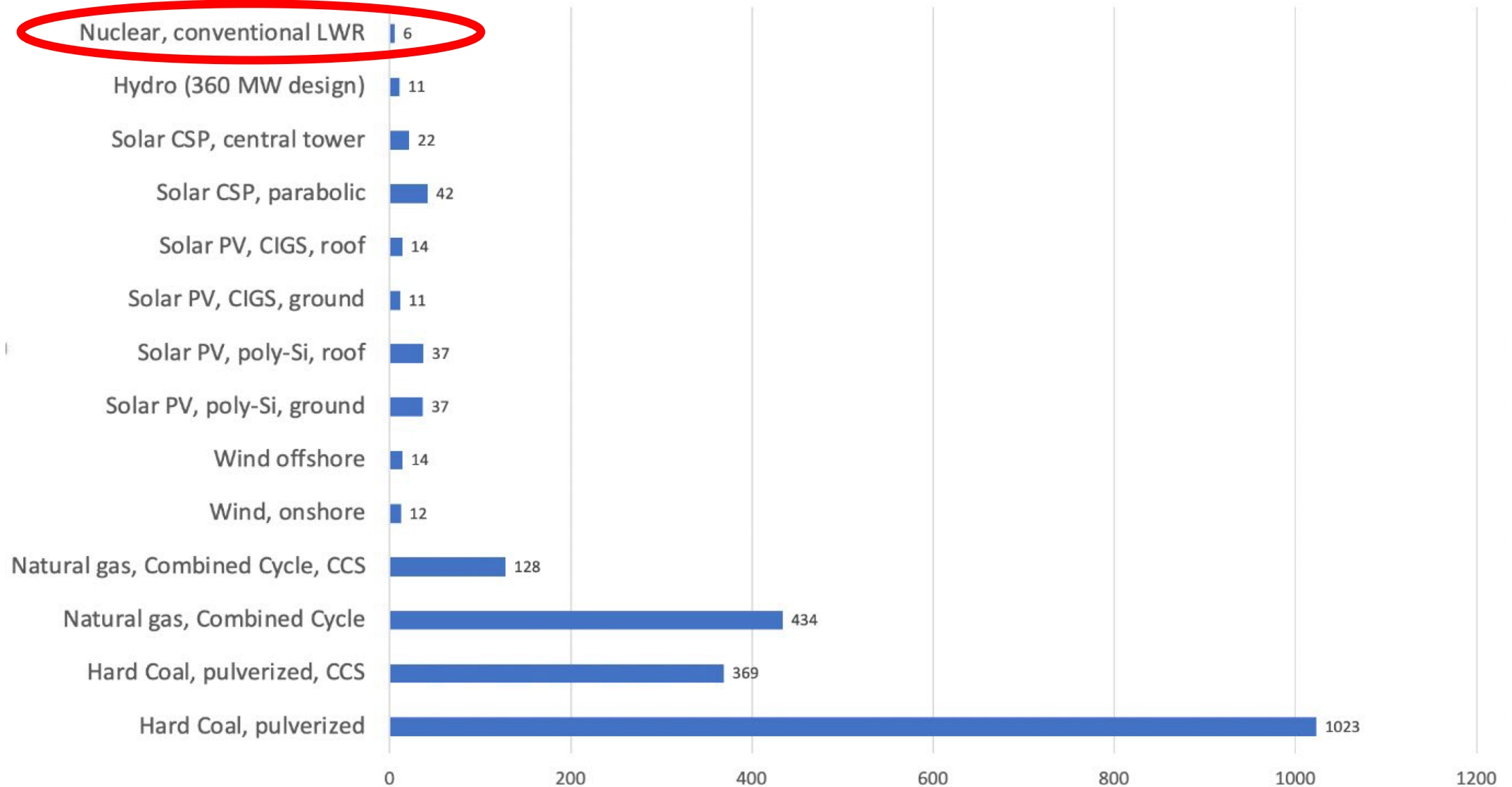
Use of Nuclear Fuel Resources for Sustainable Development – Entry Pathways

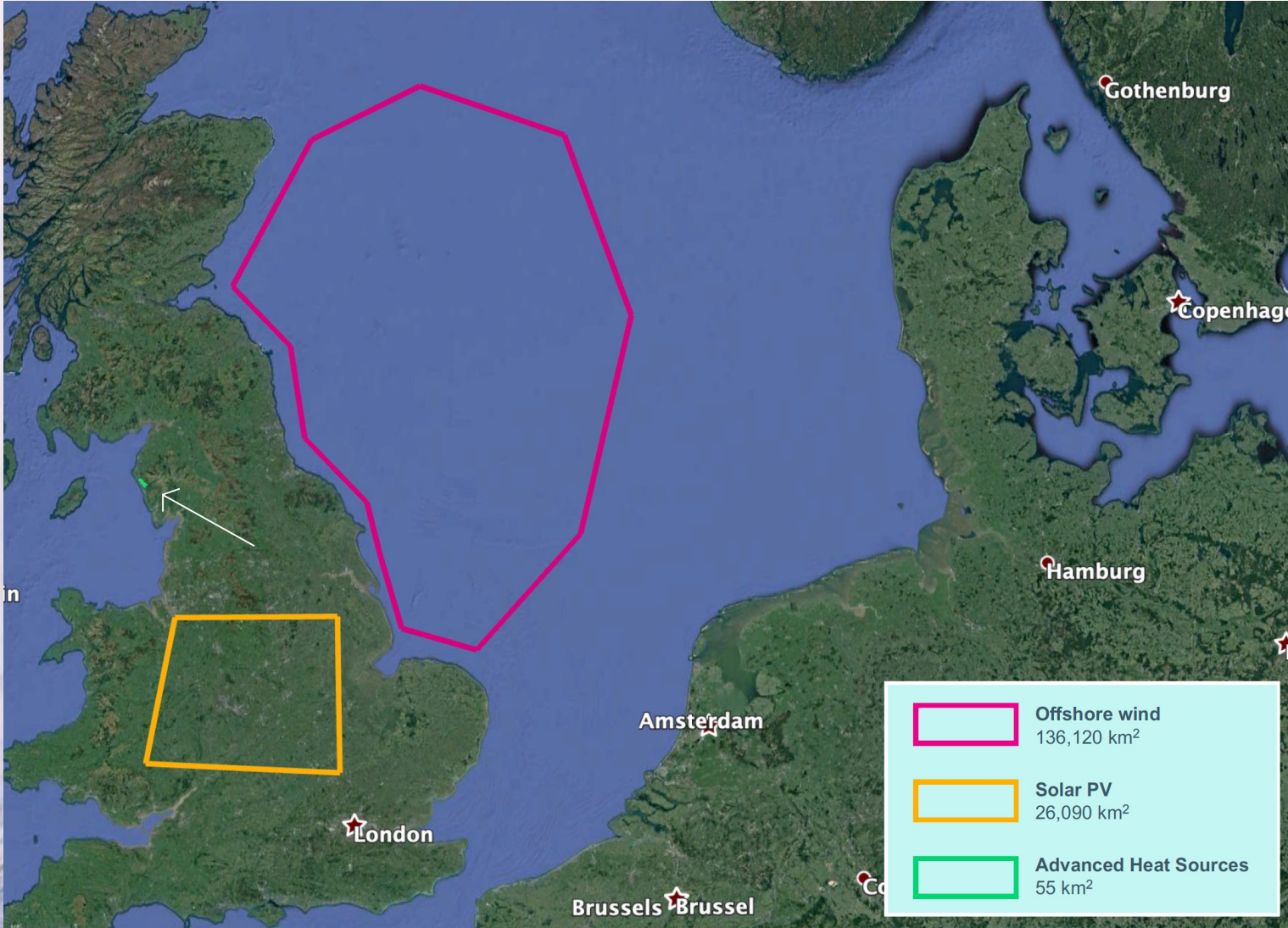


NUCLEAR IS THE LOWEST CARBON

Lifecycle emissions, Europe 2020, gCO₂-eq/kWh.

Data: UNECE 2021





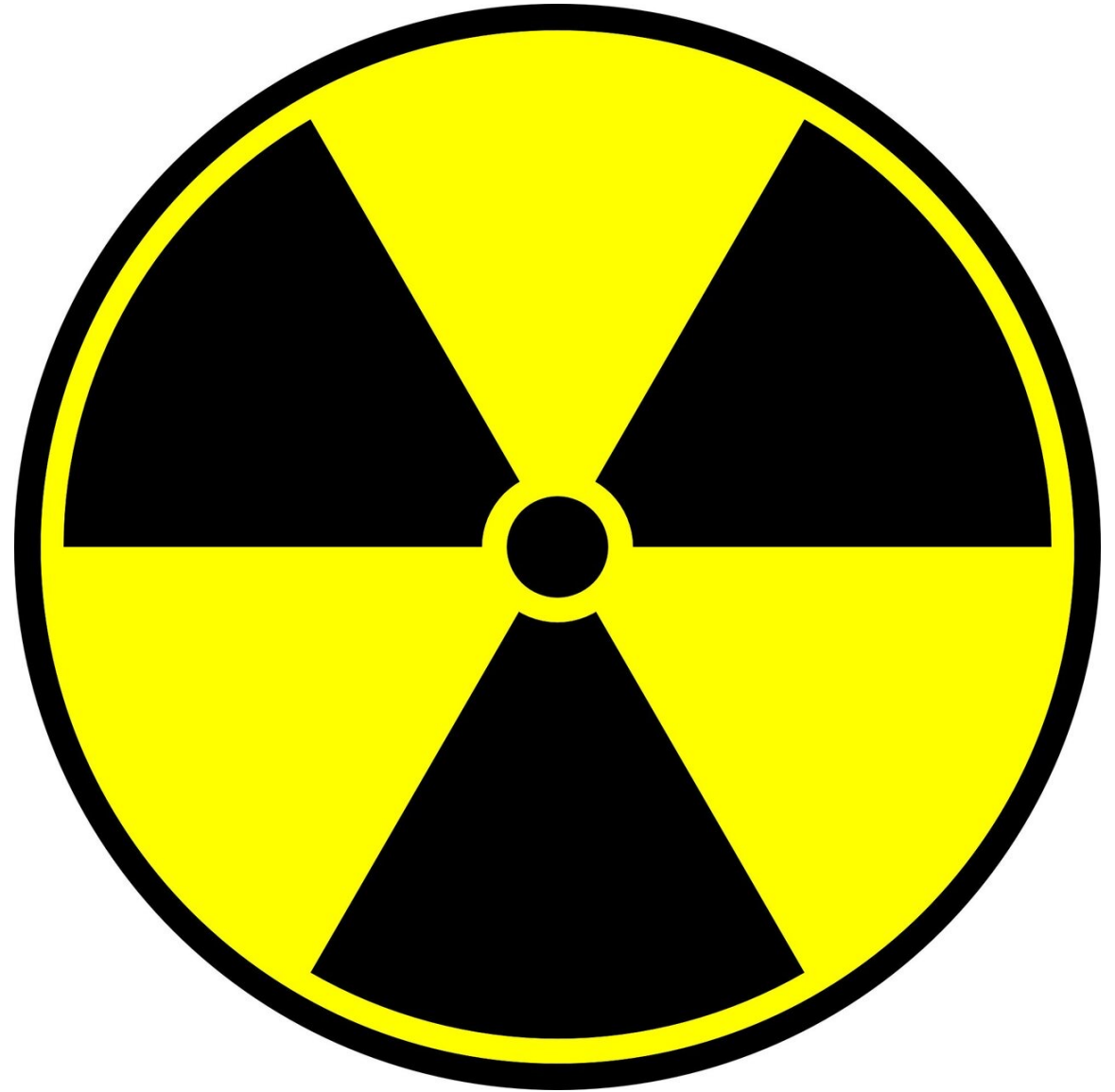
Area required to replace UK's current oil consumption with hydrogen.

NUCLEAR HAS THE
SMALLEST
ENVIRONMENTAL
FOOTPRINT



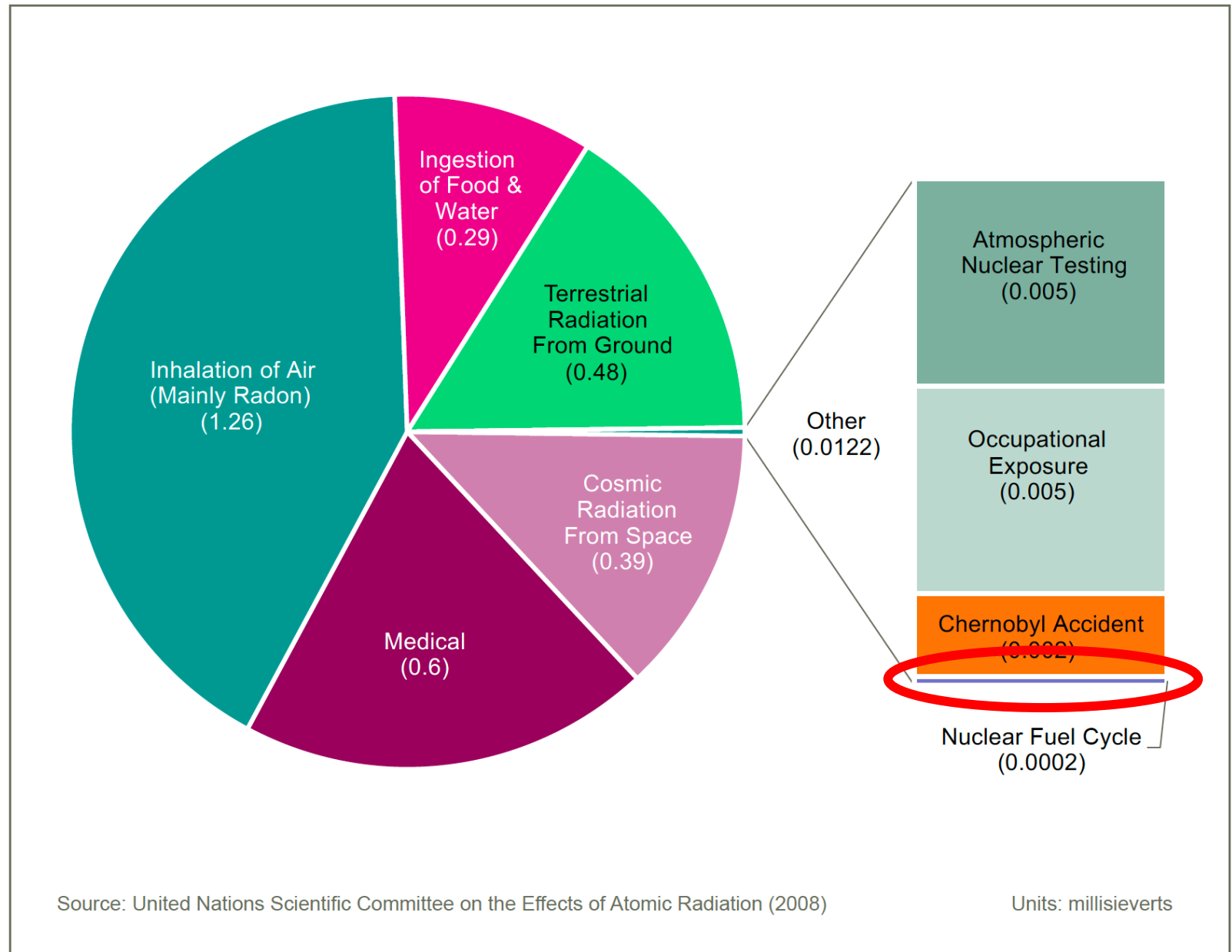
3.1

THE ISSUES



WHAT ABOUT RADIATION?

- The industry and our society has utterly failed to communicate the scale of the matter.



Source: United Nations Scientific Committee on the Effects of Atomic Radiation (2008)

Units: millisieverts

Figure 32. Sources of global radiation, average annual dose from all sources

...AND SPENT FUEL?

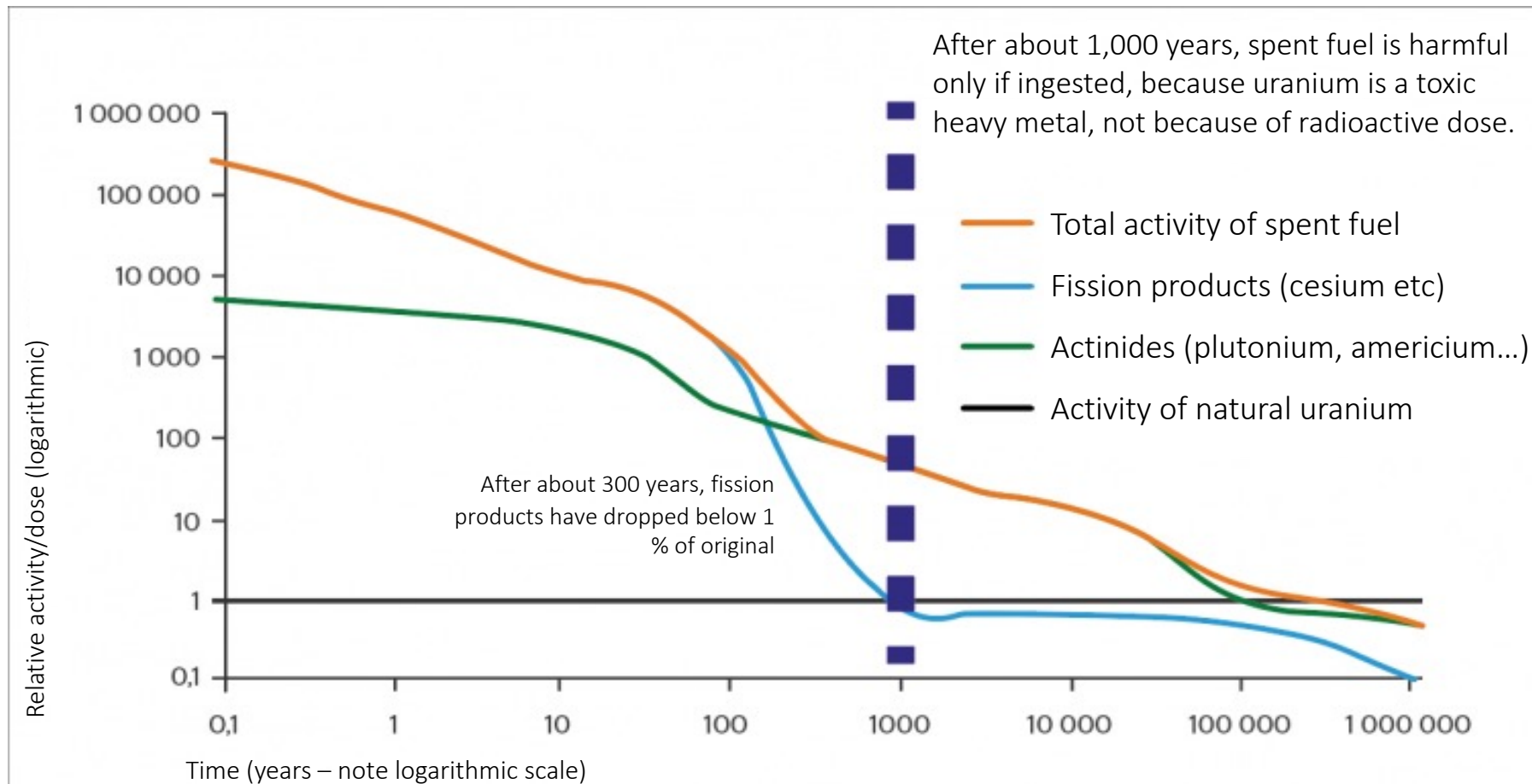
- Spent fuel is so well managed that it has never hurt anyone.
- It gets less harmful with time.
- Deep geological storage has a safety margin of roughly one million times:
 - Worst-case scenario, max dose: 0.00018 mSv/year*
 - Threshold for health hazard:
100+ mSv / year



* Based on Onkalo Deep Repository's environmental assessment.

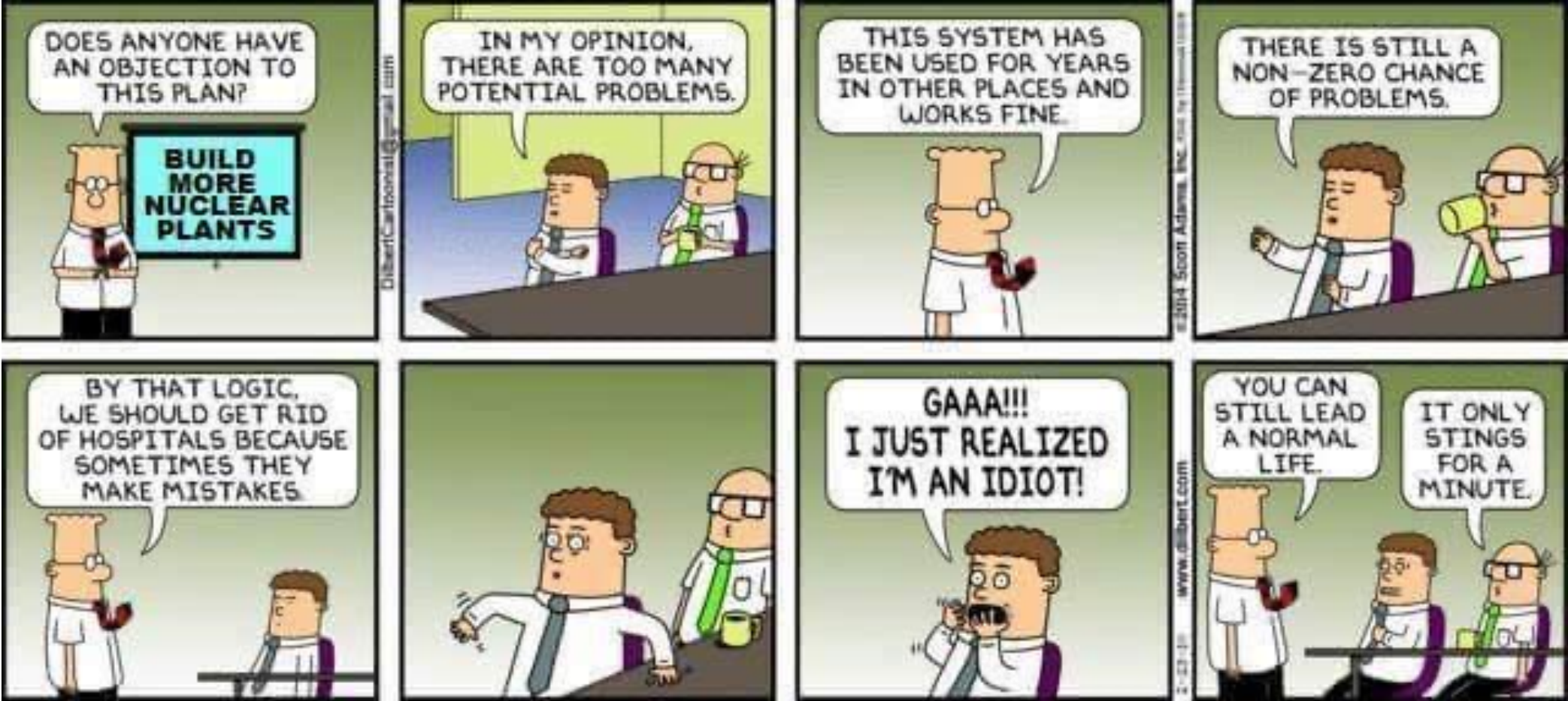
https://inis.iaea.org/search/search.aspx?orig_q=RN:45087737

DIGGING DEEPER ON SPENT FUEL...



Why nobody says this aloud?

Climate is a big challenge.
Nuclear is a big solution.



THINK ATOM

THANK YOU.

think deep decarbonization

RAULI PARTANEN

Teaser:


The Case for Waste

What if Finland started selling Repository Services for Spent Nuclear Fuel?

@MinerDeck

34.8m

Out in 2024



“I think we’re going to look back and ask ourselves how did we let at least five million people die from air pollution every year? It’s totally obscene.”

Isabelle Boemeke, isodope; science communicator