Nazarbayev University Kazakhstan
Energy Transitions:
Exploring the nexus of Sustainability, Economy and Climate

Climate Change, Sustainability and Energy

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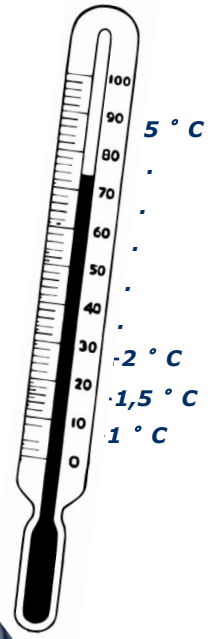
Energy use causes more than 3/4th of the annual greenhouse gas emissions.

Overview:

- Climate change
- Greenhouse Gas emissions & concentration rise
- Decomposition of the causes of GHG littering
- Energy as substrate of human activities, civilization
- Energy system transformations
- Thermal power generation
- Electricity from nature's currents
- Neoliberalism attributes and pillars
- Vision on combined energy-society transformations

A planet with fever



5 ° C

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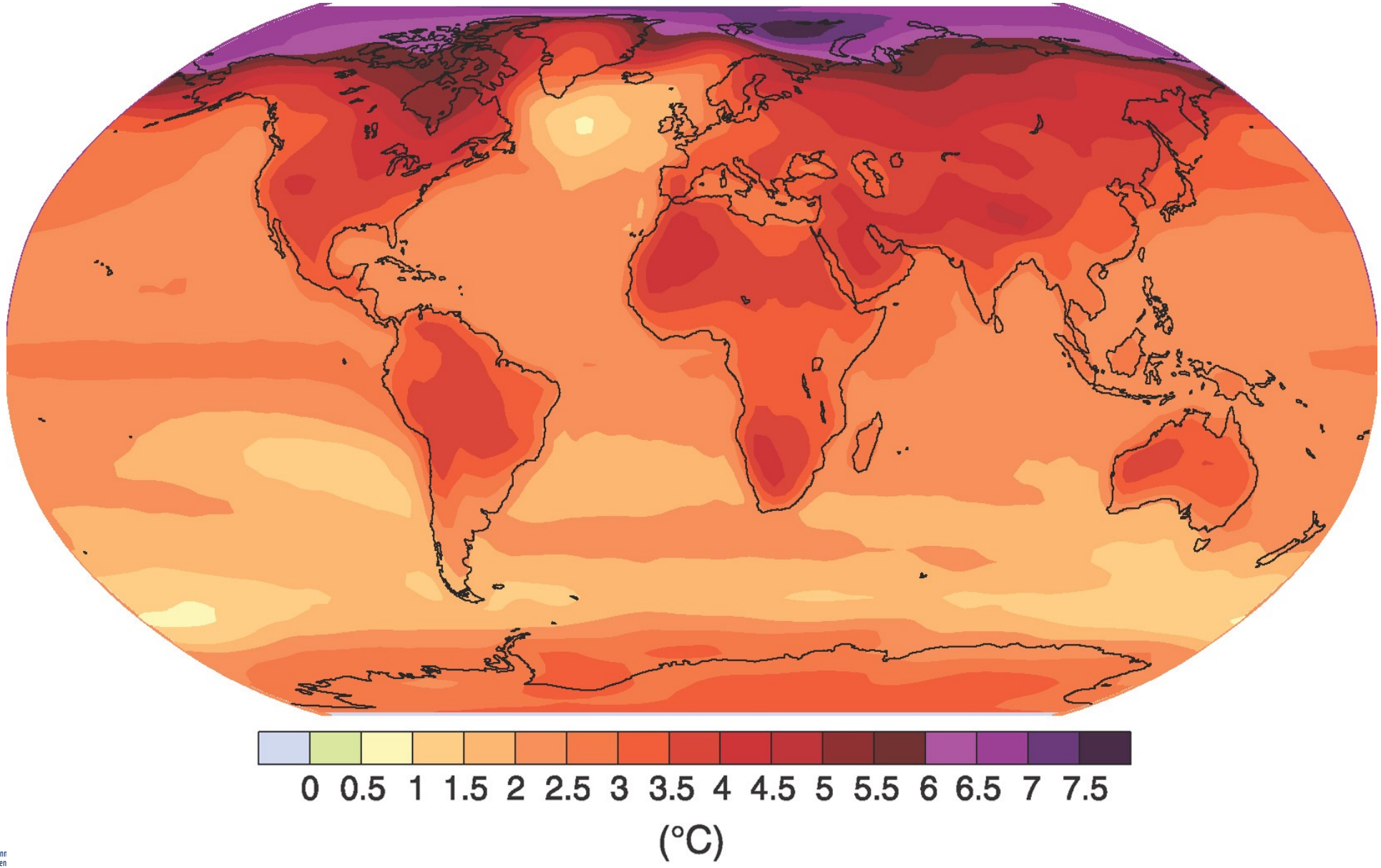
-2 ° C

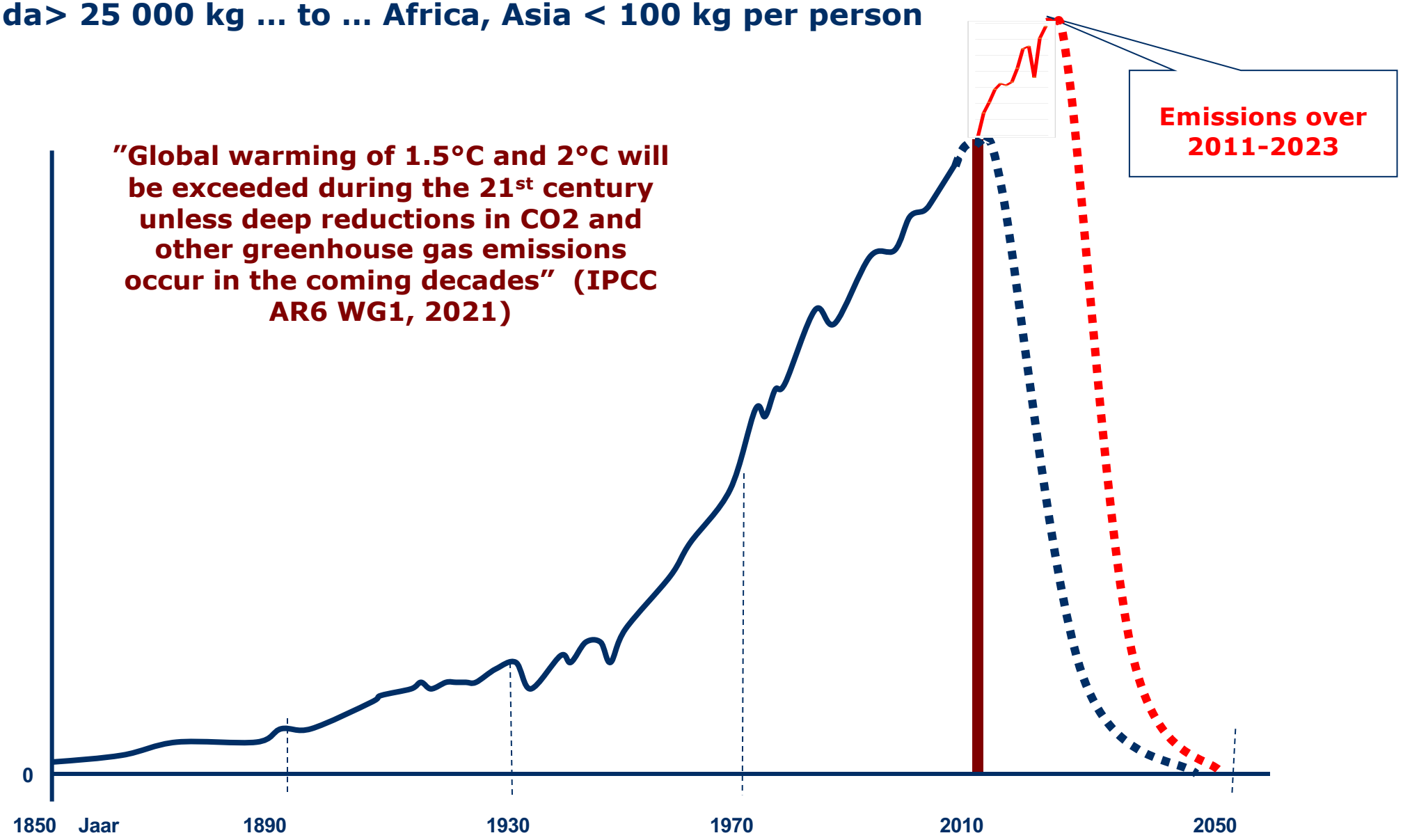
-1,5 ° C

1 ° C

Fever on Earth is spread unequally (IPCC)

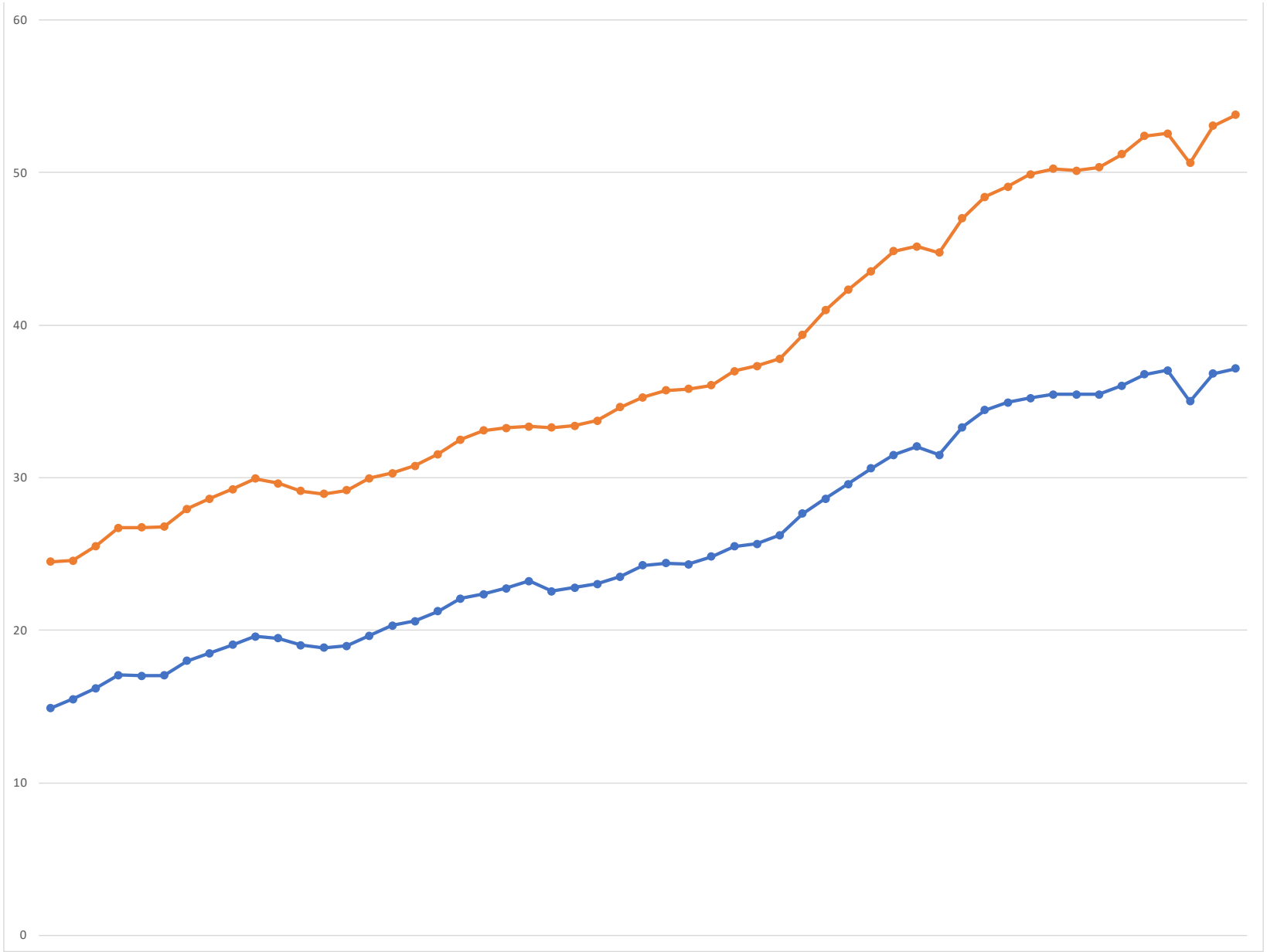


Cause of fever: annually dumped greenhouse gases in the atmosphere like *gaseous litter.* USA, Canada> 25 000 kg … to … Africa, Asia < 100 kg per person



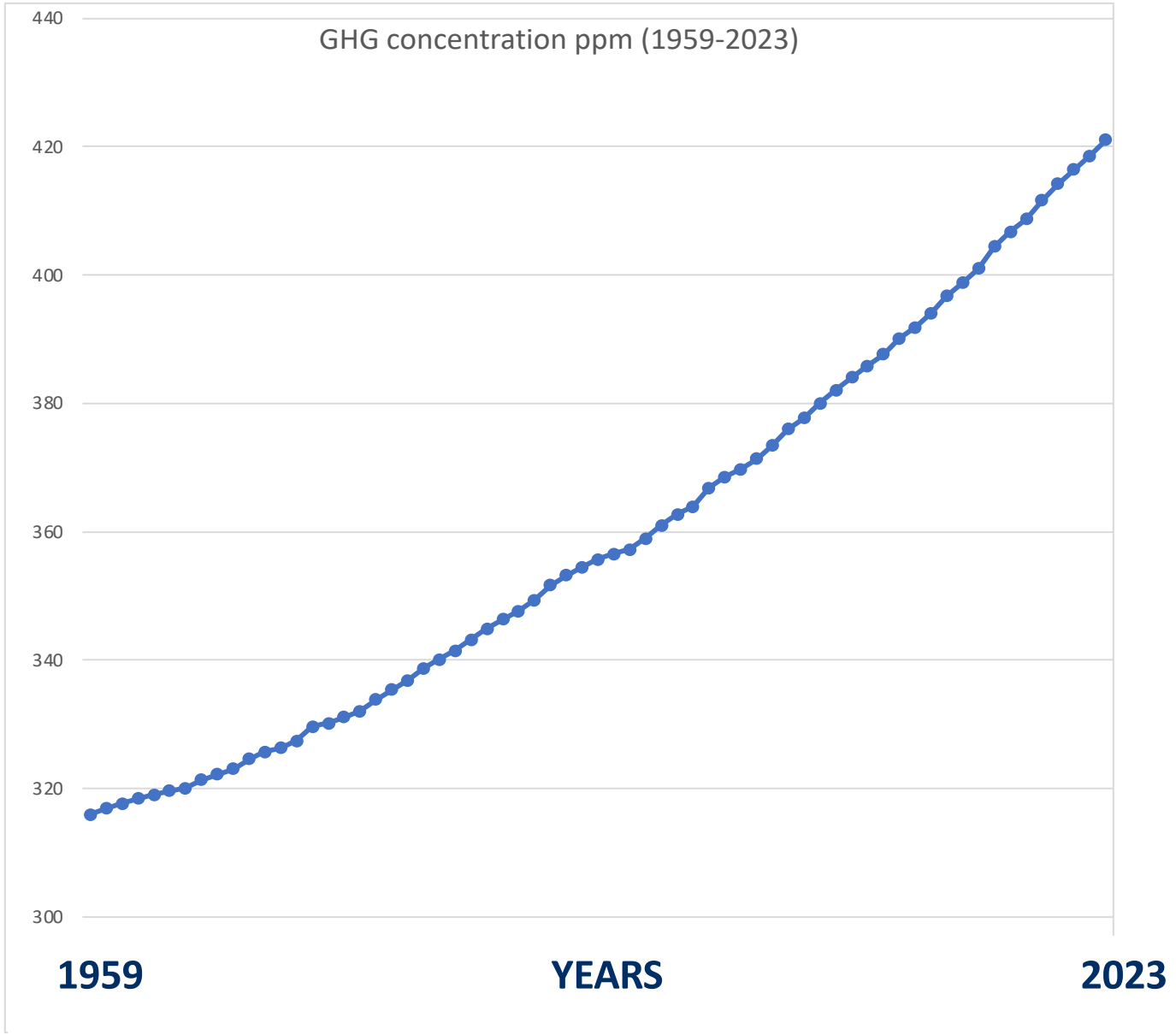
Annual emissions of greenhouse gases in Gigaton CO_2 (bottom curve) and CO_2-eq (top curve)

Annual GHG emissions in Gt CO_2-eq and CO_2

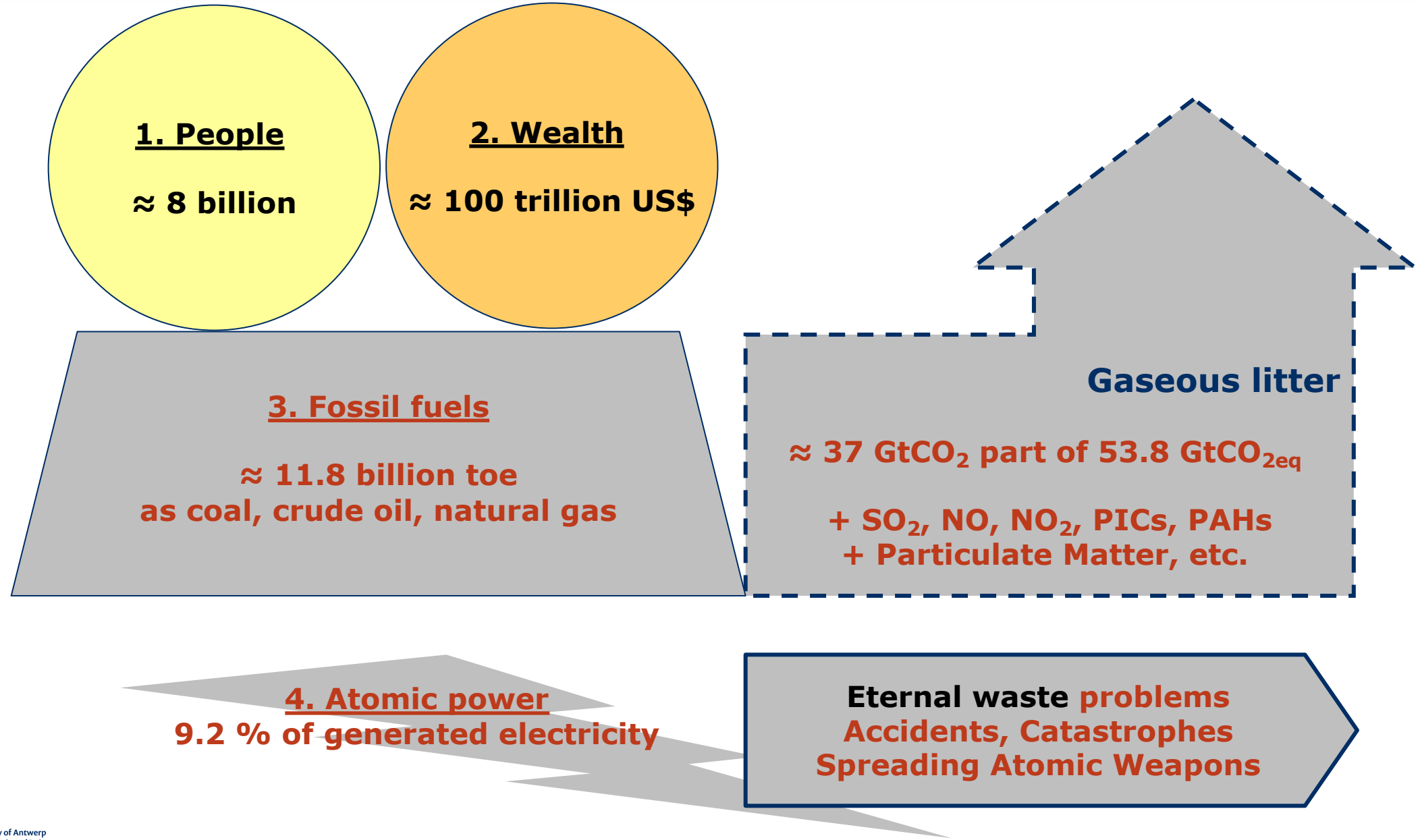


The state of the atmosphere: mounting concentrations of greenhouse gases in CO_2-eq.

CO_2-eq. GHG concentration in ppm



Present energy use causes emissions, litter, waste, risks, … in year 2022



Q & A

Do you agree?

- ✓ A mild climate is *precondition for life* on Earth
- ✓ Ongoing climate change will *destroy* human civilization
- ✓ Climate change and its severe impacts are *irreversible*
- ✓ This needs *Drastic & Urgent action* (Stern 2006)

Do you agree?

- ✓ Excessive greenhouse gas emissions by humans prompt climate change
- ✓ Fossil fuel use causes more than 3/4th of global emissions
- ✓ Emissions must stop, hence use of fossil fuels must stop
- ✓ A radical energy transformation is due

Climate is a *global energy economic commons*

- ✓ Global: *all people* and all states are involved
- ✓ Energy: main culprit and spearhead of solution
- ✓ Economic: neoliberal breakthrough-2 ⇔ U-turn to sustainable development
- ✓ Commons: public good of *sovereign* UN states creating *universal* self-governance

Human Civilization is built on a Substrate of Energy

Civilization
Lock-in
- **Paradigm economic growth**
- **Discourses (myths; fake news)**
- **Institutions (norms, institutes)**
- **Interests, small to giant**

Reversal feasible
⌘ politics, social constructs, rebellion, massive migration

ENERGY USES
=
ENERGY SOURCES
X
TECHNOLOGY

Substrate
Lock-in
- **Infrastructures**
- **Habits (!mobility)**
- **Vested interests (oil&gas, electricity, atomic power, multinational corporations)**

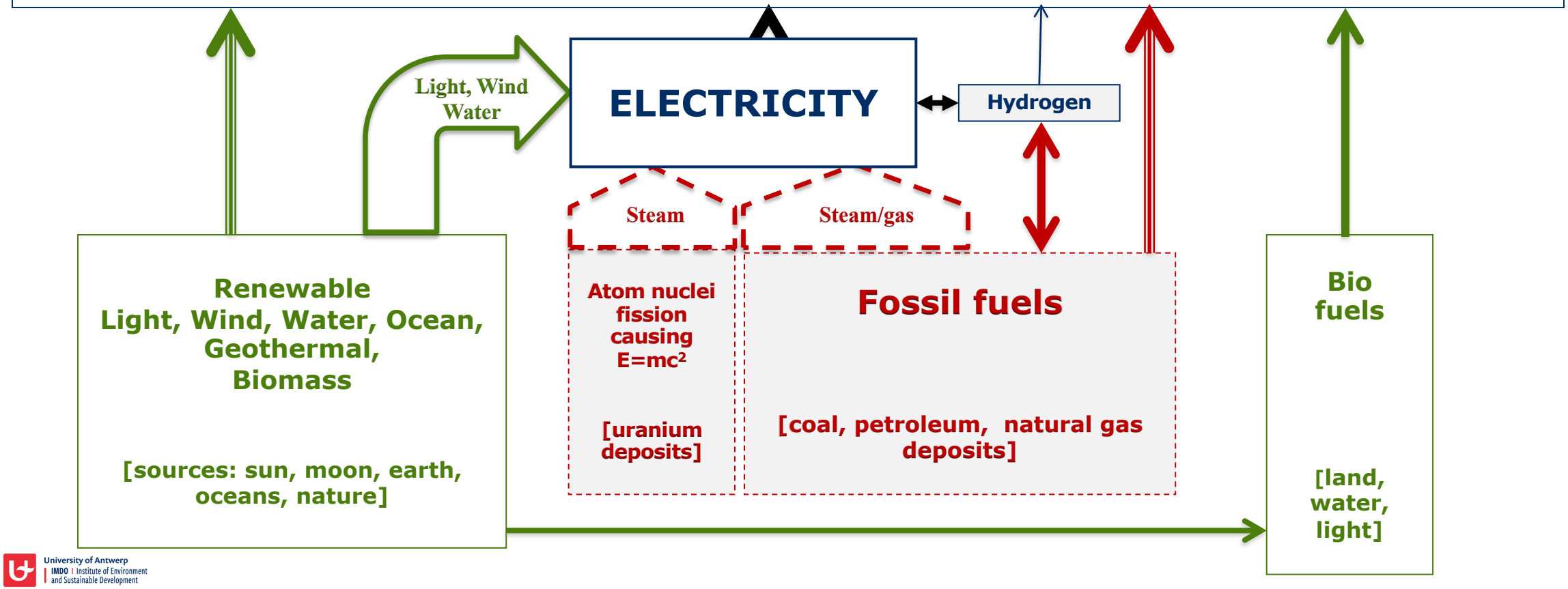
Reversal feasible
⌘ inventions, innovations, knowledge & technology

Human Activities Need Energy Services.
Energy sources are renewable streams and biofuels, fossil fuel and uranium stocks

ACTIVITIES in
Households ✣ Services ✣ Land use ✣ Industry ✣ Commerce ✣ Transport ✣ Recreation ✣ Education ✣ …

require

ENERGY SERVICES like
Light ✣ Electronics ✣ HVAC ✣ Process heat ✣ Drive power stationary, mobile ✣ …



Energy system transitions – transformations

Of all times, spontaneous, *wanted*

- Progress by domesticating fire, animals; inventing tools
- Linked to technology from levers, wheels, sails, … to electronics, ICT, new materials, etc …

- Revolutionizes civilizations, human societies
  - 18th – 20th century: steam, electricity, internal combustion engine
  - 21st century: renewable power directly harvested in the environment

NOW: *forced transitions* by climate change, nature degradation, rising risks, …

ToDo list (blue is economically superior)

(1) Electricity as major energy transmitter

(2) Exclusively generated from renewable energy currents and stores

+ energy conservation (exclude, preclude wasteful activities)

+ rationally improving energy efficiency

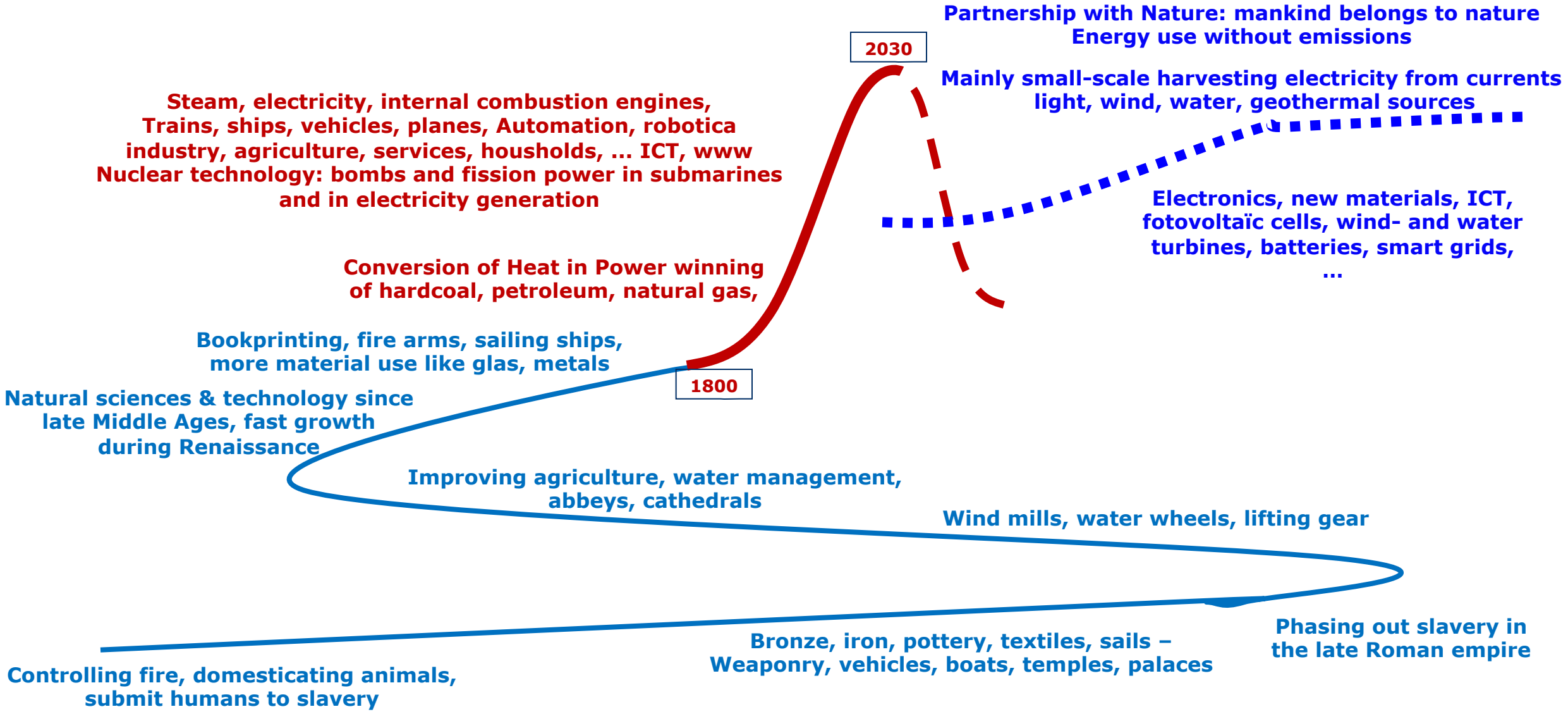
ToDo list (brown is politically problematic)

(3) Keep fossil fuels underground, immediately

(4) Phase out atomic power, immediately

Three periods in the history of energy use (Europe as example)

1 [prehistory-1800] 2 [1800-2030] 3 [2000- ∞]



Thermal power generation

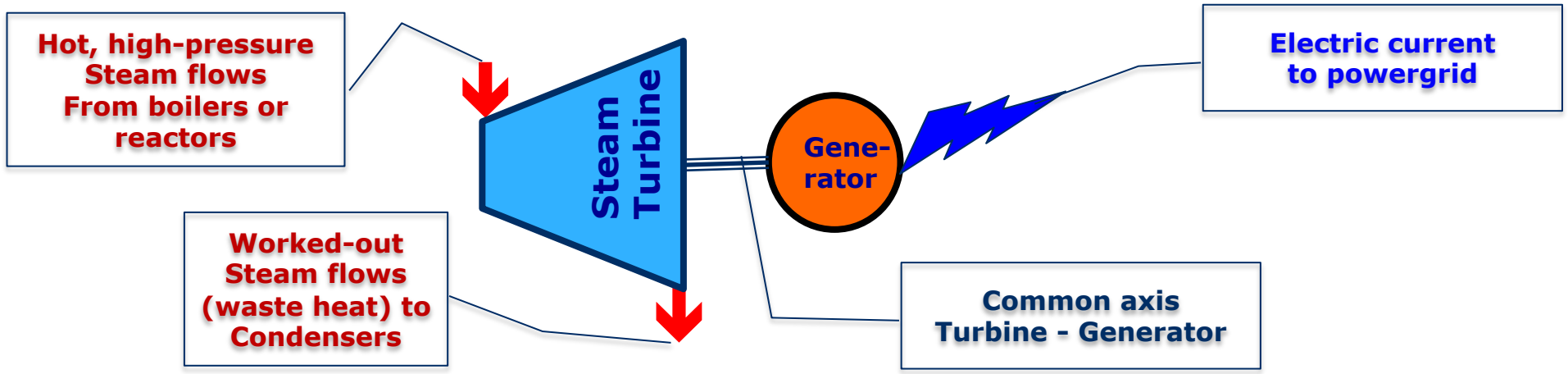
Steam era (18th – 20th century)

- **Geothermal steam at some locations (e.g., Iceland, Kenia), often low pressure, polluted, …**
- **Steam from fossil (or bio) fuels, or from atomic nuclei fission**

Pressurized hot gas currents in gas turbines.

CORE of steam power generation plant

SteamTurbine: kinetic energy in high-pressure steamflows
Causes turbine-axis to rotate
Generator converts rotation in electricity



Non-exhaustive enumeration of installations and resources needed for steam power generation

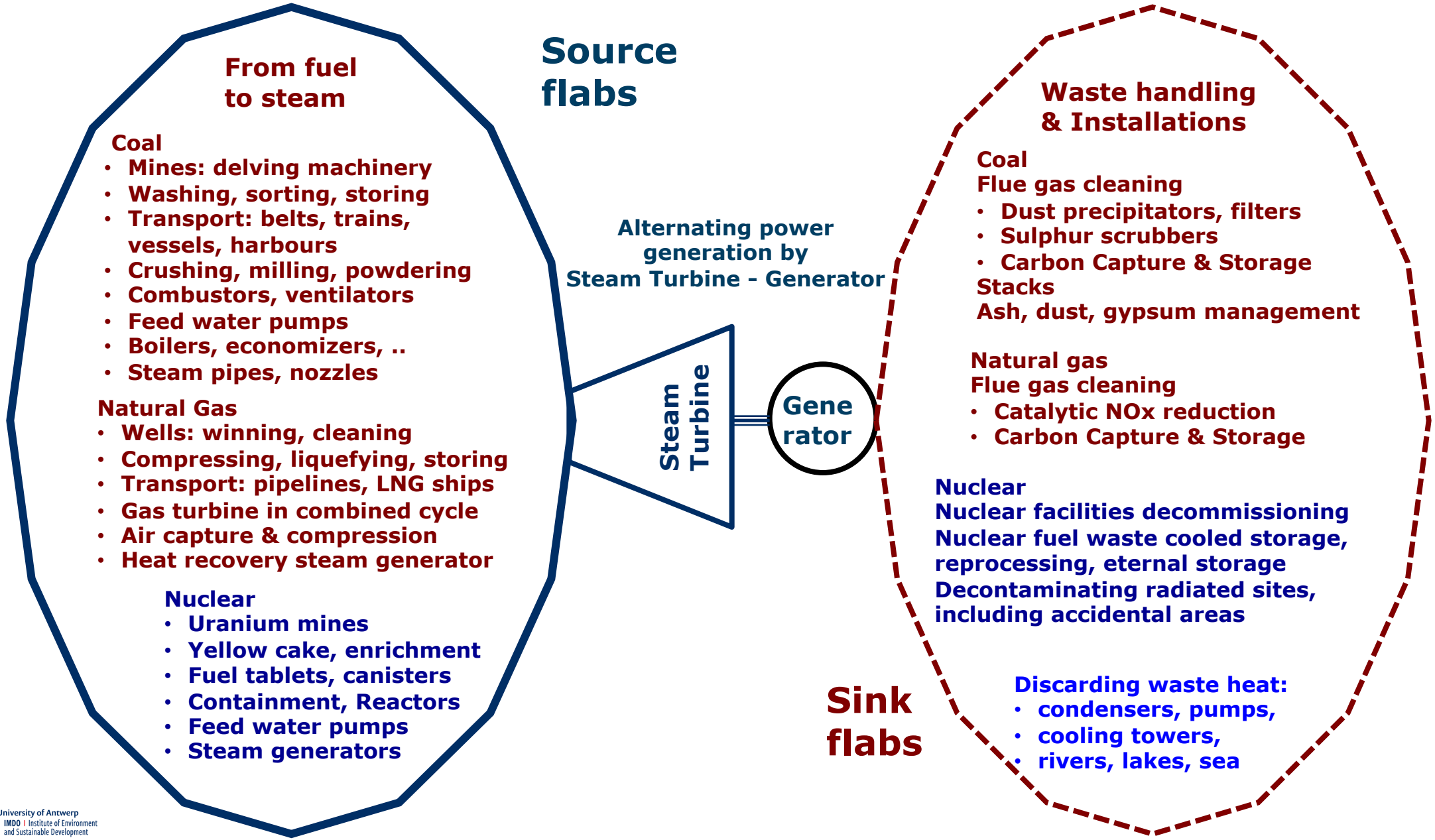
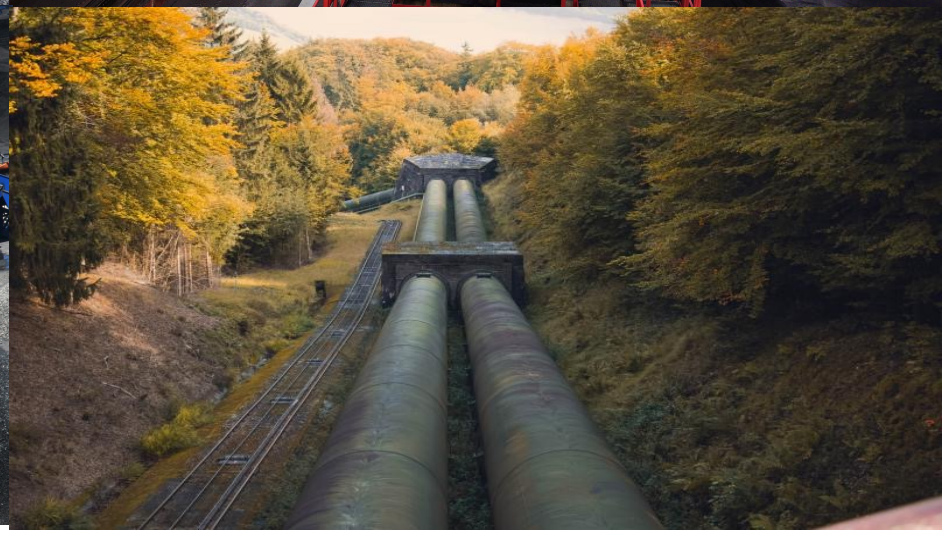
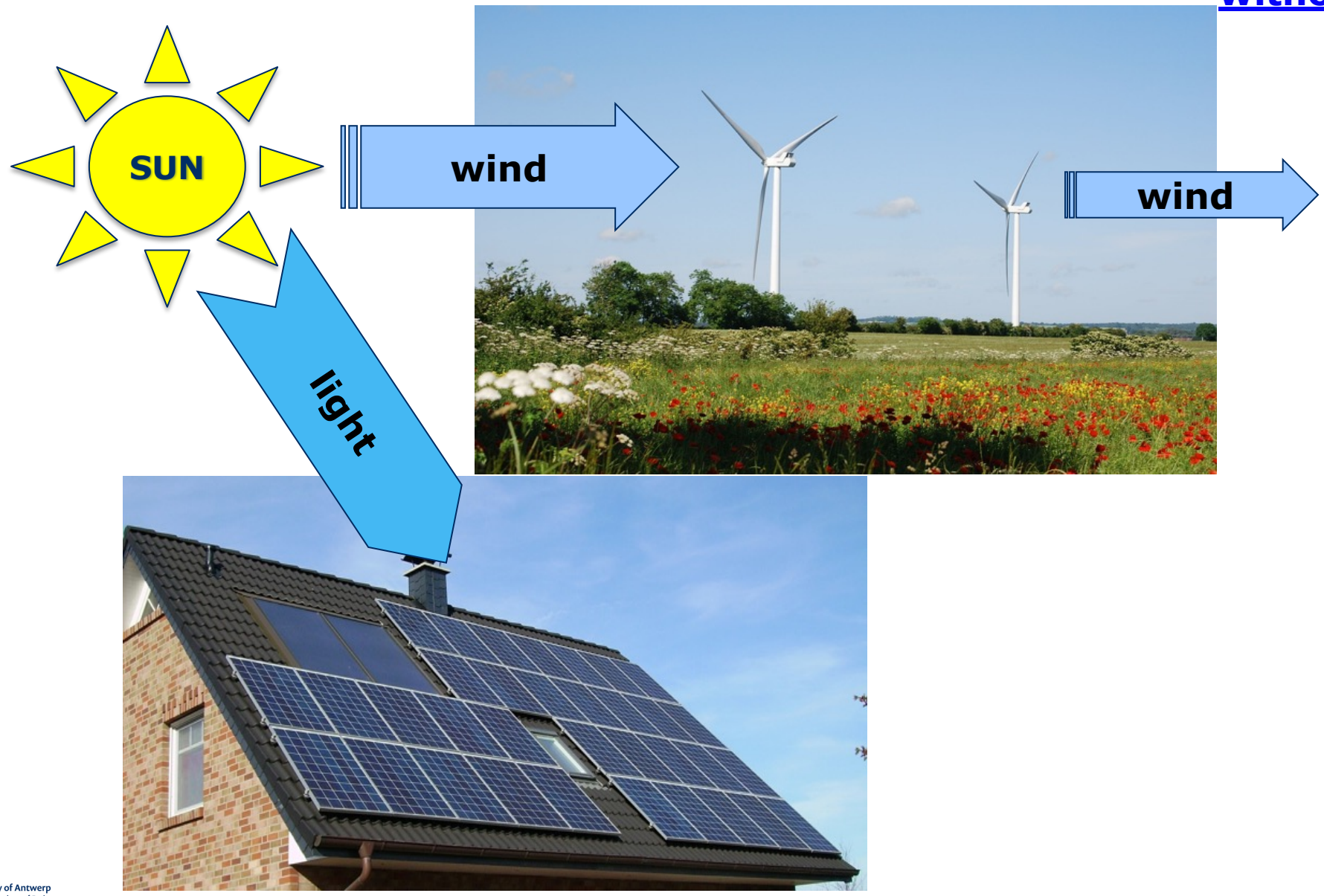


Illustration of Source flab installations coal pit, overseas transport, storing, gas pipeline



Offshore oil&gas platform, refinery, coal power plant, Fukushima Daichi nuclear plant destroyed

Harvesting ambient currents for power <u>without</u> source and sink flabs, <u>without</u> major risks



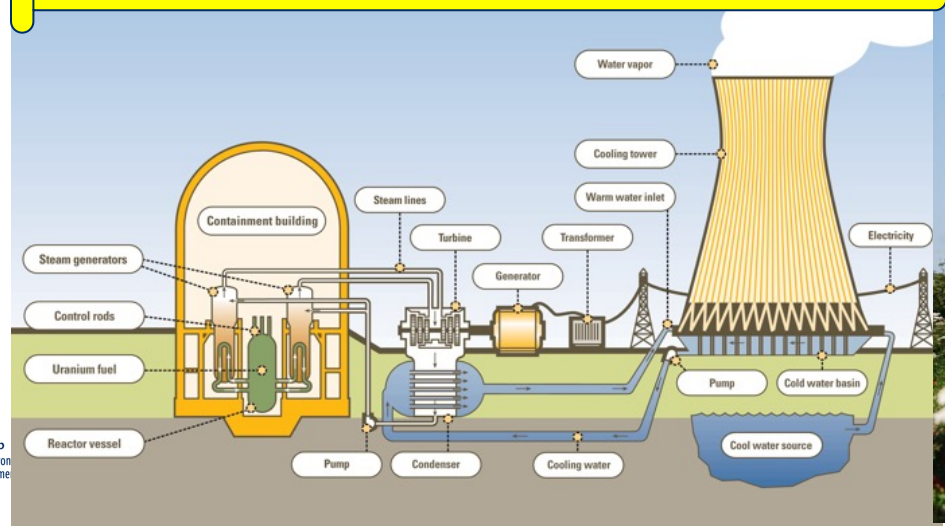
Technological reversals in electricity generation

18th – begin 21st century ⇔ **3rd millennium**

Thermal flows, costly & risky ⇔ **Harvesting ligth, wind, water**

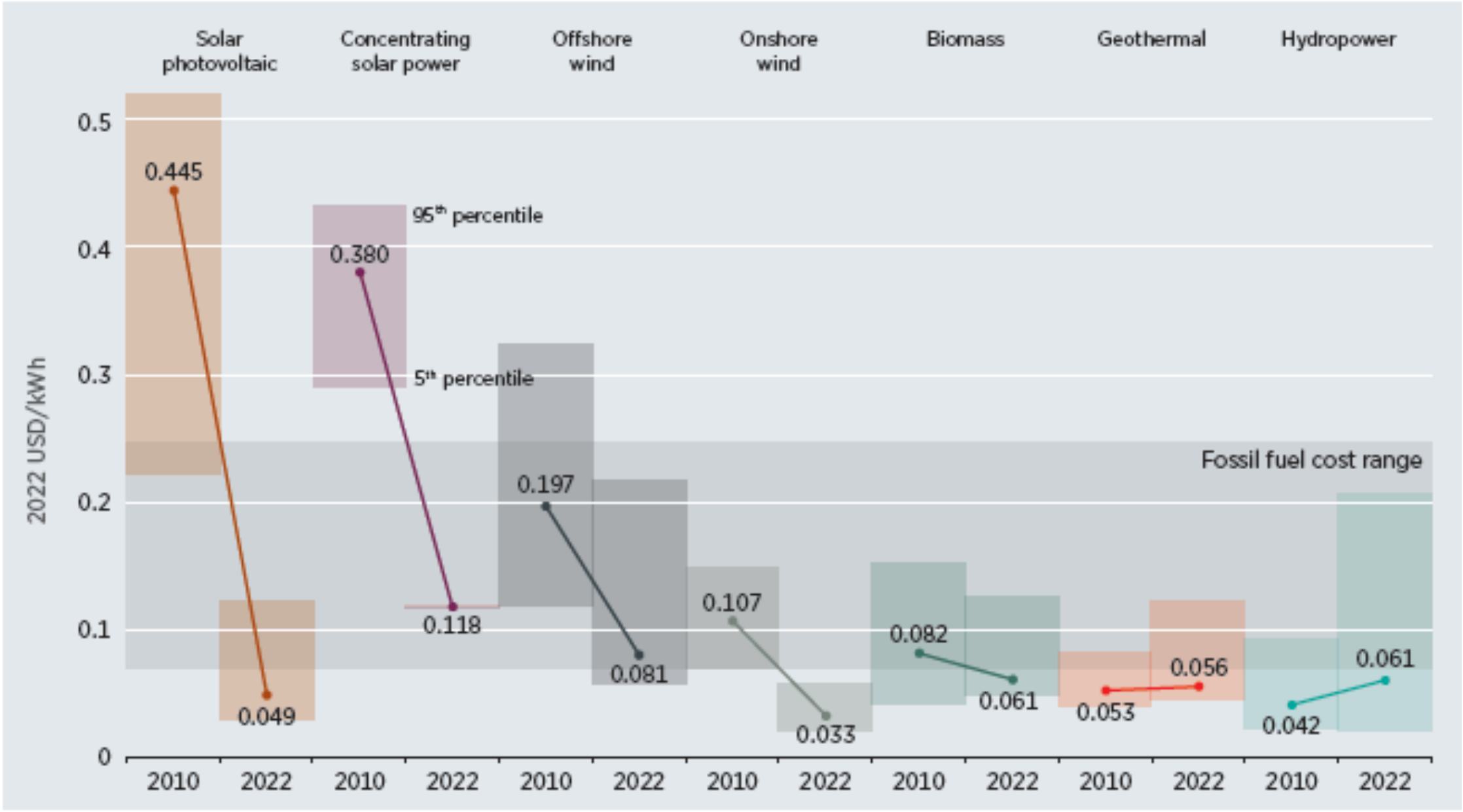
From cumbersome techniques
on concentrated energy sources

To direct harvesting
of diffuse, variable flows



Least-cost electricity from sunlight and wind (source: IRENA)

Figure S.4 Global LCOE from newly commissioned utility-scale renewable power technologies, 2010 and 2022



Neoliberal, Neoliberalism - attributes

Often named without clear meaning, contents

Three main attributes (based on Wolin, S. 2008, Democracy Incorporated. Princeton Univ.Press)

(1) Financial power, concentrated in big money clans and giant corporations, dominates obidient politicians in strategic socio-economic decision-making.

Politicans function as façade and may care for socio-economic and ecological debris

(2) Economic growth for profit is stimulated, augmenting the fortunes of the superrich, while many ecological barriers are trespassed

[UNDP based on Thomas Piketty: economic growth benefits over 1980-2016 went 12% to the 50% lower wage-earners, while 27% went to the 1% superrich]

(3) More social justice is not a political priority.

Inhumane inequality is said to be 'normal', evident difference between the poor (falling short in taking initiative) and the superrich (the ones that stimulate the growth machinery). Hence, charity patronage should suffice.

Neoliberalism is built on three main pillars

1. Intensive and unlimited use of fossil fuels.

Without this concentrated energy supply, available on human command, the neoliberal economy will disintegrate.

While the emissions of greenhouse gases visibly increase climate calamities

2. Control over money creation, money flows and stocks

With the money handles, superrich clans and giant corporations dominate politicians in money-based economies, and know to mastermind strategic socio-economic decision-making.

While populism is florishing, totalitarian regimes shift to fascist extremism, inhumane inequality grows and 'illegal' migration from poor countries is ungovernable

3. Prevalent discursive power in market economies (and beyond)

Media controlled by big money repeat the mantras of 'free markets', of the superiority of Western ideology, … culminating in the mantra ***"there is no alternative for neoliberalism"***

While ***'only alternatives make sense'*** for maintaining human life conditions on Earth. 'The specter of inverted totalitarianism' in a 'managed democracy' (Wolin, 2008) is palpable

Societal and Energy transformations for the public good: Sustainable Development and 100% renewable energy