

WILL DEEP GEOTHERMAL ENABLE SWITZERLAND TO BE CARBON NEUTRAL BY 2050?

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1 A GLOBAL AND GROWING PROBLEM

Despite decreasing economical growth, energy consumption and greenhouse gases emissions keep accelerating. In 2018, new renewables accounted only for 3.6 % of the global energy shares, nuclear for 4.4% and hydropower for 6.8%.

MAIN CHALLENGES TO THE ENERGY TRANSITION



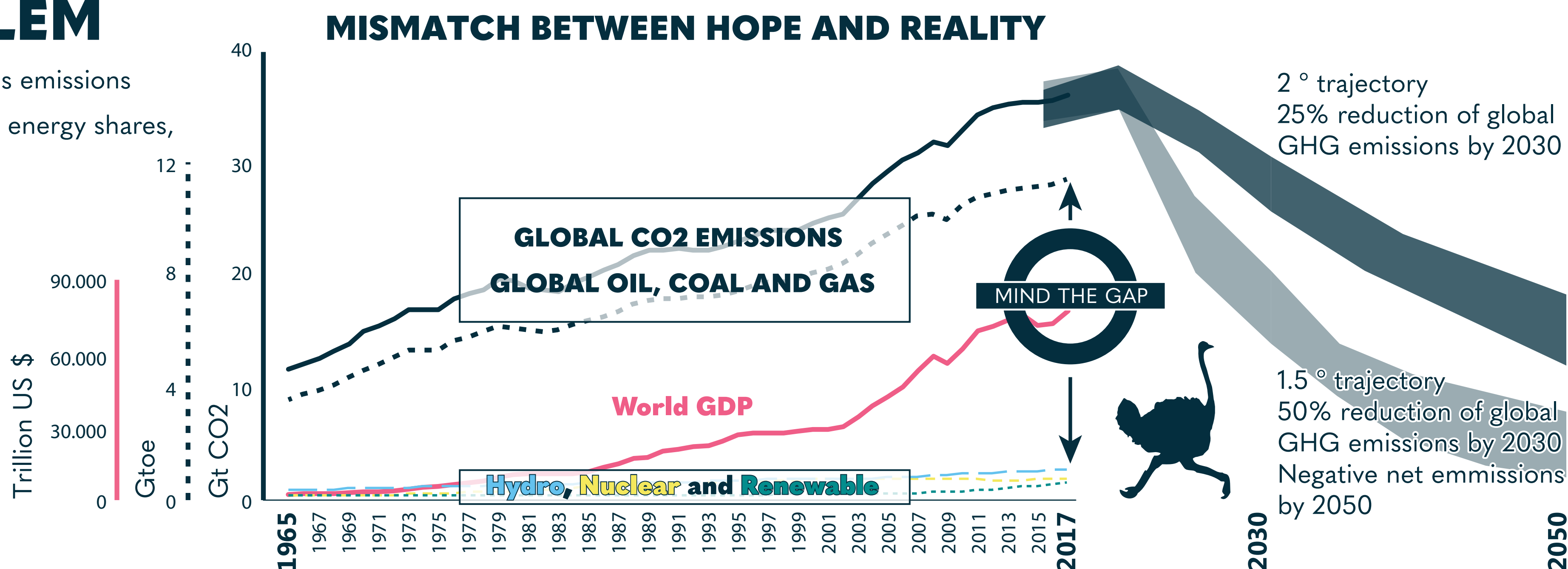
TIME Replacing the current stock of coal-fired plants by nuclear would take about 14 years, if only we had the capability to deliver a 1 GW nuclear reactor every day, day in and day out...



RESOURCES Deployment of renewable requires finite (doping) materials that are mined using cheap and abundant fossil energy, in conditions often violating human rights and with dramatic environmental consequences



EROI Energy Return on Energy Invested
Our economical system is estimated to require EROI > 9:1
- Conventional oil (1900): 100 : 1
- Shale gas (2018): 2-4 : 1
- Renewable energy (2018): below unity to 40:1 (no consensus)



ENVIRONMENTAL AWARENESS MOVEMENT INEFFECTIVE AT CHANGING THE CURSE

1962	1972	1988	1992	1997	2012	2015
Silent Spring	1st Earth Summit Stockholm	Creation of the IPCC	2nd Earth Summit Rio	Kyoto Protocol	Rio Summit +20	Paris Agreement
Rachel Carson brought back to silence	Meadows report on the limits to growth Club of Rome	International Panel on Climate Change	United Nations Framework Convention on Climate Change (UNFCCC) Agenda 21	Implementing emission trading, or how to develop a fruitful Carbon market	Political outcome document with ground-breaking guidelines on green economy policies	Objective 1.5°C by 2100 ... Yes we can?

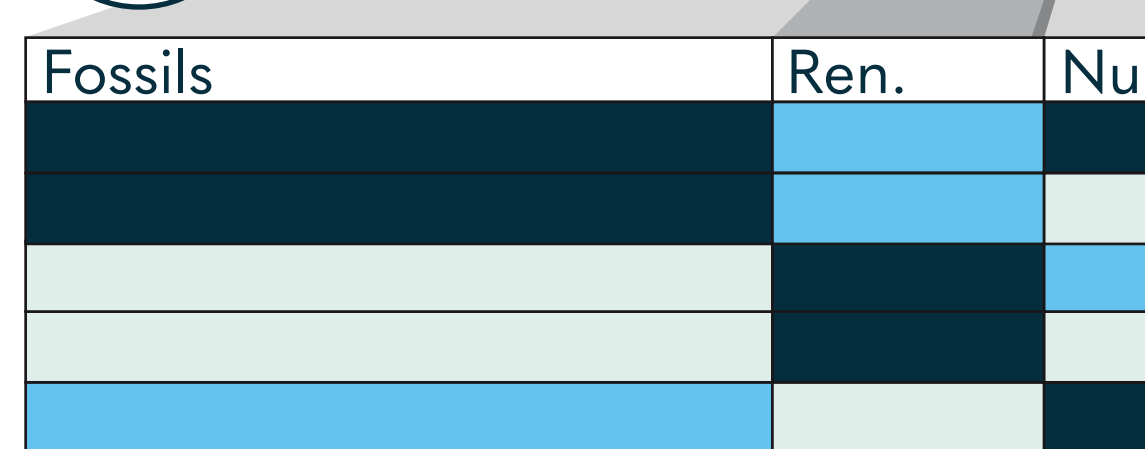
2 RENEWABLE ENERGY IS NOT SUFFICIENT: IT NEEDS TO BE SUSTAINABLE!



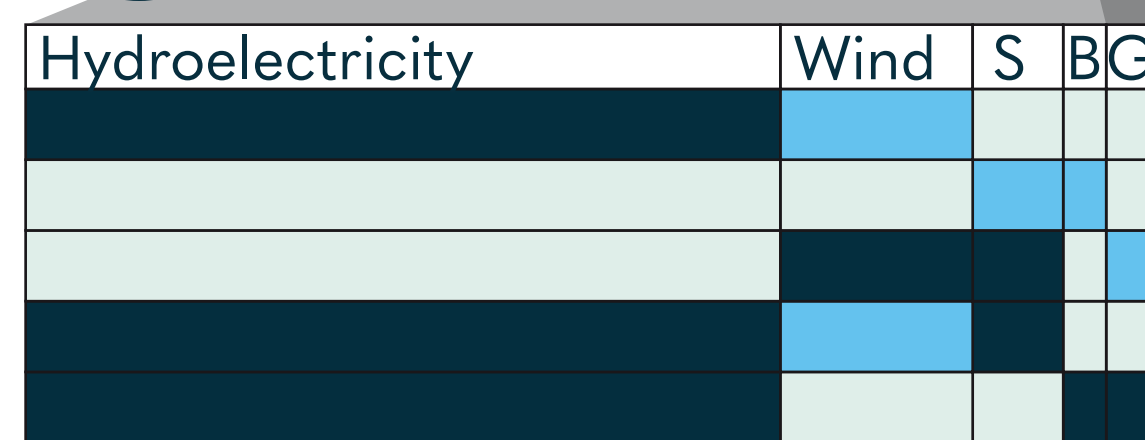
2018 WORLD GLOBAL ENERGY CONSUMPTION

Other Elec.

2018 WORLD ELECTRICITY CONSUMPTION



RENEWABLE ELECTRICITY CONSUMPTION



GEOTHERMAL ELECTRICITY PRODUCTION

Conventional HT-EGS Eaposys Eavor™

Elec: Electricity, Ren: Renewable, Nu: Nuclear, S: Solar, B: Biomasses, G: Geothermal,

HT: Hydrothermal, EGS: Enhanced geothermal system, LCA: Life-cycle assessment/analysis,

GHG-I: GHG intensity in CO₂ equivalent in TCO₂/MWh RMI: Raw material intensity in T/MWh,

Land-use intensity in km²/MWh, CF: Capacity factor, mean usage of installed power in %.

Comparative LCA processes

System 3

Process 4.1 Distribute

System 2

Process 3 Transform

System 1

Process 2 Access

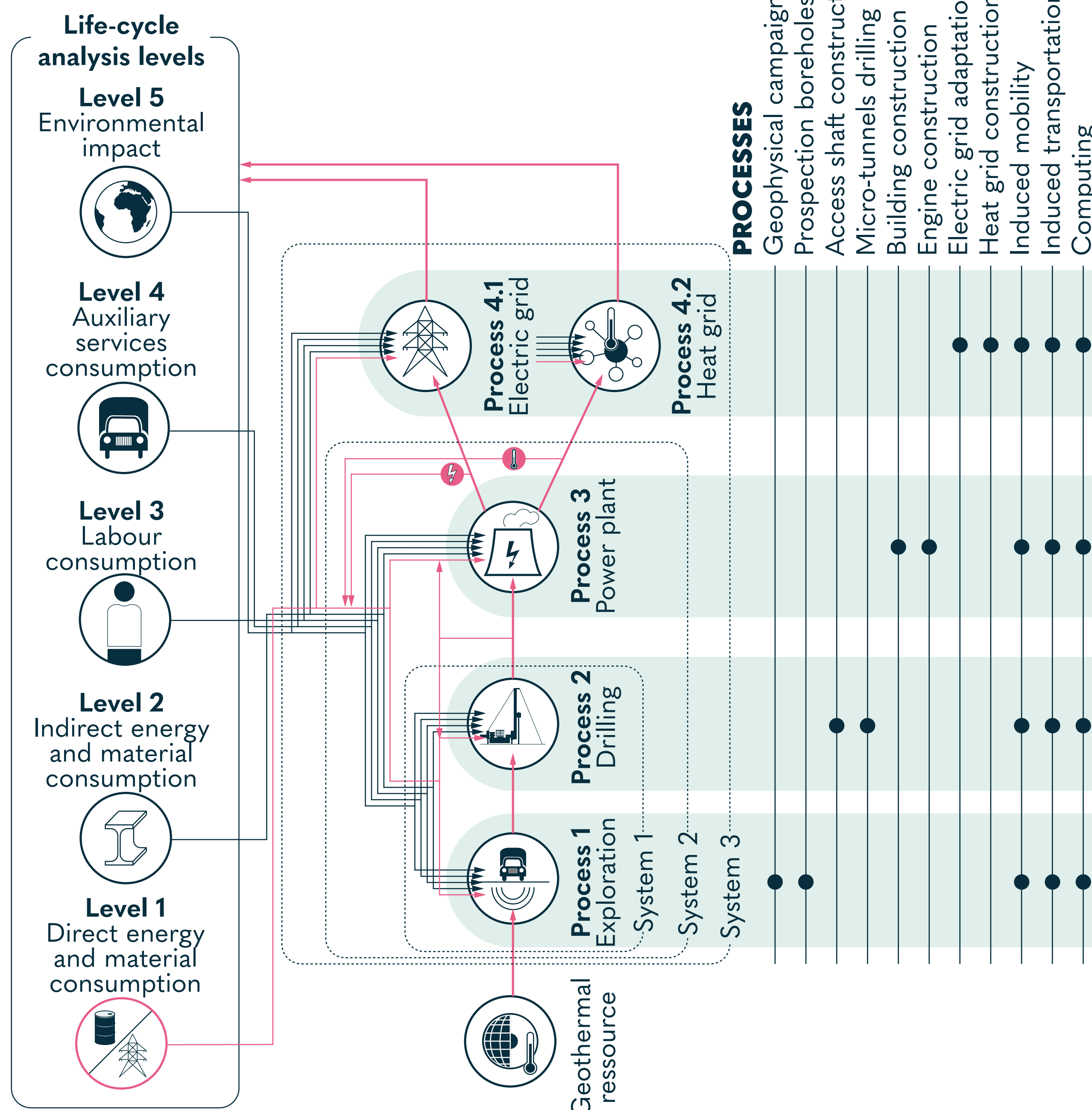
Process 1 Know

Comparatively Low High

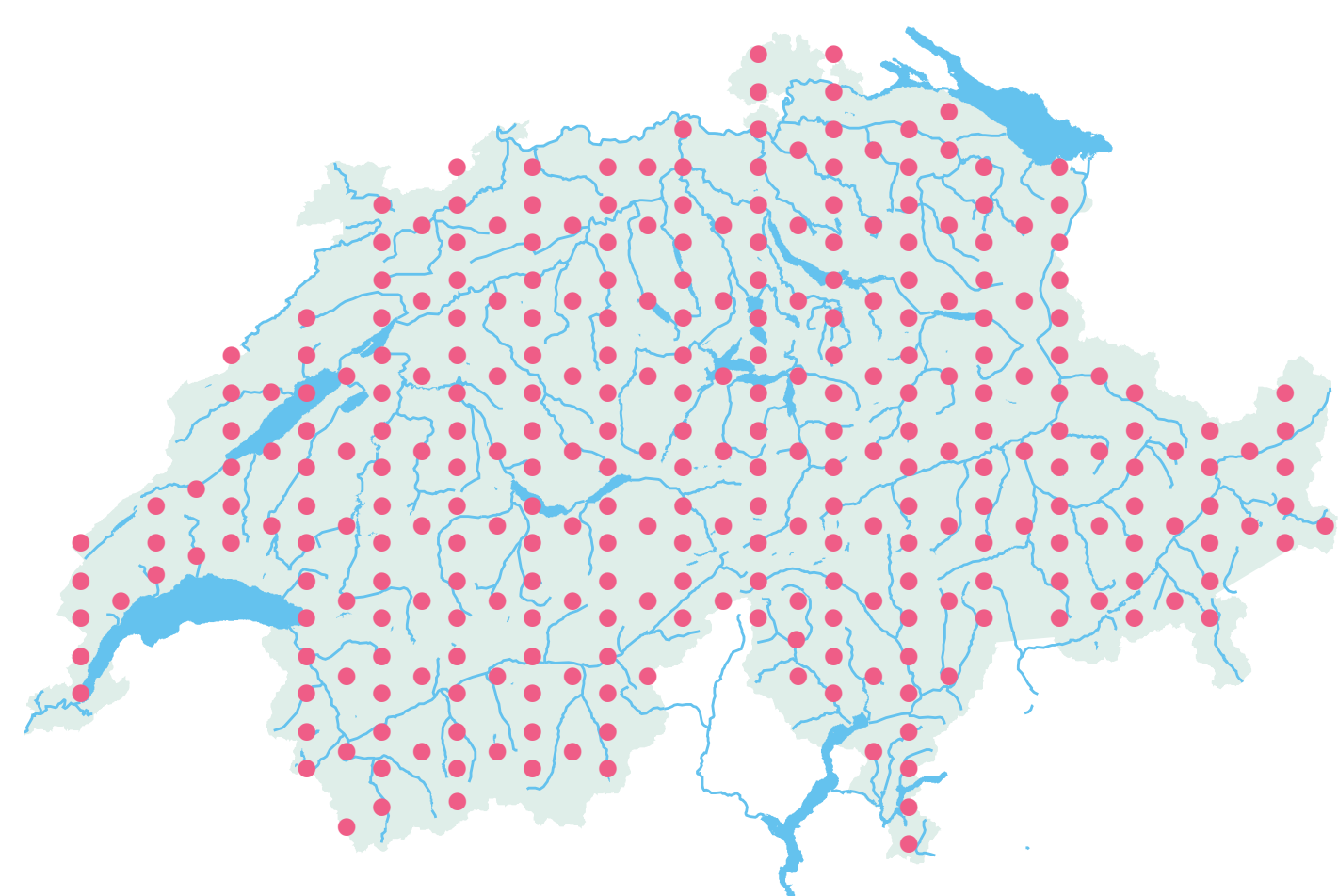
To **mitigate climate change**, most developed countries have adopted a 'much-commented' **energy transition**, aiming at implementing the Kyoto Protocol and Paris Agreement, **electrifying the world** but **losing the battle of reducing greenhouse gases (GHG) emissions**.

Renewable energy is not enough: it needs to be sustainable! Sustainability is an enormously complex notion that can be divided into environmental, social and economic sustainability. Among all renewables, geothermal is by far the most promising (99% of the Earth is hotter than a 1000°C) but still the less successful; it is often not even considered in the standard renewable energy mix!

In that context, Seismo Earth AG has initiated with CSGE Sàrl and Legacy Foundry AG a systemic life-cycle analysis of deep geothermal power plants, specifically evaluating sustainability indicators for emerging concepts of large-scale industrial geothermal power plants which will require 100's-1000's km of boreholes.



3 GEOTHERMAL TO CLOSE THE GAP: WHAT ARE THE ODDS? TAKE A BET!



(a) Scenario with current Hydrothermal / EGS technology: Switzerland needs 300 plants similar to Soultz-sous-Forêts 1.7 MW plant (15 plants/year or about 1/month starting now).



(b) Scenario of high-capacity emerging geothermal systems: We take action, we find and provide the means to develop and build reliable high capacity (> 100 MW_e) deep geothermal plants.

The Swiss Energy Strategy targets 4.4 TWh of power production by deep geothermal systems by 2050. It corresponds to 550 MW of installed capacity and about 7% of the Swiss annual power consumption (2018 basis).

The actual increase of production from alternative resources is by far not sufficient to replace energy from fossil and nuclear resources in the medium term. As long as neither the technology, nor the capacities to store electrical power at a large scale exist, wind and sunlight are unreliable sources due to their natural fluctuation, and not suitable to feed the grid at a constant rate. Geothermal energy has probably the biggest potential to close the increasing gap between the needs and the production of electrical power in a sustainable and environment-friendly way. The energy source is not subject to short-term fluctuations. The production of electrical power can be adjusted to the actual demand. Once installed, the facilities are mostly underground and do not disturb the scenery. Why are we waiting?

4 LAUNCHING EARTH POWER SYSTEMS - EAPOSYS*

Seismo Earth AG located in Biel/Bienne, Switzerland, is developing a new - patent pending - approach to heat mining for large-scale industrial power production, **EAPOSYS***, based on a closed system of micro-tunnels pierced at a depth of about 5 km. EAPOSYS* is designed to take advantage of existing connection to the grid. In August 2019, Seismo Earth has closed a first capital increase of CHF 200 K, enabling the company to initiate several work packages to further define the major development challenges:

Technology: (1) Micro-tunnels stability in 5 km deep granitic rocks by rock-engineers at **Pöyry**, FI/CH; (2) Overall hydraulic and thermodynamic dimensions of a 500 MW_e/+50yrs system, by hydraulics and thermodynamics specialists at **Helbling** Technik/Beratung+Bauplanung AG;

Sustainability: A systemic analysis of EAPOSYS* over its complete life-cycle started with **CSGE Sàrl**, Geneva;

Business model, market analysis and financials forecast consolidated by **Legacy Foundry** AG, Zürich.

*EAPOSYS is a pending registered trademark of Seismo Earth AG



On November 12, 2019, Pöyry Switzerland hosted EAPOSYS* kickoff meeting, where experts presented their first findings on the economic framework and the technical feasibility of the project.

