The role of hydro power, geothermal and CCS in net-zero emission scenarios

Gianfranco Guidati, Adriana Marcucci, and many more

SCCER FURIES

sccer future energy efficient buildings & districts

sccer mobility

SCCER SoE
SWISS COMPETENCE CENTER for ENERGY RESEARCH
SUPPLY of ELECTRICITY

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SCCER CREST

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EFFICIENCY OF INDUSTRIAL PROCESSES

Storage
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Joint Activity Scenarios & Modelling

Drivers
Population, GDP, climate, etc

SwissMod
Universität Basel
- Electricity market model
- Impact of climate on hydro power
- System adequacy of transmission grid
- Cross border electricity prices

SwissRes
UNIVERSITÉ DE GENÈVE
- Bottom-up building stock model
- Scenarios for building renovation costs

CESAR
Empa Materials Science and Technology
- Bottom-up building stock model
- Scenarios for building renovation costs

Industry
UNIVERSITÉ DE GENÈVE EPFL
- Modelling of industrial processes
- Scenarios for energy savings and costs

Distribution grids
EPFL
- Bottom-up optimization distribution grids
- PV hosting capacity and storage needs

HOCHSCHULE LUZERN WSL HSR HOCHSCHULE FÜR TECHNIK RAPPERSWIL

…and more on
- Climate impact on HDD/CDD
- Potential of solar thermal
- Potential of biomass
- Etc.

Sectoral models

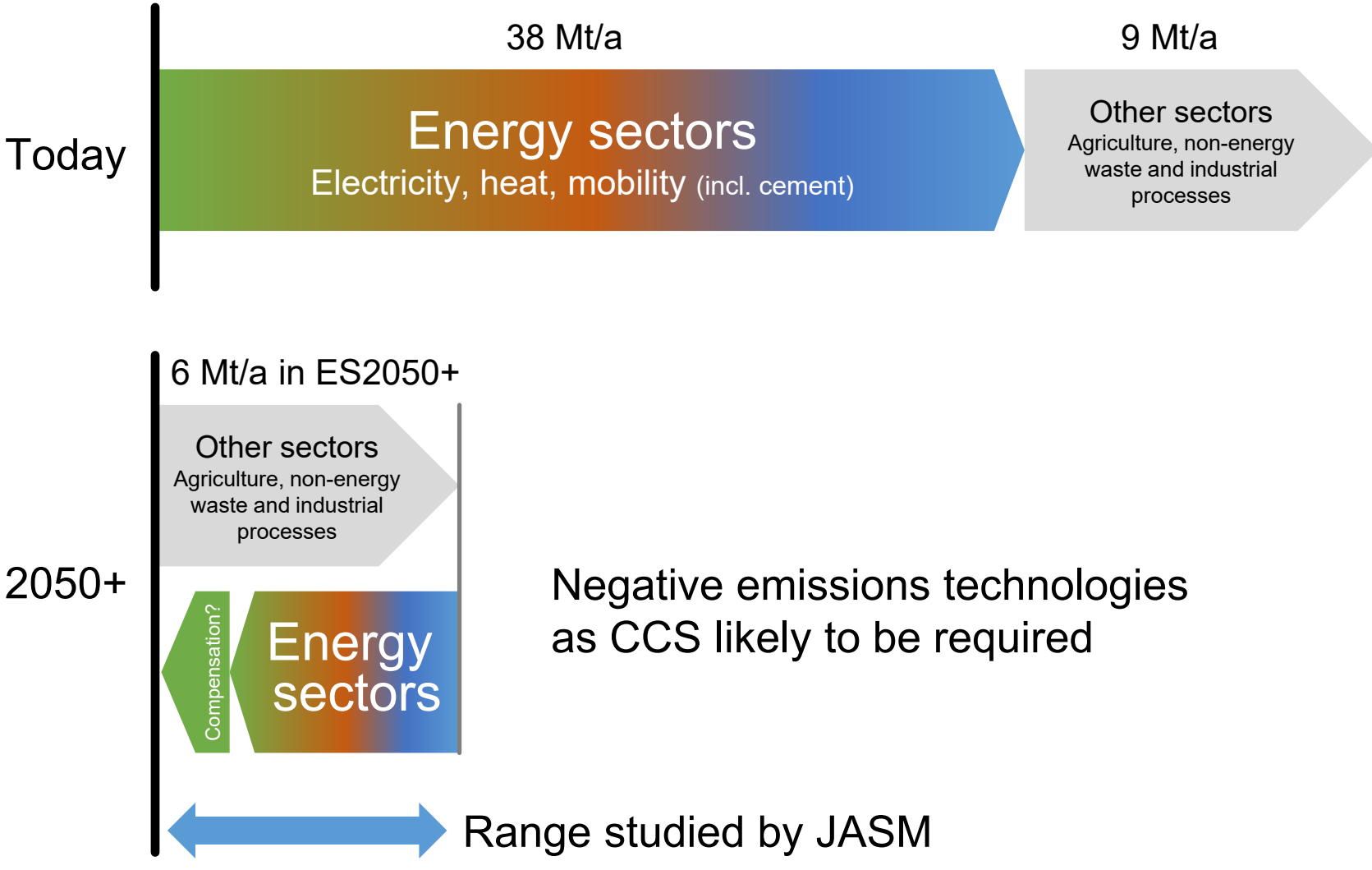
STEM
PAUL SCHERRER INSTITUT PSI
- Swiss Times Energy System Model
- Technology-rich bottom up model
- Optimization of full energy system
- Transition of today to 2060

SES
ETH EPFL
- Swiss Energyscope
- Simpler bottom up model
- Optimization of full energy system
- Fast, allows for Monte Carlo analysis
- Snapshot model

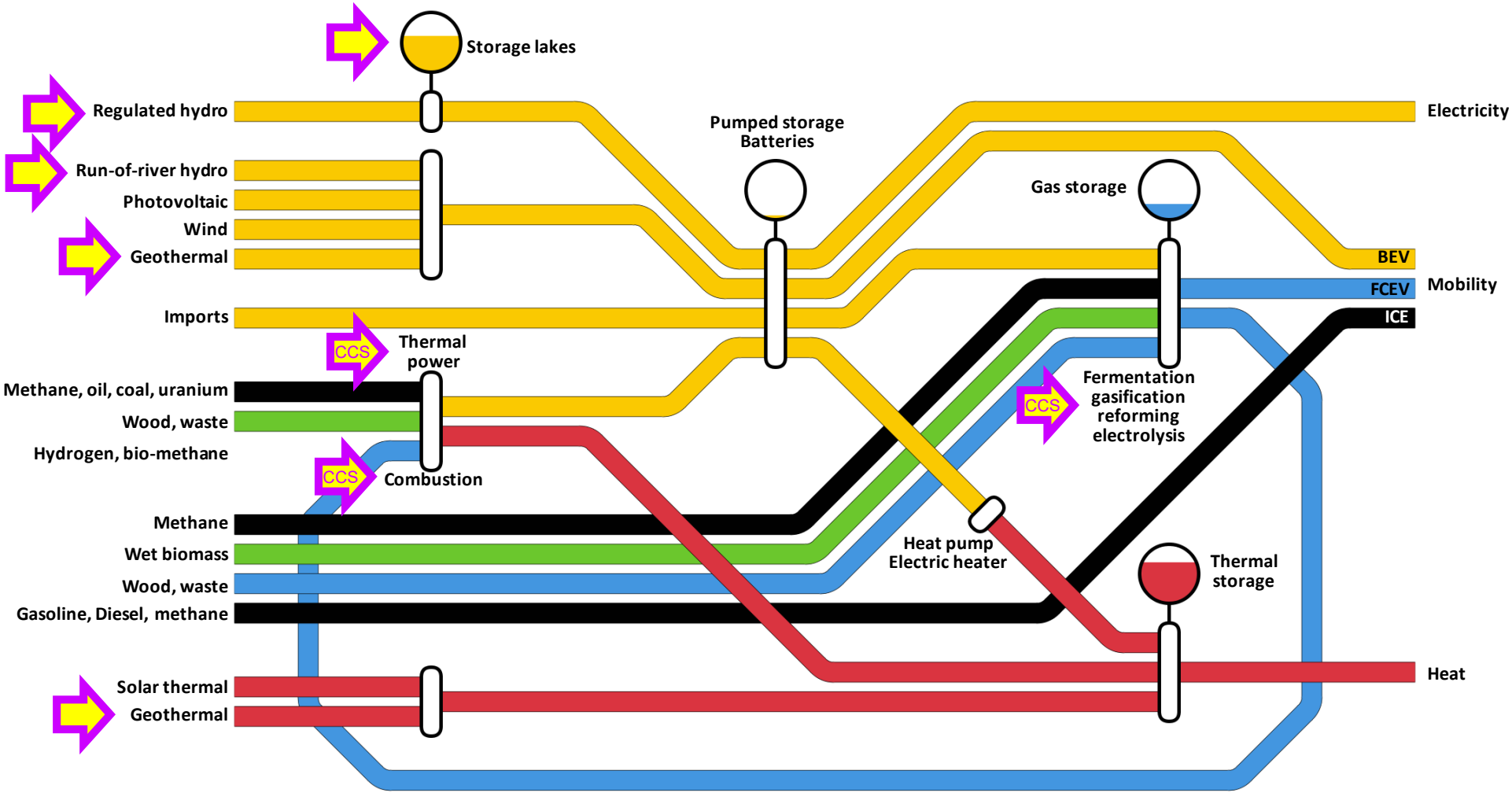
Energy system models

Business-as-usual and Net-zero scenarios for Switzerland 2050+

Definition of net-zero ($Mt_{CO2,eq}$)



The energy system

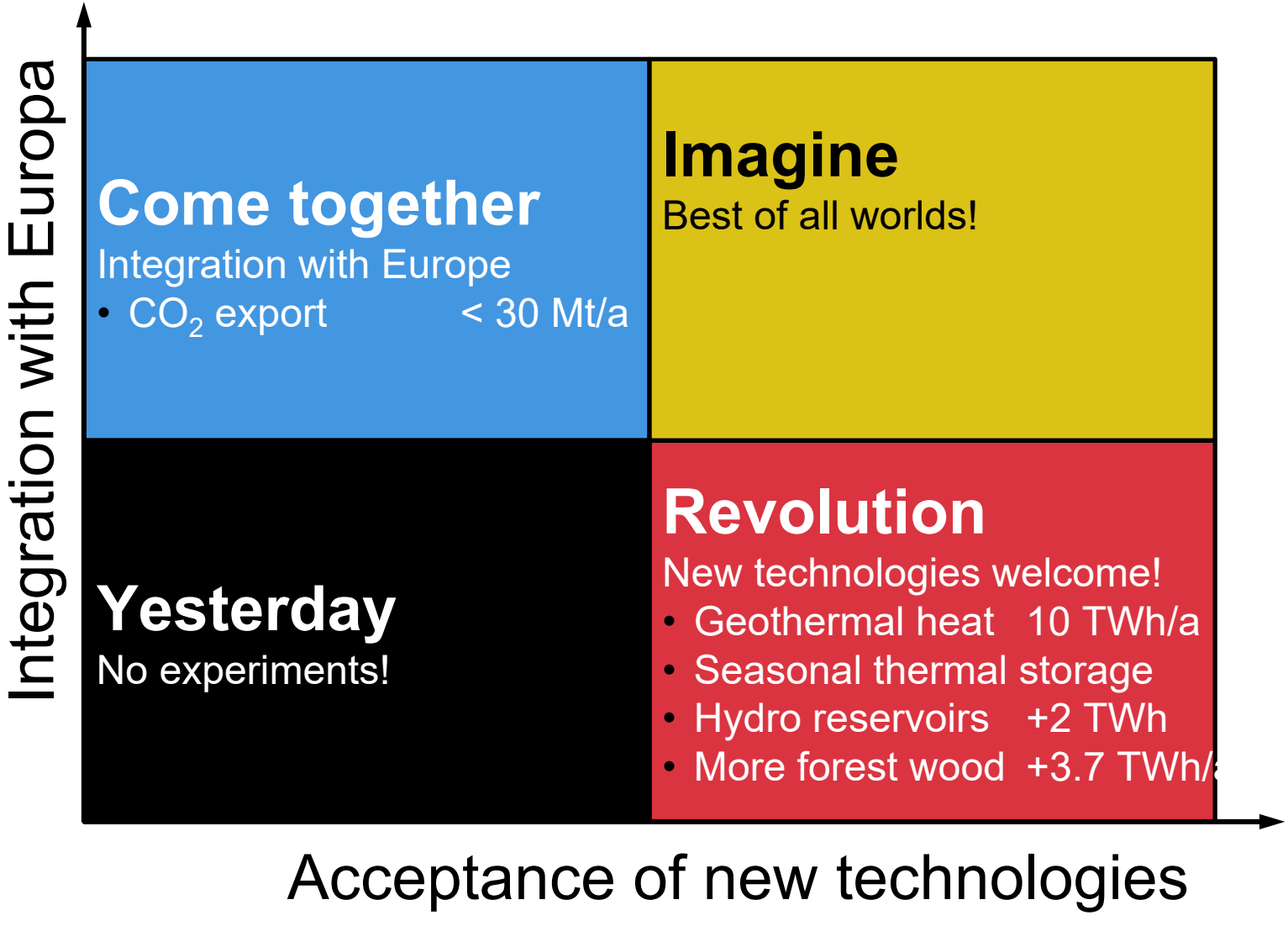


Spotlight on SCCER-SoE technologies

- Hydro power
  - Increase of reservoir volume by dam heightening
  - Importance of flexibility
- Geothermal energy
  - Optimal use
- Carbon Capture & Storage
  - Storage volumes
  - Sources of CO2

Swiss Energyscope (ETH)

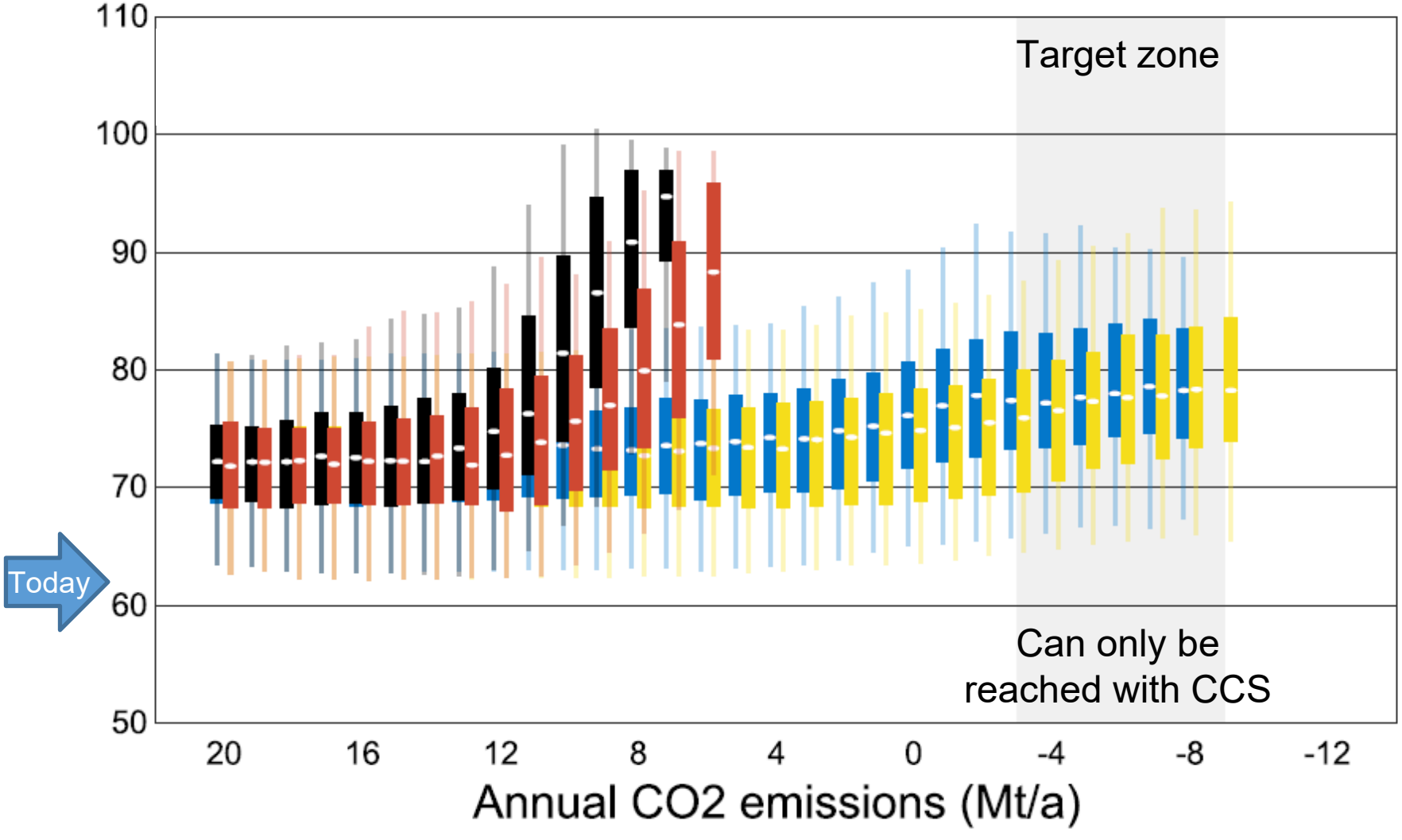
Variants of CLI scenario



Swiss Energyscope (ETH)

Total electricity consumption / generation (TWh/a)

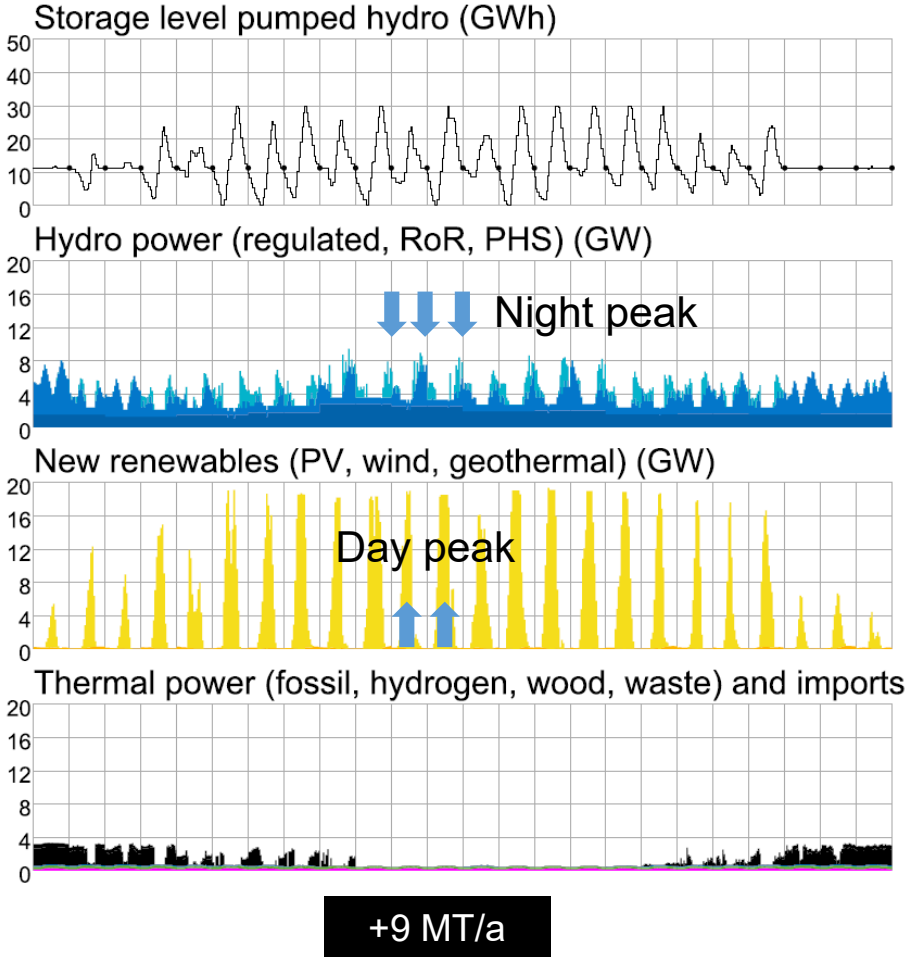
Come together	Imagine
Yesterday	Revolution



Question #1 on hydro power

What is the value of increasing generation, flexibility and seasonal storage volumes?

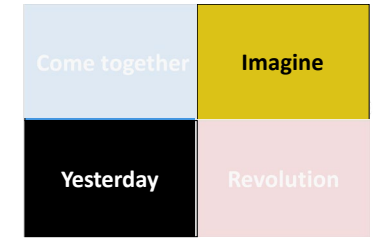
Hydro power
Demand for flexibility, pumped storage

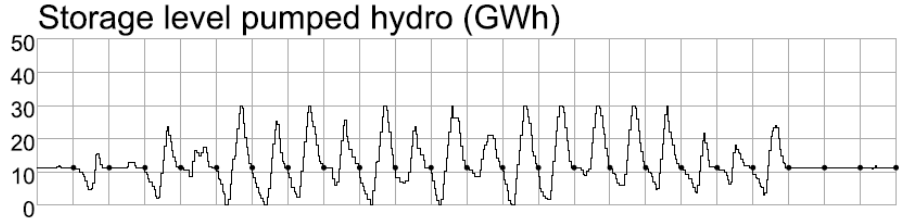


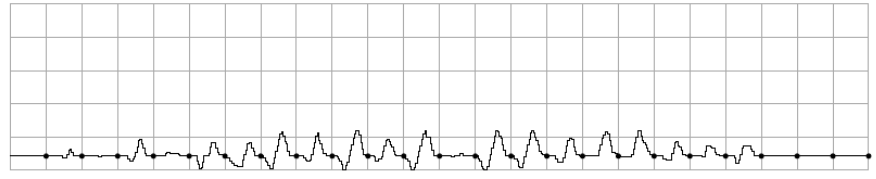
+9 MT/a

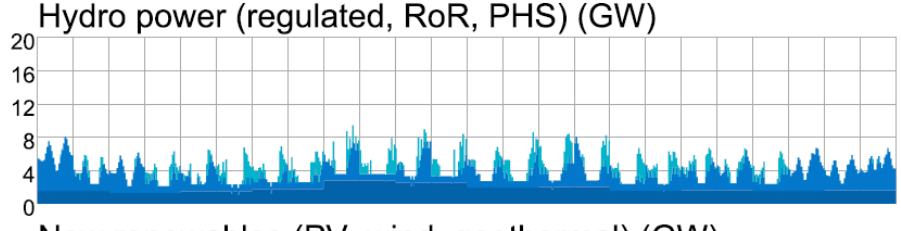
Large demand for flexibility of storage plants + pumped hydro storage to manage photovoltaic generation

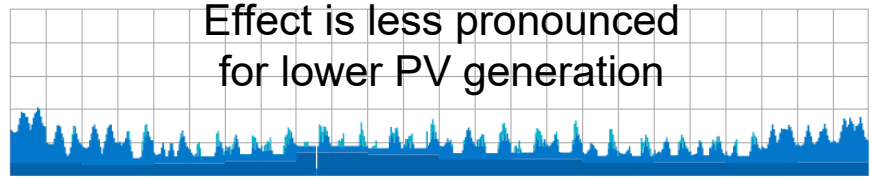
Hydro power
Demand for flexibility, pumped storage

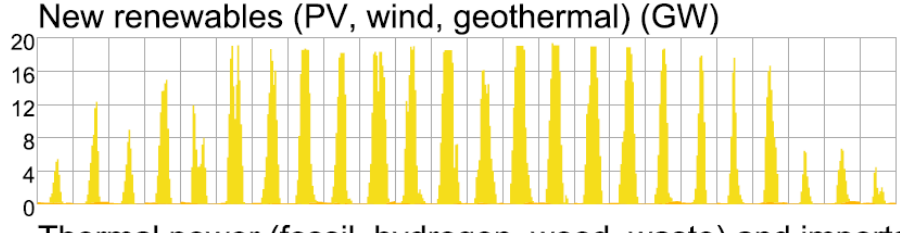


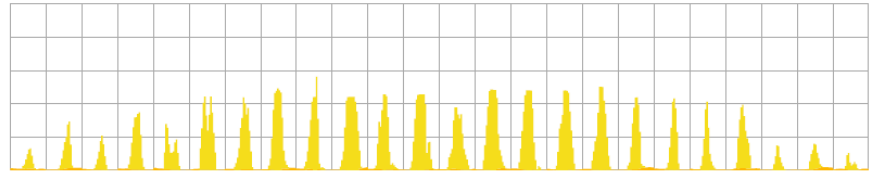


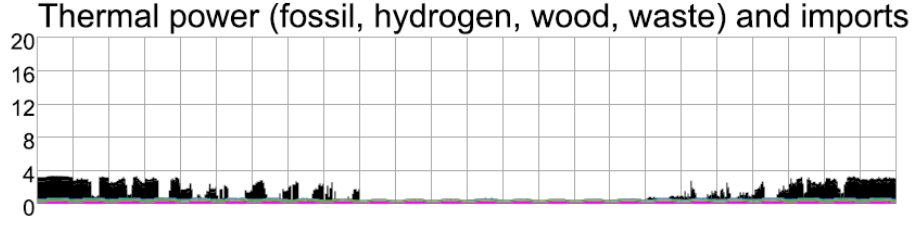


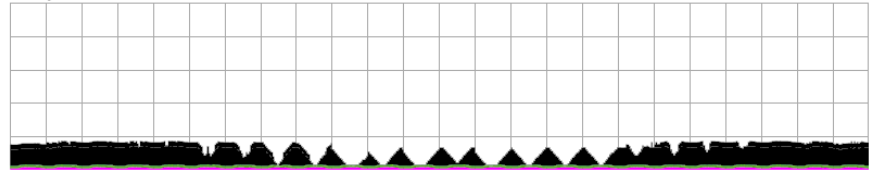












+9 MT/a

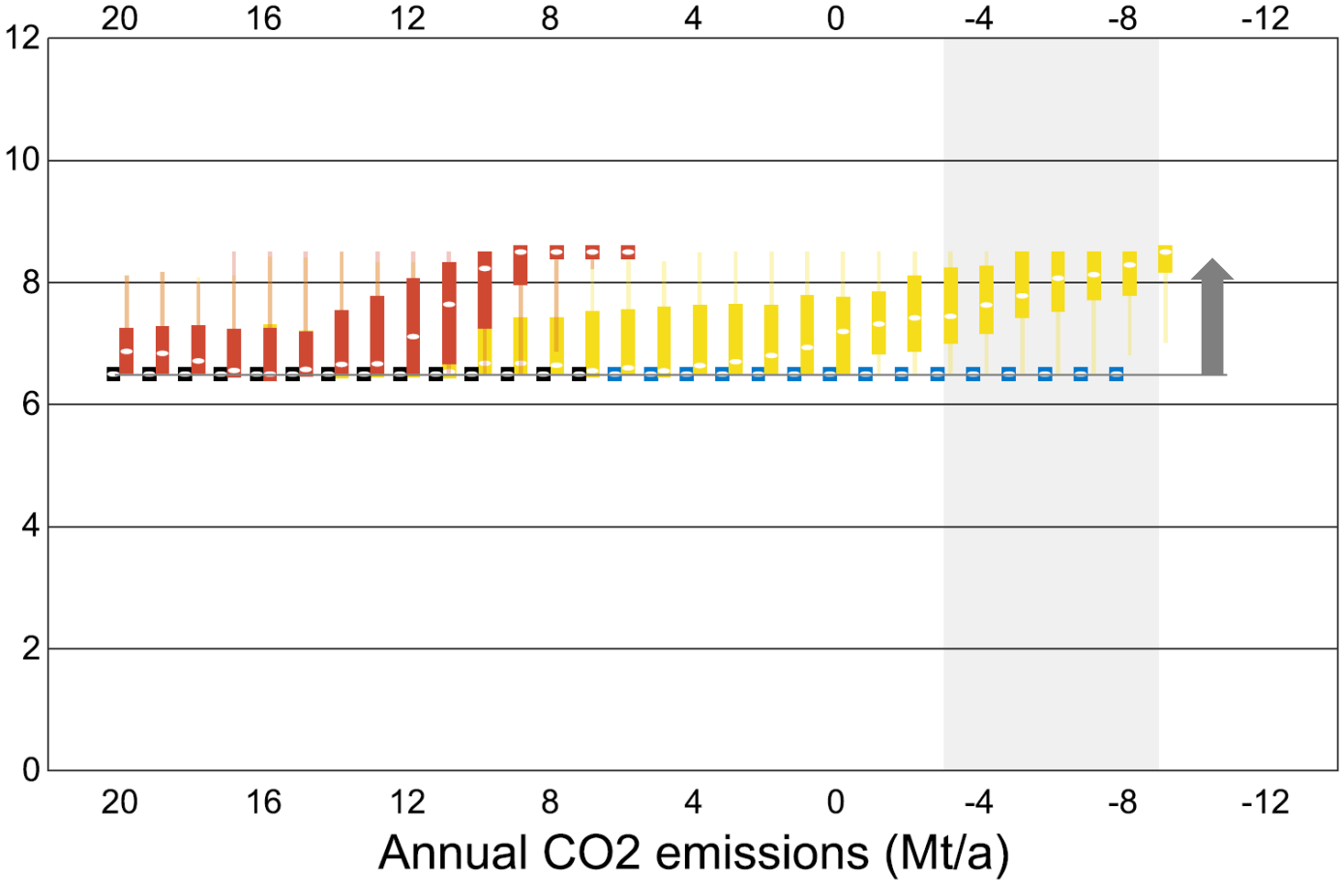
-6 MT/a

Hydro power

Increase of reservoir storage volume (TWh)

Come together	Imagine
Yesterday	Revolution

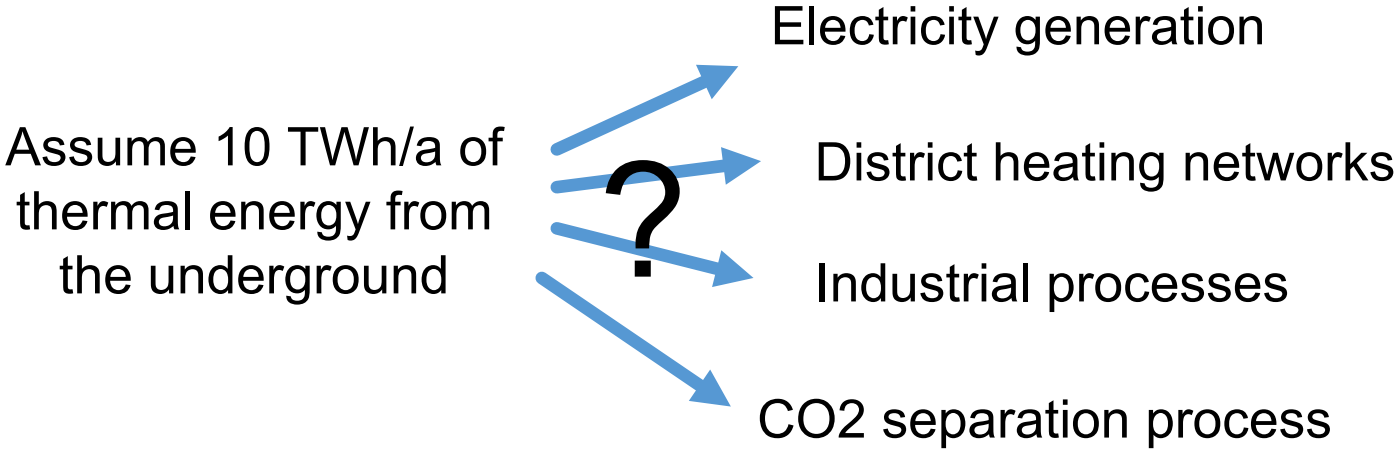
Dam heightening available



Increase by 2 TWh is beneficial for low emission scenarios

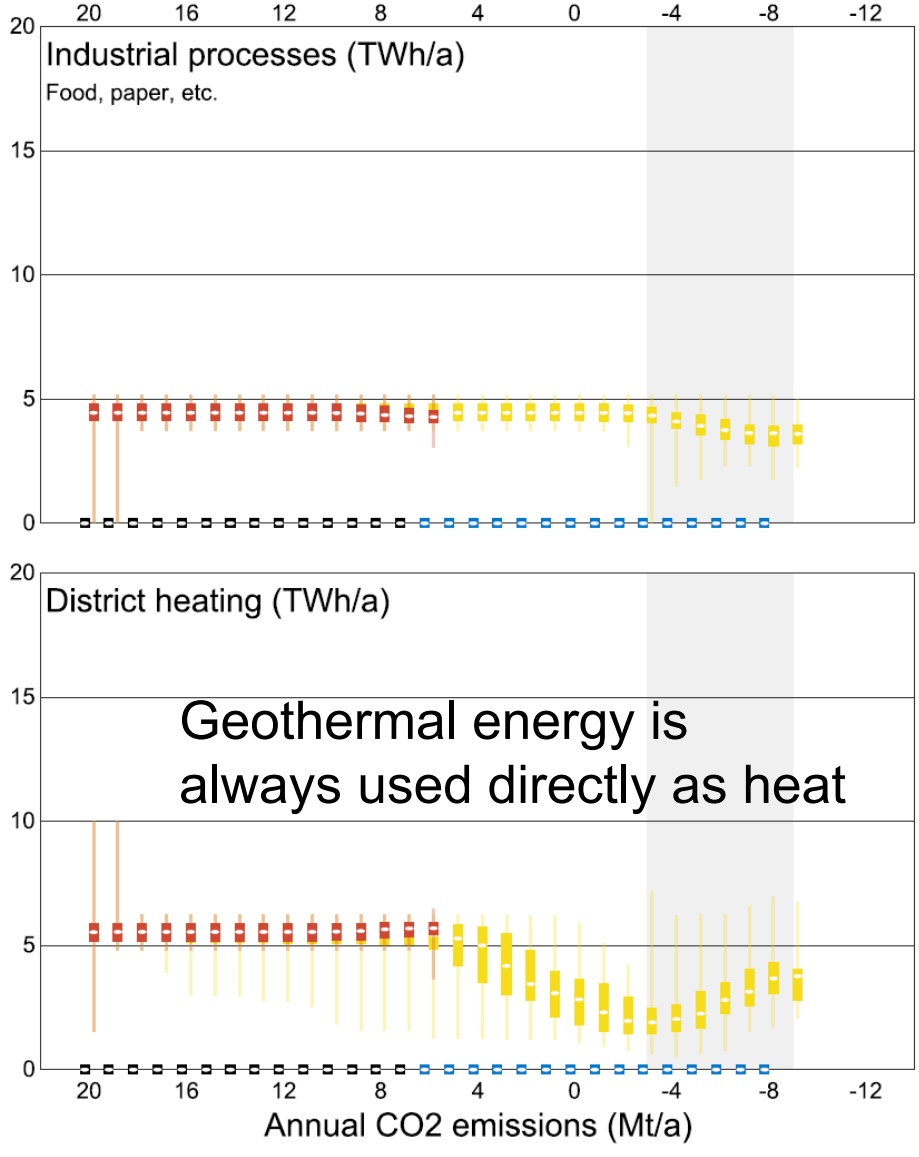
Question #2 on geothermal

Where to best use geothermal energy?



Geothermal energy
Optimal usage

Come together	Imagine
Yesterday	Revolution

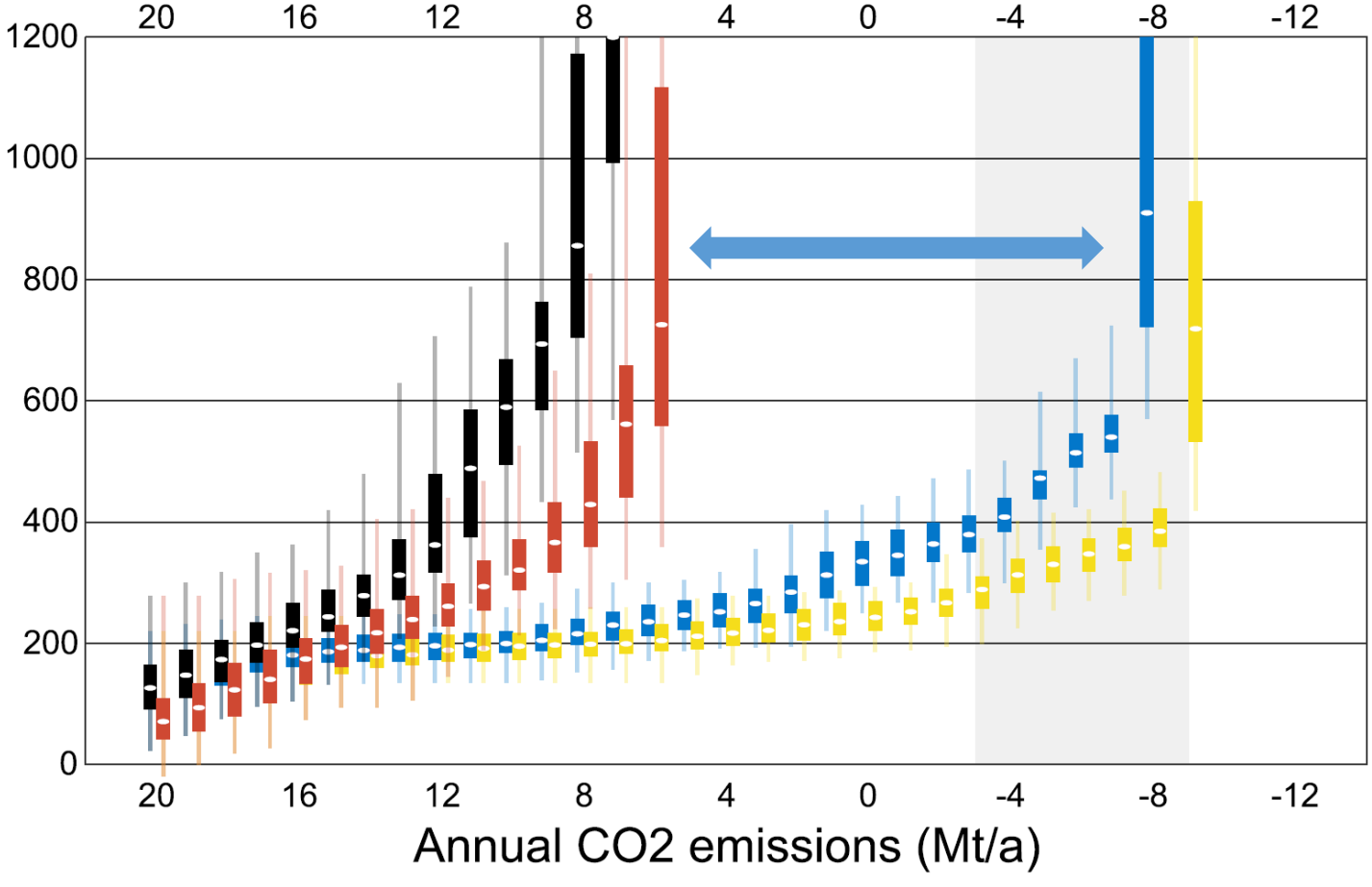


Question #3 on CCS

What is the value of CCS, where is it applied?

Carbon capture and storage (CCS)
Marginal CO2 avoidance costs (CHF/t_{CO2})

Come together	Imagine
Yesterday	Revolution

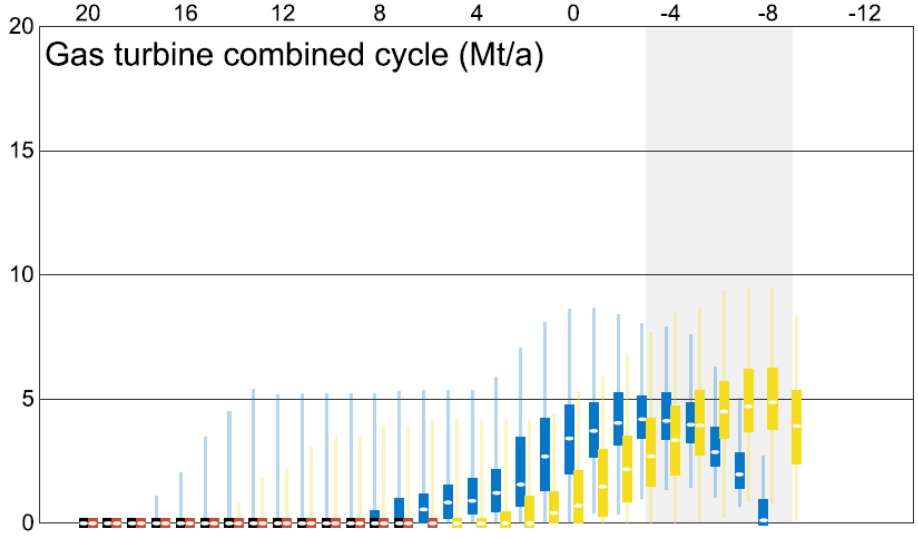


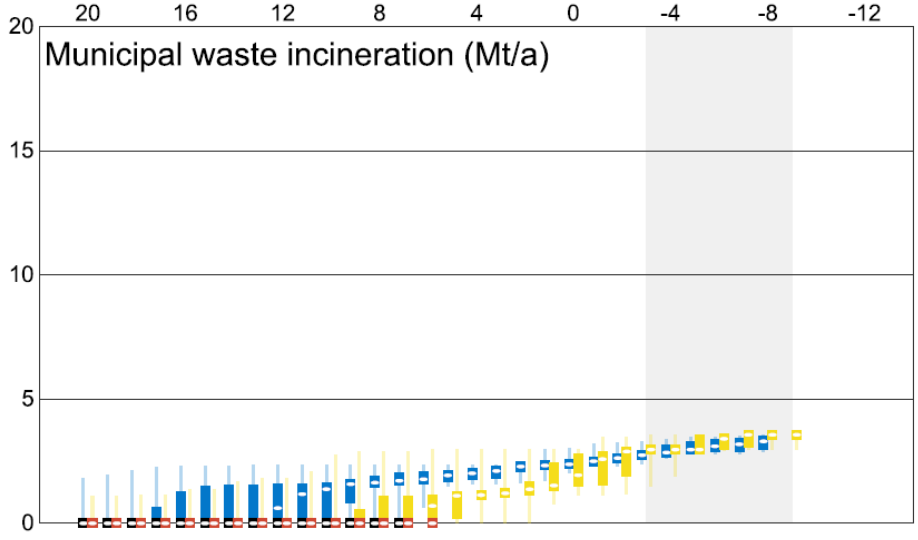
The Swiss climate targets cannot be reached without CCS

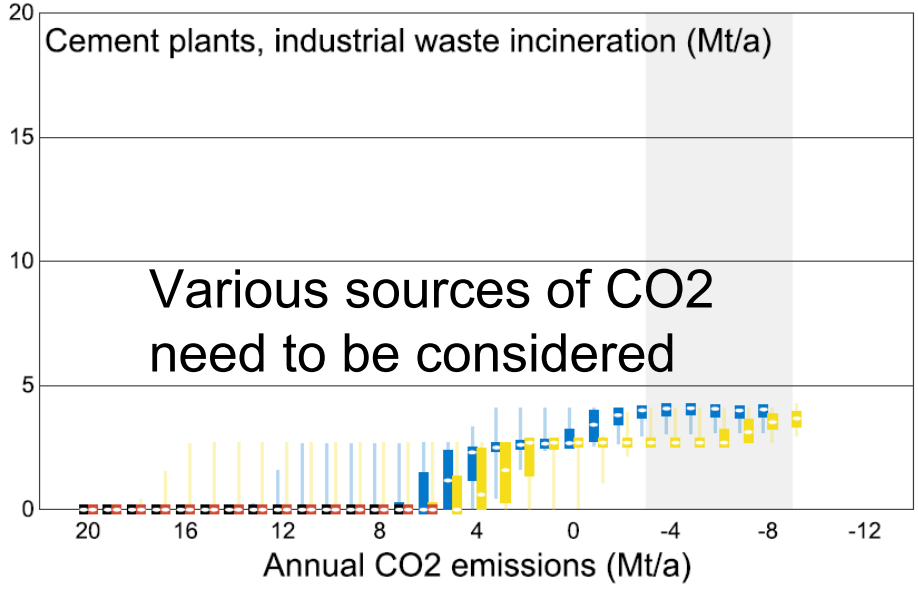
Carbon capture and storage (CCS)

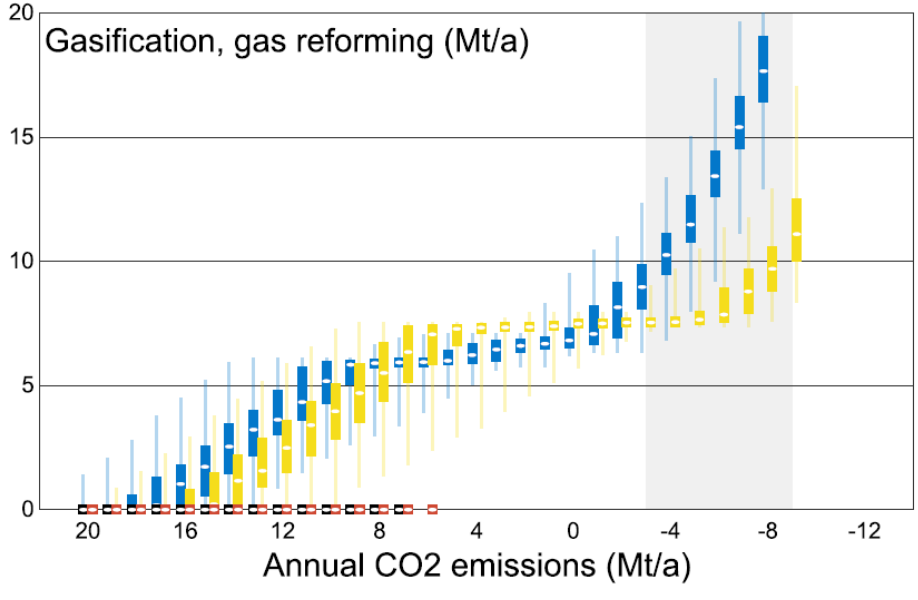
Source of captured CO2

Come together	Imagine
Yesterday	Revolution





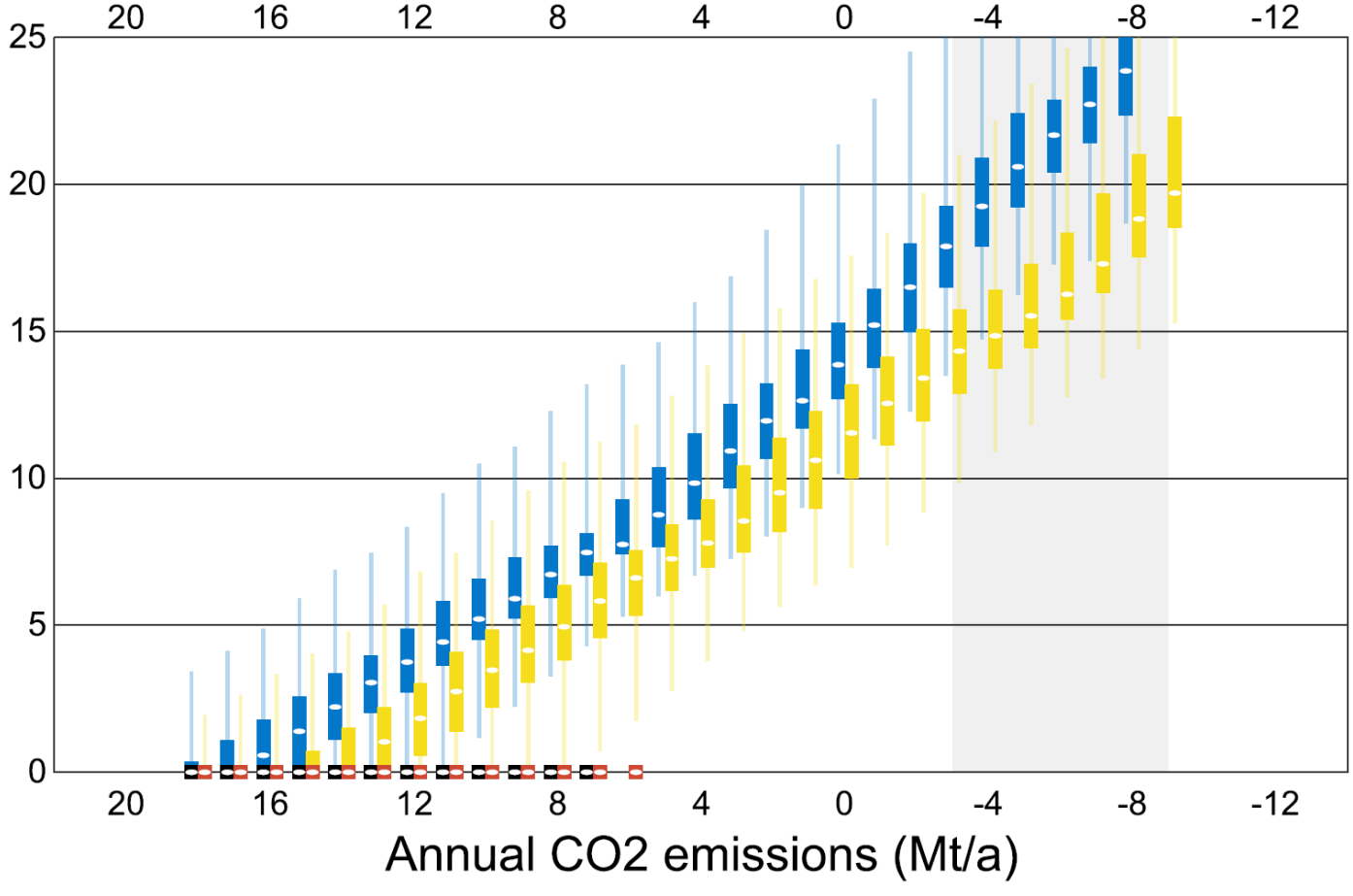




Carbon capture and storage (CCS)

Annual storage of CO_2 (Mt/a)

Come together	Imagine
Yesterday	Revolution



We will need to store 10-20 Mt of CO_2 per year

Hydro power, geothermal and CCS

- SCCER-SoE picked the right subjects!
- All technologies are essential for reaching the Swiss climate targets
  - Flexible hydro power plants act as a partner to photovoltaics
  - Increasing reservoir volume helps in winter
  - Geothermal supplies valuable low-temperature heat – and it helps the electricity sectors by reducing load on heat pumps
  - CCS allows to generate negative emissions which are needed to compensate other sectors
- These technologies will make their impact – for a reasonable CO_2 price of a few hundred CHF per ton_{CO2}

Thank you for your attention!

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