Long term energy transformation pathways

Integrated scenario analysis with the Swiss TIMES Energy Systems Model (STEM)

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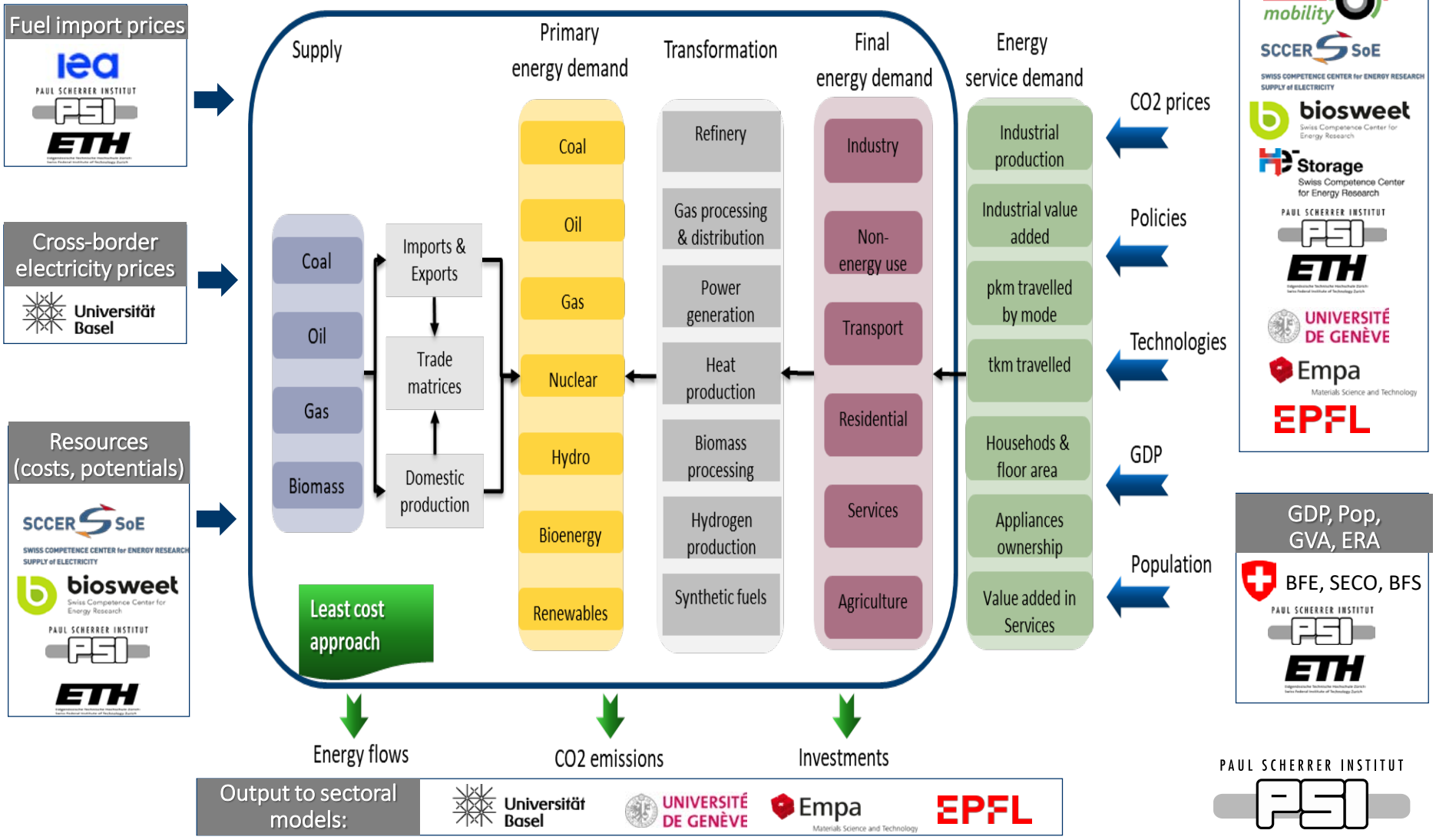
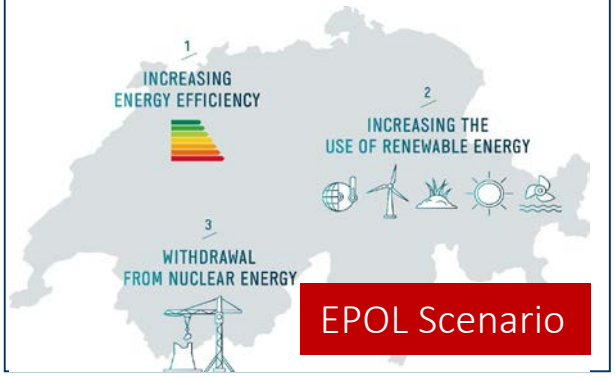
STEM links with JASM & other SCCERs

- Based on IEA-TIMES with full representation of the Swiss energy system
- Assesses transition pathways via contrasting "what-if" scenarios



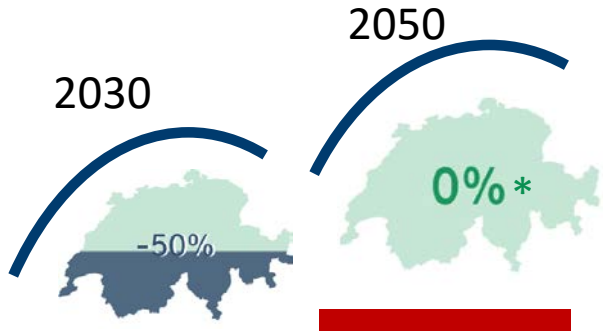
Scenarios and variants assessed with STEM

Energy policy objectives



EPOL Scenario

Climate policy objectives



CLI Scenario

Core scenarios

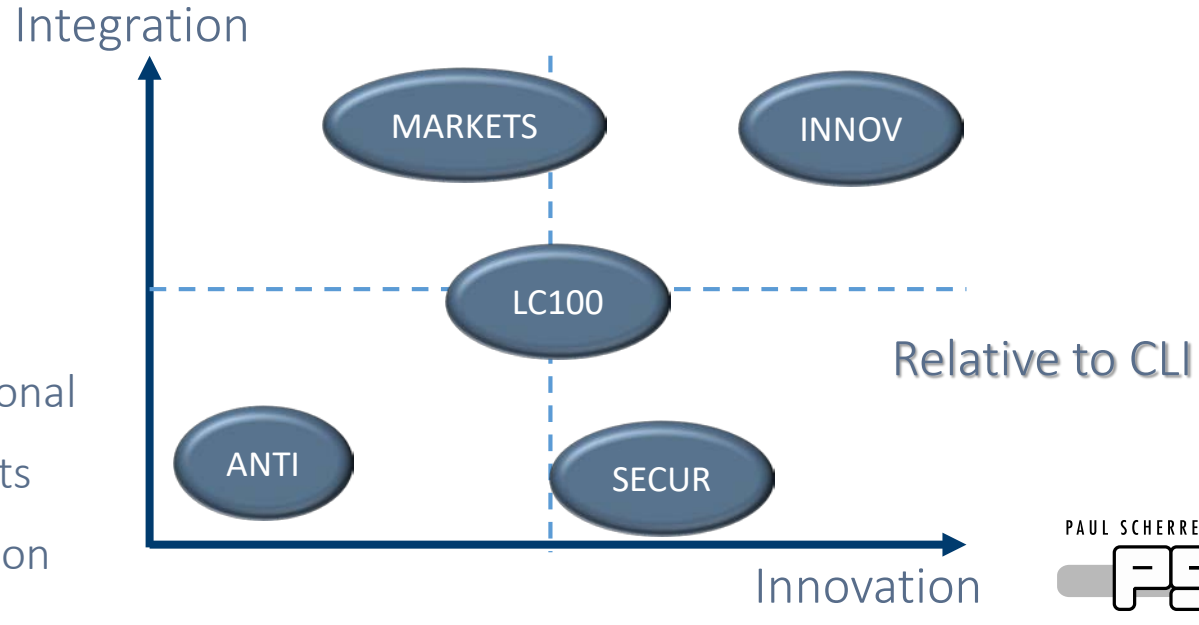
+

Business As Usual (BAU) for benchmarking

* In STEM only from the energy system and industrial processes (non-CO2 emission from agriculture are excluded as well as emissions related to international aviation)

Variants

- Social acceptance
- Energy security
- Integration of RES
- Integration of local, national and international markets
- Technology and innovation



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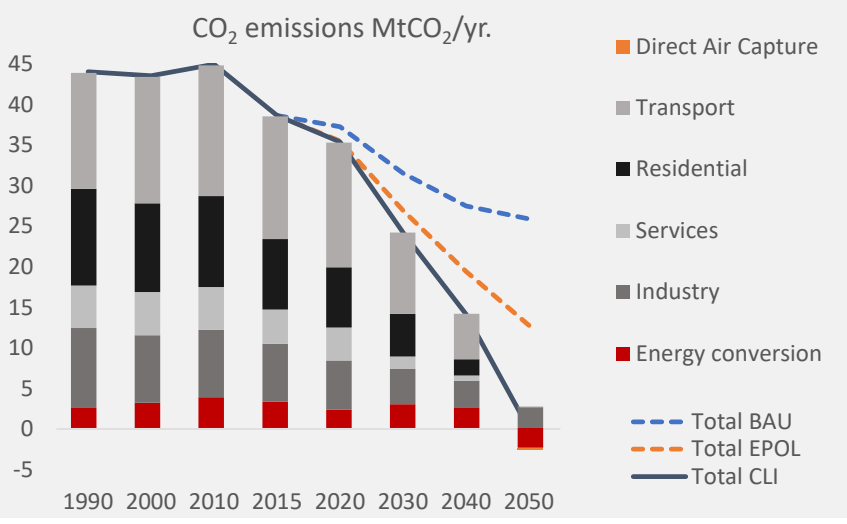
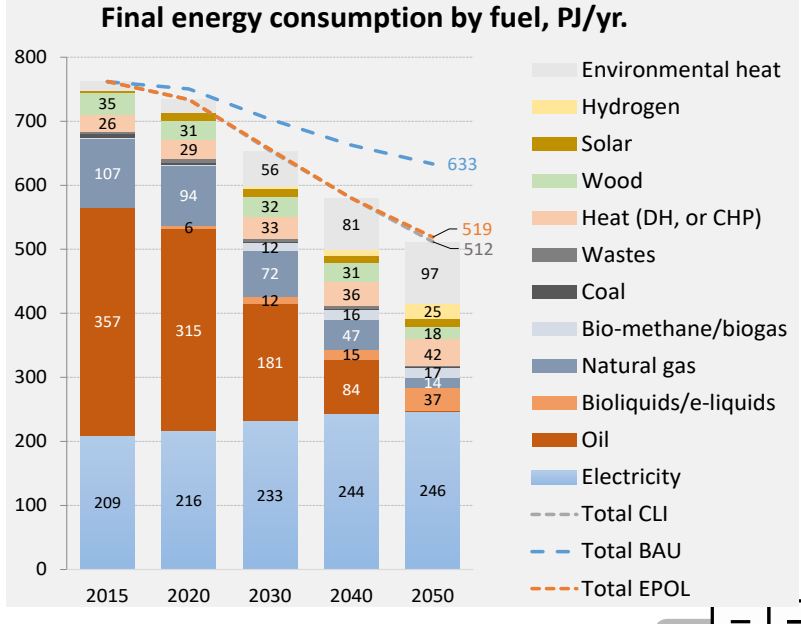
Key block elements in achieving net-zero: CCS, efficiency, electricity, synfuels/e-fuels/biofuels

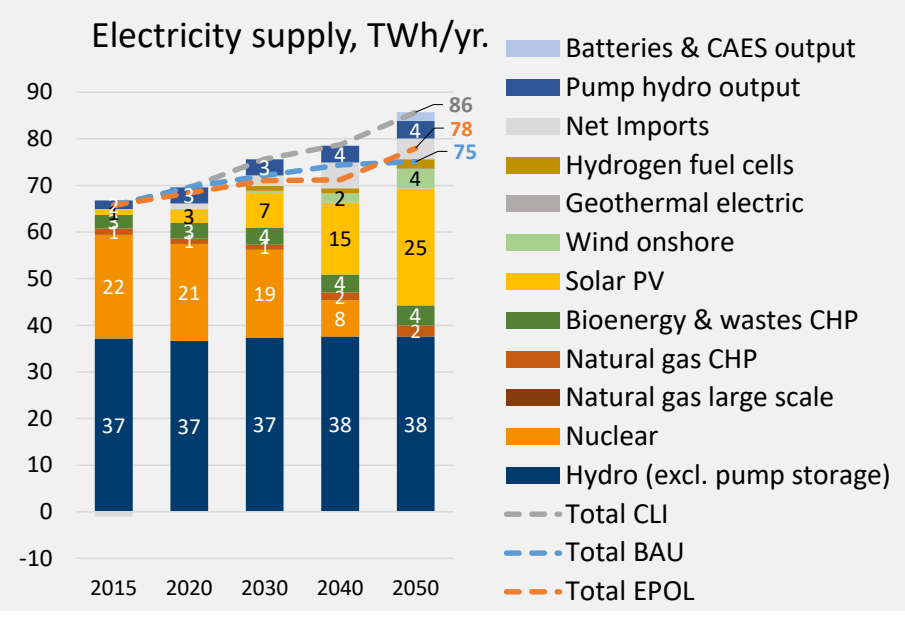


- Decarbonisation of the end-use sectors
- Remaining emissions only in industry
- CCS & negative emissions:
  - CCS related to waste incineration and industrial processes
  - CCS related to wood gasification for hydrogen and syngas production
  - Direct Air Capture as a backstop technology
- ca 9 Mt CO_2 captured in 2050, of which ca 4 Mt in NETs
- If storing CO_2 in CH is limited → needed access to sites abroad

- Decarbonisation of end-use sectors is based on efficiency and electrification
  - 6x more heat provided by heat pumps in buildings in 2050
  - 4 out of 5 cars is electric in 2050
  - Heavy trucks in 2050: H2 (33% of total), e-fuels/biofuels (57% of total) and electric (10% of total)
- The speed of transformation is critical to avoid lock-ins in carbon intensive heating and mobility technologies
- In 2050, remaining fossil fuels only in industry (gas-based)
- Hydrogen, e-fuels and biofuels have share >15% in 2050
- Electricity share close to 50% in 2050

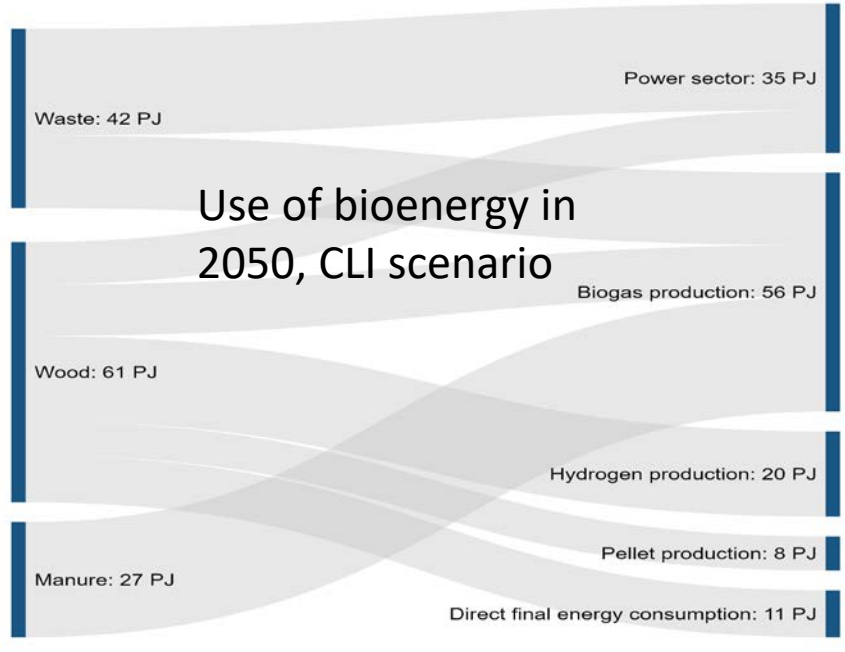


Energy supply needs to largely exploit sustainable renewable potential



- Deployment of solar PV almost doubles in each decade
- Important to maintain current hydropower levels
- Use of bioenergy & wind in power supply increases
- Net imports in winter ca. 6 TWh
- > 40% of generation in medium-low grid levels
- Much of the increase in supply in the last decade due to mobility and electrolysis

- Bioenergy has a key role in the future Swiss energy system as it decarbonise uses and contributes to negative emissions
- Exploitation of manure potential needs to be mobilised
- New uses of wood via gasification in hydrogen and syngas production → with CCS to deliver negative emissions



Increased flexibility is needed based on storage, P2X, DSM and G2V/V2G

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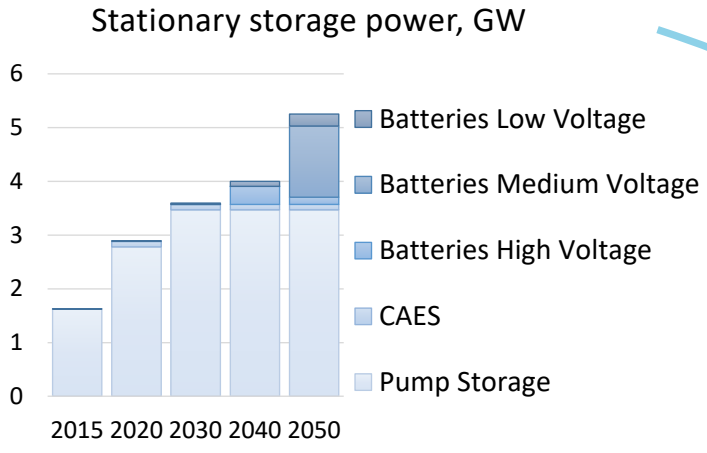
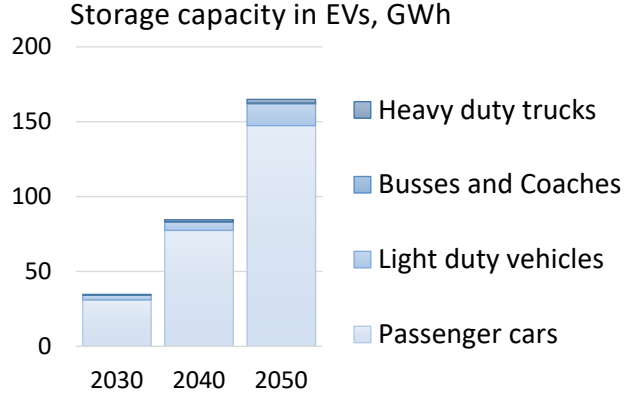
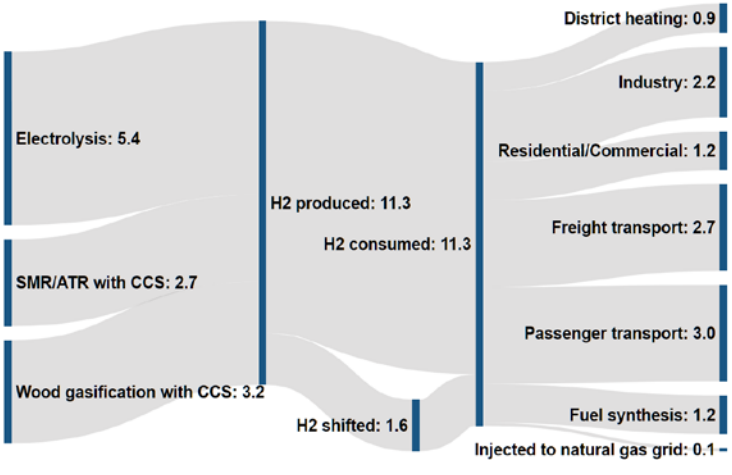
Electricity storage in all grid levels



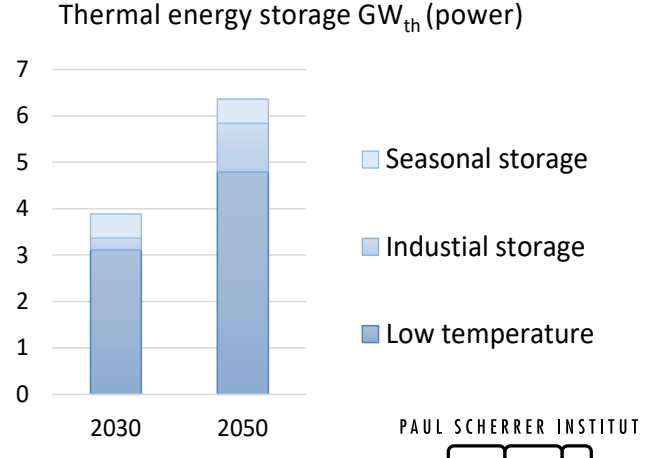
Smart charging (G2V) and discharging (V2G) in transport



Sector coupling (seasonal storage + H2)



Flexible loads (incl. thermal storage)



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Key findings (incl. insights from variants)

- Achieving the Swiss energy and climate goals would require:
  - Scaling up clean technologies: solar PV, heat pumps, alternative vehicles
  - Spreading the use of electricity in heating and mobility sectors
  - Implementing energy savings measures in end-use sectors
  - Integrating CCS and NETs in energy and climate policy
  - Foster innovation in clean and renewable hydrogen → important for end-use decarb. and balancing

- The net-zero target is technically feasible but in order to achieve this target at lowest possible costs it requires:
  - Engagement of citizens and social acceptance of new technologies
  - New social practices to promote smart use of energy and efficiency
  - Exploitation of domestic renewable resources
  - Access to international energy markets (electricity, e-fuels, biofuels)
  - Access to international CO_2 storage sites, if domestic sequestration is limited/uncertain
  - Global cooperation and coordination in climate policy and technology innovation

- Depending on the national and international context of the energy transition, its cost for the period 2020-2050 varies from 70 BCHF to 450 BCHF (discounted at 2.5%) , relative to BAU
- The CLI core scenario has a cost of 130 BCHF from 2020 to 2050, discounted at 2.5% , or 340 CHF/capita-year , relative to BAU

Thank you for your attention!

Visit us on www.sccer-jasm.ch

My thanks for their support go to:
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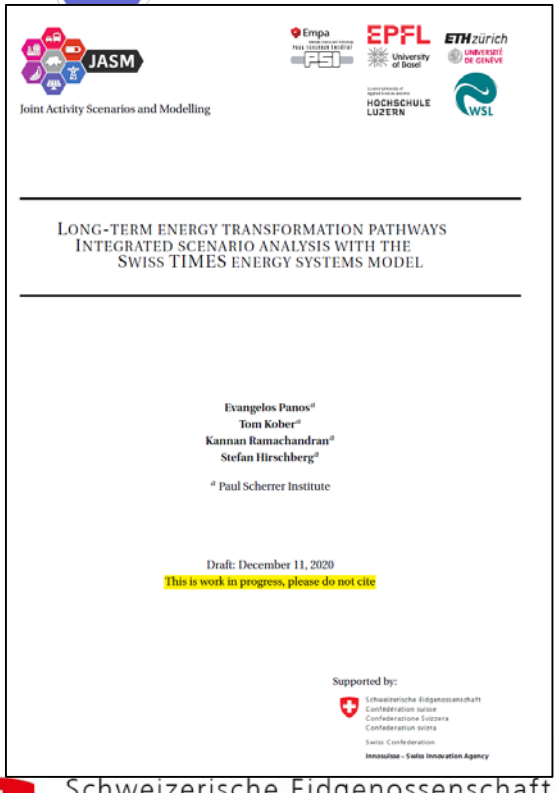
Mr. Kannan Ramachandran
Dr. Stefan Hirschberg



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Joint Activity Scenarios and Modelling

LONG-TERM ENERGY TRANSFORMATION PATHWAYS
INTEGRATED SCENARIO ANALYSIS WITH THE
SWISS TIMES ENERGY SYSTEMS MODEL

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