



# CREST SimLab: Model Comparison on Swiss climate policy

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In cooperation with the CTI



**Energy**  
Swiss Competence Centers for Energy Research



Schweizerische Eidgenossenschaft  
Confédération suisse  
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Swiss Confederation

Commission for Technology and Innovation CTI

# Swiss Energy Model Platform (SEMP)

- Analysis of policy questions using different modelling approaches
  - Define a policy question
  - Define a set of scenarios
  - Simulate the scenarios with the different models
  - Compare the results to identify common trends and differences
  - Improve models: Learning from the differences

# 1st SEMP

- Assessing consequences (energy & economy) of reaching 2 different emissions targets for 2050:
  - 1.5 and 1.0 tCO<sub>2</sub> per capita
- Swiss climate policy moving in the direction of a market-based framework (steering).
  - Evaluating the efficiency of alternative carbon pricing options

# Scenarios

- BAU:

- Harmonized GDP (1.28% p.a) and total energy demand
- Current policies: CO<sub>2</sub> levies [CHF/tCO<sub>2</sub>]:

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	2010	2015	2020	2035	2050	Reference
CO <sub>2</sub> tax thermal fuels	36	60	120	120	120	CO <sub>2</sub> Levy
CO <sub>2</sub> tax motor fuels	0	0	0	0	0	CO <sub>2</sub> Levy

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- Climate scenarios:

- 1.5 and 1.0 tCO<sub>2</sub> per capita (15.45 and 10.3 MtCO<sub>2</sub> in 2050)
- Carbon taxes:
  - 1 Economy-wide uniform carbon tax
  - 2 ETS + Uniform tax in non-ETS sectors
  - 3 ETS + Differentiated tax in transport and heating fuels

# Models and harmonization

- Model types

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<b>Whole economy (top down)</b>	<b>Energy (bottom up)</b>
CEPE-HH (ETH, Rausch & Landis)	STEM (PSI, Ramachandran)
CEPE-3x16 (ETH, Rausch & van Nieuwkoop)	
CITE (ETH, Bretschger & Marcucci)	
GEMINI-E3 (EPFL, Thalmann & Vielle)	

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- Regional coverage:

- Switzerland: CEPE-HH, CITE and STEM
- Global: CEPE-3x16, GEMINI-E3

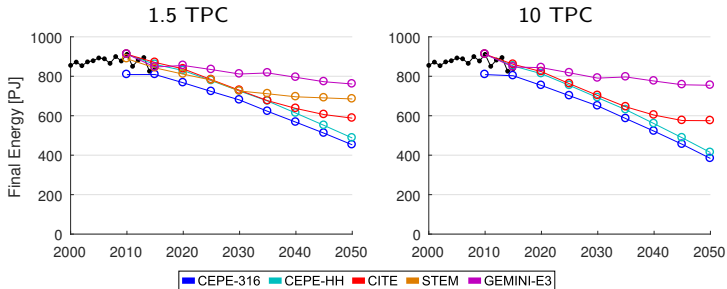
- Harmonizing assumptions about:

- Population (10.3 Million in 2050)
- Energy prices from IEA

# Preliminary results

- Energy demand: Total and by sector
- Electricity demand and generation
- Carbon prices
- GDP losses
- Consumption losses
- Investment
- Sectoral emissions
- Energy system:
  - Electricity: Installed capacities, hourly dispatch of electricity supply
  - Transport: Number of cars by technology/fuel type, fuel demand
- ...

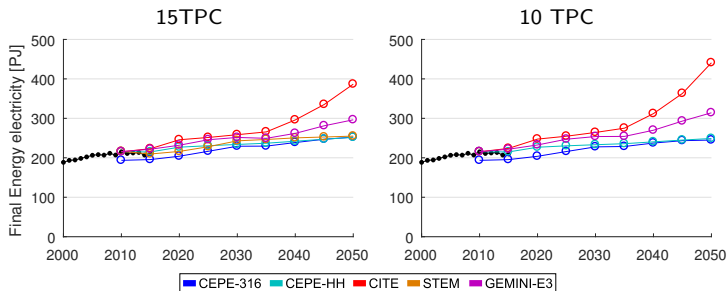
# Energy demand: Total



## ● Average annual growth rate of energy demand:

- 1.5TPC:  $-1.6$  to  $-0.4\%$
- 1.0TPC:  $-2$  to  $-0.5\%$

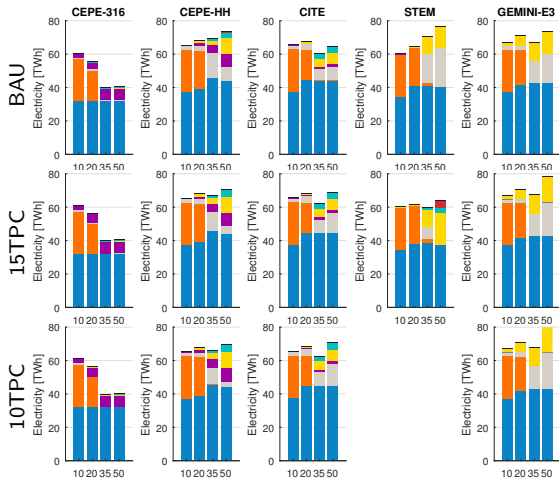
# Electricity demand



→ Increase in electricity demand with increase in ambition of emissions target



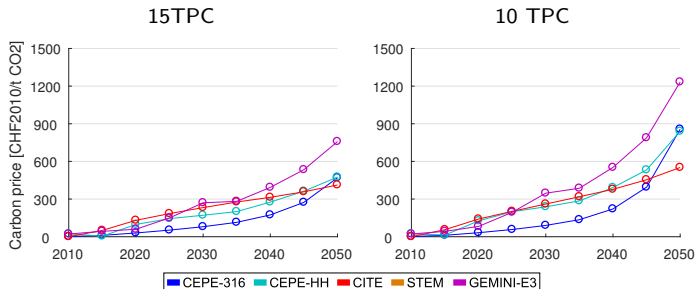
# Electricity generation



- Large expansion of renewables: wind and solar
- Imports vs. expansion of RES

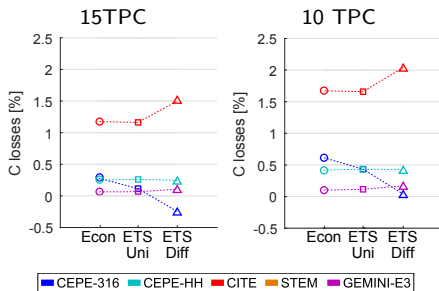
# Carbon prices: average across economy

## Economy-wide uniform tax



- 2035 carbon price: 115–280 CHF/tCO<sub>2</sub> and 135–385 CHF/tCO<sub>2</sub>
- 2050 carbon price: 410–790 CHF/tCO<sub>2</sub> and 550–1230 CHF/tCO<sub>2</sub>

# Cumulative consumption losses



- Cumulative discounted losses: 0.05–1.2 % and 0.1–1.7 %
- ETS + Uniform tax: Similar to uniform tax
- ETS + Differentiated tax: 2 models with results in different directions (interaction with existing tax distortions)

# In general

- Main contribution:
  - Understanding differences in results and what do they mean for policy decisions
  - Special issue in SJES
- Achieving 1.5 and 1.0 tCO<sub>2</sub>e p.c.:
  - Lower energy demands: decrease by 0.4 – 1.6% in 1.5TPC and 0.5 – 2% in 1.0TPC
  - Hydro, wind, solar very important role
  - 2050 carbon price: 410–790 CHF/tCO<sub>2</sub> and 550–1230 CHF/tCO<sub>2</sub>
  - Different effects from having differentiated CO<sub>2</sub> taxes: Interaction with existing tax distortions, decarbonization strategy in transport sector (electrification)

# Special issue SJES: content

- 1 Swiss Energy Modelling Platform: Overview of Model Results  
(Florian Landis, Adriana Marcucci, and Sebastian Rausch, ETH)
- 2 Growth impacts of Swiss steering based climate policies  
(Marcucci, A. and L. Zhang, ETH)
- 3 Determinants of the Distribution of Climate Policy Cost in Switzerland  
(Florian Landis, ETH)
- 4 Lowering CO<sub>2</sub> emissions in the Swiss transport sector  
(Philippe Thalmann and Marc Vielle, EPFL)
- 5 The Swiss Nuclear Phase-Out: The cost of self-sufficiency  
(R. van Nieuwkoop, ETH)
- 6 Differential sectoral CO<sub>2</sub> taxes in Switzerland: Carbon leakage across energy system and their technological implication for long term CO<sub>2</sub> mitigation goals  
(K. Ramachandran, PSI)
- 7 Linking electricity prices and costs in bottom-up top-down coupling under changing market environments  
(Sophie Maire, Frank Voehringer, and Philippe Thalmann, EPFL)
- 8 Swiss electricity market design: Policy coordination and investment incentives  
(Nicolas Weidmann-Ordonez, Frank C. Krysiak, Hannes Weigt, UniBasel)

Thank you for your attention

Contact:

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# Harmonization and BAU scenario

- Harmonizing assumptions:

	2010	2020	2035	2050	Reference
Population (million)	7.8	8.7	9.8	10.3	BFS Scenario A-00-2015
Oil price [2010\$/barrel]	78	105	120	129	2015 Energy technology
Gas price [2010\$/MBtu]	7.5	10.4	11.7	12.4	Perspectives, IEA

- BAU → Current policies:

	2010	2020	2035	2050	Reference
Potential GDP (rel. to 2010)	1	1.18	1.43	1.66	SECO 2015
Energy demand (rel. to 2010)	1	0.94	0.84	0.78	BAU, Energieperspektiven 2050, BFE
CO <sub>2</sub> tax thermal fuels (CHF/tCO <sub>2</sub> )	36	120	120	120	CO <sub>2</sub> Levy
CO <sub>2</sub> tax motor fuels (CHF/tCO <sub>2</sub> )	0	0	0	0	CO <sub>2</sub> Levy