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Influence of long term electricity sector developments in Europe on the Swiss electricity system: Risks and opportunities for electricity trading

Outline

• Introduction
• Objectives
• CROSSTEM model
• Scenarios
• Preliminary results
• Issues and Challenges
• Outlook
Introduction

- Electricity accounts for one quarter of Swiss energy demand
- Large differences in seasonal output, seasonal demand.
- Creates seasonal dependence on electricity import.

![Electricity generation mix 2010](image)


Future of Electricity sector

- Nuclear phase out – No replacement of existing Nuclear power plants at the end of their lifetime. Last power plant off grid by 2034.
- The Swiss Energy Strategy (SES) 2050
  - Uncertainty regarding future supply options – A combination of gas based generation, renewables and electricity imports are mentioned.
Future of Electricity sector – Tradeoffs

Developments in Europe
• Integration of intermittent Renewables
• Nuclear phase-out?
• CO₂ emission targets
• Gas imports

Supply Security

Cost of Supply

Climate change

• Cost implications of renewable / low carbon policy
• Revenue from trade

• Balancing supply and demand
• Intermittent nature of renewables
• Electricity imports

System balancing

• CO₂ emission targets
• Expansion of Gas plants

Electricity Supply Options
Gas
Renewables
Import

STEM-E – Swiss TIMES Electricity Model

Model Features
• Single region model
• Time horizon: 2000 – 2100 in 18 time periods
• An hourly timeslice (288 timeslices)
• Characterization of about 140 technologies and over 40 energy and emission commodities

Key Parameters
• Exogenous electricity demand for the future
• Range of primary energy resources
• Electricity import and export from four countries

R Kannan & H. Turton (2011) - Documentation on the development of the Swiss TIMES electricity model
Available at http://energyeconomics.weo.psi.ch=applications/documentation/PSI-bericht-11-03.pdf

22.06.2013 PSI, Seite 6
Objectives

- Analyse developments in the neighbouring countries – Germany (DE), Austria (AT), France (FR) and Italy (IT)
- Quantify the extent to which these developments affect the Swiss electricity sector
- Can Switzerland depend on imported electricity?

CROSSTEM Model

- CROSs border Swiss TIMES Electricity Model
- Extension of the STEM-E model to include the four neighbouring countries
- Time horizon: 2000 – 2050 in 14 unequal time periods
- An hourly timeslice (288 timeslices)
- Detailed reference electricity system with resource supply, renewable potentials and demands for 5 countries
- Calibrated for electricity demand and supply data between 2000-2010
- Endogenous electricity import / export based on costs and technical characteristics
3 Scenarios selected for Analysis

- **Base (BASE)** – No specific constraints on technology choice, nor any emission targets, Swiss BAU CO2 tax applied,

- **Low Carbon (LC)** – A cap on the total CO$_2$ emission from electricity generation is applied across all regions. Level of decarbonisation to reach 60% of 1990 levels by 2030, 98% by 2050$^1$.

- **Renewable Scenario (REN)** – A minimum of 20% of the CROSSTEM demand is to be met by renewable sources by 2020$^2$, 40% by 2050. - Excluding hydro!


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Key assumptions

- **Nuclear phase-out** – in Switzerland and Germany has been assumed. Only France will continue with its nuclear program

- **Electricity Demand** – Obtained from GEMINI – E3, a dynamic recursive CGE model$^3$

- **Renewable potential** – Renewable penetration in accordance with various national and European studies$^4$

- **CCS potential** – Implemented based on European studies

- **Self Sufficiency constraint** – No net import / export for future years for all countries – except LC scenario!

- **Trade with “fringe regions”** – Enable or Disable ? If enabled, then historical maximum values set as upper bounds


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  studies.
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  all countries except LC scenario!
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  Economy, Energy and the Environment, Marc Vielle – Personal Communication

• CO2 price – Swiss BAU CO2 tax applied in all regions.
• Fuel Prices – Universal fuel prices from WEO 2010.
• No trade loss – In endogenous and exogenous trade, no trade loss
  assumed.
• Copper Plate regions – No transmission lines, nor transmission costs, only
  interconnectors between regions

5. BFE (2012b) Energieperspektiven für die Schweiz bis 2050. Energienachfrage und Elektrizitätsangebot in
  der Schweiz 2000 – 2050.
Electricity generation mix – 5 countries

CO₂ emissions – 5 countries
Electricity generation costs (Rp/kWh)

Load Curves

BASE – Summer Weekday - 2050
BASE – Summer Weekday - 2050

Load Curves

CH: SUM-WK (2050)

DE: SUM-WK (2050)

Load Curves

BASE – Summer Weekday - 2050

Load Curves
BASE – Summer Weekday - 2050

And so on … … …

And so on … … …
Load curves – comparison between scenarios

Switzerland – Summer Weekday - 2050

Switzerland – Fall Saturday - 2050
Conclusions

• Model over a long term horizon combined with dispatch aspect achieved.
• Quantified the developments in the neighbouring countries and its impact on the Swiss electricity sector was achieved.
• Importance of pumped storage and trade to balance load demands was analysed
• Results need to be refined - Outlook

Issues and Challenges

Model deficiencies
• Trade with Fringe countries – Enable or Disable ?
• Pumped Storage – Not pumping at off-peak and discharging at peak

Modelling Challenges
• Computational time – 50 hours!!!
• Data Collection & Uncertainties – Difficulty in obtaining consistent data from certain countries. Discrepancies between different data sources
• Scenarios and Policy – No coherent story line
Outlook

- Continuous improvement of the model – update potentials, technology data, costs, calibration of model – eg. Gas plants in Switzerland
- Refinement of results
- Scenario development and implementation – Analysis of Swiss Energy Strategy in light of European developments
- Possibility for the inclusion of transmission lines
- Methods to improve computational requirements – eg. period definition

Thank you for your attention !!!