Task 4.4

Title

Joint Activity Scenarios & Modeling (JA-S&M)

Project (presented on the following page)

Impact of EU Electricity Policies on Long-term Electricity Supply in Switzerland
A. Singh, R. Kannan, T. Kober

SCCER SoE
SWISS COMPETENCE CENTER for ENERGY RESEARCH
SUPPLY of ELECTRICITY

SCCER-SoE Annual Conference 2017

In cooperation with the CTI
Energy
Swiss Competence Centers for Energy Research
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Impact of EU Electricity Policies on Long-term Electricity Supply in Switzerland

Antriksh Singh, Ramachandran Kannan, Tom Kober
Energy Economics Group, Laboratory for Energy Systems Analysis,
Paul Scherrer Institut, 5232 Villigen PSI, Switzerland
Email: antriksh.singh@psi.ch

The sustainability of Switzerland's electricity system in the mid- to long-term can be highly influenced by technical, economic and political developments in Europe, in particular the neighboring countries. In capacity of the Task 4.2, the European Swiss TIMES Electricity Model (EUSTEM) is used to assess the impacts of key EU policies on the Swiss electricity system. EUSTEM is a multi-region, long-term capacity expansion model with high temporal resolution. We assess a range of Switzerland's electricity supply up to year 2050 in framework of the EU policies of nuclear decommissioning and decarbonization, to understand potential pathways for energy transition in Switzerland to meet the goals of the 2050 Swiss Energy Strategy. Outputs from EUSTEM will be used to develop a novel Bi-level Electricity Market Model (BEM).

European Swiss TIMES model (EUSTEM)

EUSTEM is a cost optimization framework of the whole electricity system with long time horizon (2050+) and an hourly representation of inter annual variabilities. The model covers 96% of EU-28 electricity supply (Fig. 1) with a detailed representation of Switzerland. From a social planner's perspective, economic dispatch and international electricity trades, along with intermittent renewables generation, are assessed to satisfy given electricity demand. The model is suitable to assess long-term electricity supply using what-if type scenario. To illustrate its strengths, we present two exemplary scenarios.

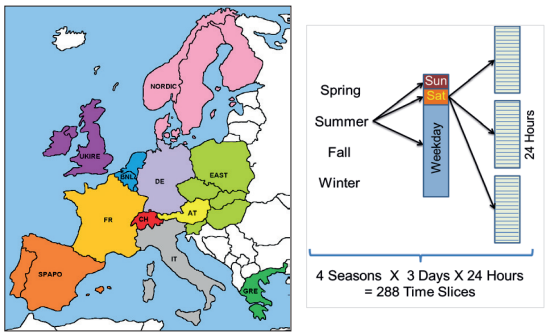

Fig 1. Regions in EUSTEM (Left); and definition of temporal details (Right)

European Electricity Scenarios

Reference shows the least cost electricity supply for the electricity demands from the EU reference scenario. Some of the existing EU policies, for example, nuclear phase-out, renewable targets, etc. are implemented.

Climate scenario aim for 95% CO_2 emissions reduction from 1990 levels in the whole EU electricity system by 2050.

Electricity Supply in the EU

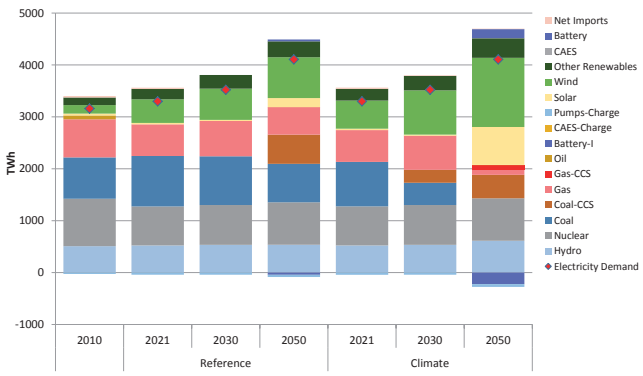

Fig 2. Generation profile in EU 2030 in and 2050

In **Reference** scenario, bulk of baseload electricity is generated by nuclear and coal power plants. Supply from wind and solar PV reaches 21% by 2050. In **Climate** scenario, 45% of the 2050 generation is from solar PV and wind. Additionally, adoption of storage technologies (to cope with increased share of variable renewables generation) become prominent. For base load, 2030 onwards, in addition to the hydro and nuclear, carbon capture and storage (CCS) technologies gain traction and replace conventional gas/coal power plants.

Impacts on Switzerland's Electricity System

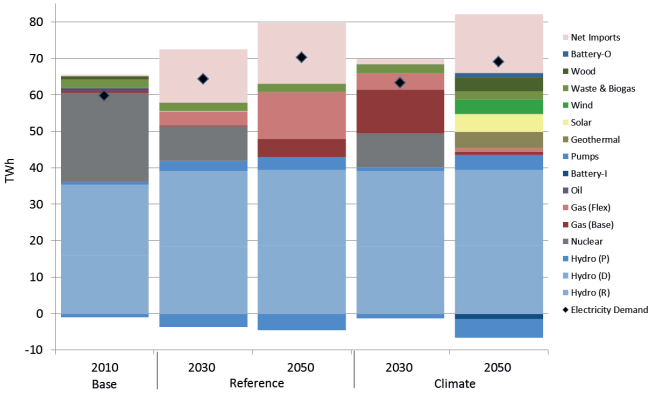

Fig 3. Electricity supply in Switzerland in Reference and Climate scenarios

By 2050, **Reference** scenario shows substitution of nuclear primarily by gas electricity generation (in absence of low-cost renewable alternatives), with greater reliance on low-cost imports (limited by interconnection capacity) and pumped hydro storages.

In **Climate** scenario more than 25% of the generation is from a diverse portfolio of new renewables (Fig. 3). While the level of electricity import in Switzerland in 2050 is similar in the two scenarios, the electricity imports in **Reference** case constitute of low-cost coal based generation whereas in **Climate** scenario has greater share of renewables.

In 2050, cost of electricity generation in **Climate** scenario is 65% higher compared to **Reference** scenario due to significant investments in new renewables generation capacity and costly imports.

Conclusions and Outlook

Climate targets lead to mass adoption of variety of renewables in EU, albeit at a higher cost. In Switzerland, electricity generation from gas and imports from neighboring countries emerge as cost effective supply options due to limited renewable potential and higher costs of renewables electricity generation in the near future. In both the scenarios new investments in cross-border interconnections are needed. Additionally, more new storage capacity is required in **Climate** scenario.

EUSTEM is continuously developed, within the scope of SCCER-SoE and other projects. The model is being updated in terms of future technology cost, renewable resource potentials and their variability, dispatch features, etc. Eventually, understanding of pathways for development of electricity system derived from EUSTEM will be utilized for development of new market models in the coming years.

References

Shivakumar, A., C. Taliotis, P. Deane, J. Gottschling, R. Pattupara, R. Kannan, D. Jakšić, K. Stupin, R. V. Hemert, B. Normark and A. Faure-Schuyer, 'Need for Flexibility and Potential Solutions. Europe's Energy Transition - Insights for Policy Making', Academic Press, 2017

R. Pattupara, 'Long-term Evolution of the Swiss Electricity System Under a European Electricity Market', Ph.D. Thesis, ETH Zürich, 2016