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Modelling the energy future of Switzerland after the phase out of nuclear power plants

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In September 2013, the Swiss Federal Office of Energy (SFOE) published the final report of the proposed measures in the context of the Energy Strategy 2050 (ES2050). The ES2050 draws an energy scenario where the nuclear must be substituted by alternative sources. This implies a fundamental change in the energy system that has already been questioned by experts, e.g. [Piot, 2014]. Therefore, we must analyse in depth the technical implications of change in the Swiss energy mix from a robust baseload power such as nuclear, to an electricity mix where intermittent sources account for higher rates.

Accomplishing the ES2050 imply difficult challenges, since nowadays nuclear power is the second most consumed energy source in Switzerland. According to the SFOE, nuclear accounts for a 23.3% of the gross production, only surpassed by crude oil products (43.3%). Hydropower is the third source more consumed, representing approximately the half of the nuclear (12.2%). Considering that Switzerland has almost reached the maximum of its hydropower capacity, renewables are more likely to be the alternative when the nuclear phase out takes place. Hence, solar and wind power will play an important role in the future Swiss energy mix, even though currently new renewables account for only 1.9% of the gross energy consumption.

In this study we look for realistic and efficient combinations of energy resources to substitute nuclear power. Energy modelling is a powerful tool to design an energy system with high energy security that avoids problems of intermittency [Mathiesen & Lund, 2009]. In Switzerland, energy modelling has been used by the government [Abt et. al., 2012] and also has significant relevance in academia [Mathys, 2012]. Nevertheless, we detected a gap in the study of the security in energy scenarios [Busser, 2013].

This study examines the future electricity production of Switzerland using Calliope, a multi-scale energy systems model, developed at Imperial College, London and HES [Pfenninger, 2015]. It has been specifically design to represent high shares of renewable energy, allowing for the estimation of the Swiss energy transition with high level of detail. Calliope includes topology characteristics of the electricity system, and variability of radiation and wind, which enables the analysis of intermittency in renewable electricity sources, in order to fulfil the electricity demand at all hours. Three energy scenarios are modelled; first, the higher energy production of renewables in Switzerland and the import of natural gas to supply the demand; second, imports of wind power from North Sea with high level of intermittency; and third, imports of solar power from North Africa, with less intermittency but with higher risk of internal turmoil.

To summarise, we analyse in detail the energy scenarios of Switzerland when the nuclear power plants will be ceased. A gap currently present in academia, such as the future energy security in Switzerland, is covered by our Calliope modelling.

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