COST/BENEFIT ANALYSIS OF FURTHER EXPANSION OF THE AUSTRIAN TRANSMISSION GRID TO ENABLE FURTHER RES-E INTEGRATION

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Overview

The target of the European Commission is to achieve a harmonized European electricity market with an almost single price for electricity across EU Member States. This objective is based on at least the following reasons: significant social welfare increase due to optimal utilization of electricity generation and transmission in Europe, increasing security of supply and renewable electricity generation as well as limitation of price fluctuations due to variable renewable electricity generation as a result of better market coupling.

The work presented in this paper is part of an European project in the Intelligent Energy – Europe (IEE) program (called GridTech[1]), where a fully integrated impact assessment of the implementation of new technologies (e.g. RES-E generation, bulk storage, transmission network technologies) into the European electricity system is conducted, to study the optimal exploitation of the full potential of future RES-E generation across Europe with lowest possible total electricity system cost. The GridTech project applies two approaches: top-down modelling covering the EU30+ region and bottom-up modelling of selected European target countries. The analyses in GridTech are fully in line with actual EU policies and legislation (Directive 2009/28/EC, NREAPs, Regulation 714/2009/EC, Communication COM (2010) 677/4, “Energy Roadmap 2050” (Communication COM (2011) 885/2)). Also the “Ten-Year Network Development Plans (TYNDPs)” and “Projects of Common Interest (PCIs)” of the European Network Transmission System Operators for Electricity (ENTSO-E) are taken into account accordingly.

For the top-down modelling for the EU30+ region the simulation tool MTSIM[2] is used. Some of the results of this top-down analysis, notably those concerning electricity exchanges between countries and the associated wholesale prices are applied as inputs for the regional analysis in selected target countries, setting the boundary conditions of the regional analysis.

This paper examines the bottom-up modelling approach for Austria (one of the target countries) of the above mentioned project. The main focus is the analysis of the costs and benefits of the Austrian transmission grid expansion, such as new high-voltage alternating current (HVAC) and HVDC lines or the implementation of dynamic line rating (DLR) and a flexible AC transmission system (FACTS) to enable smooth further integration of RES-E generation. Special focus in result interpretation is put on the TSO’s point-of-view.

Methods

For this Austrian bottom-up approach a fundamental market model has been developed in MATLAB ([1], [2]), to analyse in detail the further development of the Austrian electricity market and transmission grid qualified to enable the further integration of RES-E generation. Austria is divided into 17 nodes, which correlate with the main substations within Austria, and 7 neighbouring country nodes. Generation is allocated to the closest node. Load allocation is based on population figures and large industrial sites. All parallel transmission power lines between the nodes are merged to one representative transmission power line, which leads to a total of 34 transmission power lines (see Figure 1 below).

The objective of the Linear Optimisation Problem (LOP) model is to obtain the schedule that minimizes the total operational costs of the electricity system by considering various costs such as: variable costs (e.g. fuel, O&M and CO_2 costs). There are also several technical constraints implemented, e.g. generation capacity constraints, maximum ramp rates,

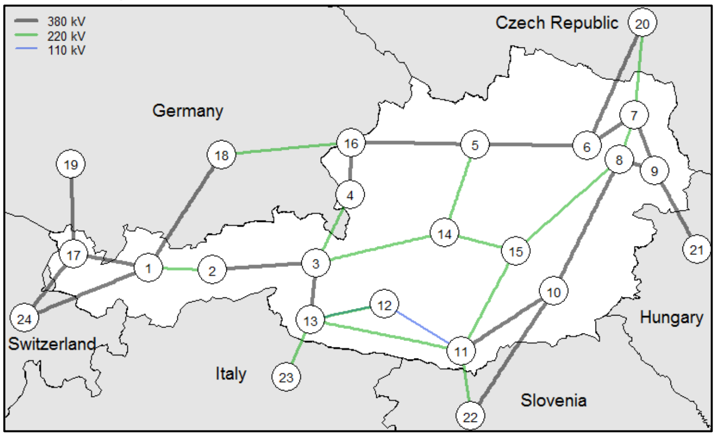

Figure 1: Austrian transmission grid supposed for the year 2020

[1] “Impact Assessment of New Technologies to Foster RES-Electricity Integration into the European Transmission System” (IEE/11/017/SI2.616364), www.gridtech.eu
[2] MATLAB tool developed from Ricerca sul Sistema Energetico - RSE S.p.A., Milano.

reservoir balance, spill of hydro, RES-E generation technologies etc., which have to be fulfilled in the whole simulation horizon. For simulating the load flows a power transfer distribution factor (PTDF) matrix is used.

The hourly based results of the scenarios 2020 and 2030 provide the basis for the calculation of the electricity system benefits (welfare, congestion rent, fossil fuel, CO_2 emissions and others).

Results

At present preliminary results exists only. In the full paper final results will be presented. The preliminary results already indicate that the expansion of the transmission power line in Salzburg (from node 4 to 3, see Figure 1 above) is necessary in 2020 and 2030 with the assumptions made (not least due to the fact, to significantly support wind and PV integration in Germany). But the transmission power line expansion in Carinthia (node 13 to 11) is, if someone considers it from an Austrian point-of-view only, not necessarily needed (i.e. overcapacity). However, these results would change significantly, if the interconnection capacities to Italy are expanded in the future. Corresponding sensitivity analyses will also be included in the final results.

In addition to the presentation of results of the overall cost/benefit analyses of the 2020 and 2030 scenario, also in-depth analyses of the functioning of the Austrian electricity system (notably also the stress on the transmission grid) under extreme conditions occurring over short periods of time (from several hours to a few days) in a year are conducted (summer/winter, high/low load, high/low wind and/or PV generation, dry/wet hydro generation situation, etc.). Main output variables considered in this context shall include reliability ones (related to the amount and frequency of non-served energy in the electricity system under extreme conditions) and those associated with the amount of RES-Electricity generation that the electricity systems can’t absorb in these situations (measured, for example, in the form of the volume of RES-Electricity spillages occurring).

Conclusions

The modelling results quantifying the electricity system benefits and the corresponding cost are expected to support the ranking of the need of transmission expansion in the Austrian electricity system to enable the further integration of RES-E generation. In particular, the economics from the TSO’s point-of-view is investigated in detail, because this is essential to justify transmission grid expansion in the long-run.

References

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[2] M. Shahidehpour, H. Yamin, and Z. Li, *Market operations in electric power systems: Forecasting, scheduling, and risk management*. [New York]: Institute of Electrical and Electronics Engineers, Wiley-Interscience, 2002.