Detailed simulation of a future renewable power system in Germany and Austria
-
On the importance of coupling heat and power and other flexibility measures

Gerhard Totschnig*, Andrè Ortner, Johannes Radl
Energy Economics Group (EEG), Institut für Energiesysteme und Elektrische Antriebe Technische Universität Wien
Gusshausstrasse 25-29 / 370-3, A - 1040 Wien, Österreich
*totschnig@eeg.tuwien.ac.at

(1) Overview

In the paper technically and economically feasible pathways to reach a more than 90% renewable power system in Germany and Austria are simulated with the highly resolved power and heat system model HiREPS. The importance and dynamic interplay of different aspects are analyzed to derive a robust understanding. E.g: The impact of increased coupling of the power and heating system and other flexibility measures; Investigating the need for new electricity storage and the importance of hydropower and pumped storage; The optimal share of solar and wind power, the role of heat pumps, solar thermal and power to gas. Further the effects of the variable renewable energies on spot market prices are simulated and an optimal investment analysis is conducted for the power and heat system.

(2) Methods

The HiREPS model is a hourly resolved optimization model which simulates the optimal investment decisions and the unit commitment in the heat and power system. In this paper the HiREPS model of Germany and Austria is used. The model includes a detailed simulation of the thermal power plants (including startup costs and efficiency reductions at part loaded operation), very detailed modeling of over 400 hydropower plants, of heat supply technologies, of the variable renewables solar and wind and of alternative storage and demand flexibility options. A sensitivity analysis is used to analyze the importance of the different parameters and power system components.

(3) Results and Conclusions

The simulation results show that a renewable power system in Germany and Austria is possible at only modest cost increases compared to a fossil dominated reference scenario. The coupling of heat and power system lowering the overall system costs. In the least cost solution more than 100GW of photovoltaic power and 200GW of Wind power are utilized. The biggest challenge seems to be the socially acceptable the buildup of the huge wind capacity. Storage limitations and costs propose only a limited challenge.

References

Nitsch, J., Wenzel,B.(2009) “Langfristszenarien und Strategien für den Ausbau erneuerbarer Energien in Deutschland – Leitszenario 2009“, Herausgeber: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), 2009

Sachverständigenrat für Umweltfragen (SRU)(2010) “100% erneuerbare Stromversorgung bis 2050: klimaverträglich, sicher, bezahlbar“, *Stellungnahme Nr. 15*, ISSN 1612-2968, 2010

Schlesinger, Lindenberger, Lutz (2010) „Energieszenarien für ein Energiekonzept der Bundesregierung“, Studie für das Bundesministerim für Wirtschaft und Technologie Projekt Nr. 12/10, 2010

Höflich, B., Et. al (2010) “Analyse der Notwendigkeit des Ausbaus von Pumpspeicherwerken und anderen Stromspeichern zur Integration der erneuerbaren Energien.“ Abschlussbericht für die Schluchseewerk AG, 2010

Saint-Drenan, YM., Oehsen, A., Gerhardt,N., Sterner,M., Bofinger,S., Rohrig,K. (2009)“Dynamische Simulation der Stromversorgung in Deutschland nach dem Ausbauszenario der Erneuerbaren-Energien-Branche“ Abschlussbericht an Bundesverband Erneuerbare Energie e.V., 2009