A techno-economic catalogue for system flexibilization

Fabian Schipfer, TU Wien Energy Economics Group, +43 680 328 3654, schipfer@eeg.tuwien.ac.at
Tilman Schildhauer, Paul Scherrer Institute, tilman.schildhauer@psi.ch
Elina Mäki, VTT Technical Research Centre of Finland, elina.maki@vtt.fi
Ernst Höftberger, BEST Bioenergy and Sustainable Technologies GmbH, ernst.hoeftberger@best-research.eu
Daniela Thrän, Helmholz Center for Environmental Research, daniela.thraen@ufz.de
Christiane Hennig, 'Deutsches Biomasseforschungszentrum gemeinnützige GmbH, Christiane.Hennig@dbfz.de
Ian Rowe, U.S. Department of Energy, ian.rowe@ee.doe.gov

Overview

Variable renewable energy (VRE) production based on photo voltaic and wind energy is on the rise to phase out consumption of fossil fuels on one hand and to provide electricity for a growing multi-sectoral demand on the other. Continuing and increasing growth rates in different world regions are more and more contributing to the emission reduction goals but will inevitably also lead to temporal imbalances in production and consumption patterns. Curtailment, electricity and heat storage, improved transmission and demand response will thus play an important role in system flexibilization.

Methods

While the integration into existing energy models of most of these short- to medium term options is built upon a growing literature base, we aim to provide a detailed techno-economic catalogue including options for flexibilization of the energy system on a weeks and even seasonal time scale. The catalogue and underlying nomenclature are developed to enable a quick look up of techno-economic parameters which are necessary to valorise flexibility functions from various technologies. Within the consortium and work of the International Energy Agency (IEA) Bioenergy Technology Collaboration Programme (TCP) Task44 on system integration and flexibilization, we categorize and quantify the potential added-value of especially bioenergy and hydrogen technologies to support the market diffusion of VREs to reach significantly higher variable renewable energy shares.

Results

Hydrogen and bioenergy can provide short-term options such as flexible electricity generation to cover demand peaks or it can serve as a carbon source for Power-to-X (PtX) processes, i.e. supporting negative ancillary services. Biomass and hydrogen can be furthermore converted to versatile chemical energy carriers which can be stored seasonally and distributed using existing infrastructure. Some of these flexibility options are already used commercially today, such as upgrading of biogas to biomethane for injection into the natural gas grid. For other technologies such as PtX, flexible bioenergy combined heat and power (CHPs) or upgrading of pyrolysis oil, the technology is developed, but market designs and boundary conditions need improvement for these technologies to reach their full potential.

Conclusions

Our techno-economic catalogue will contribute to energy economic research and policy design with harmonized fact recommendations for the implementation of a variety of flexibility options, going beyond operational and tactical modeling-based decision support and extending them with a broad set of long-term flexibilization measures for providing strategic decision support. The catalogues' techno-economic reference data will be used in cost-profit analysis, energy economic simulations and integrated assessment models.

References

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