SOLAR POWER GRID INTEGRATION

IN BRIEF

- The massive expansion of distributed photovoltaic (PV) systems requires additional grid integration measures.
- These measures affect distribution system operators, households or several actors simultaneously.
- A systematic comparison of the various options has shown that the consequences and risks for operators, the environment, and society vary considerably.
- There is a lack of legal and economic frameworks to better utilise the advantages of alternative measures with lower social and environmental risks.

WHAT IS IT ABOUT?

There is broad political consensus that solar energy should account for a large part of Europe's electricity generation in the future. In Austria, the current government is aiming to fully switch to renewable energy sources by 2030. A large proportion of this will be provided by distributed/decentralised photovoltaic (PV) systems. In fact, the prevalence of photovoltaics in Austria has sharply increased in recent years because of favourable framework conditions. In 2022, more than 1 GW of new capacity was installed for the first time. However, such strong increase in decentralised PV systems necesitates suitable measures to integrate this volatile form of electricity generation into the grid. Local low-voltage grids in particular are inadequately prepared for a high proportion of distributed generation as this part of the grid was originally designed for the distribution of centrally generated electricity to end users.

To maximise local electricity generation from renewable sources, appropriate measures must be taken. Various technical and organisational solutions have been proposed, some of which have already been implemented in practice, others at least in pilot projects.

Bild: unsplash/bill_mead

PV expansion challenges grid expansion

Some of these solutions include: limiting or throttling the feed-in power; the provision of reactive power by PV inverters; the expansion and strengthening of the grid infrastructure; the use of voltage-regulated transformers; the use of battery systems; the control of consumers on the demand side (demand response).

The situation in Austria is currently as follows: As grid expansion cannot keep pace with the dissemination of PV systems, grid operators severely limit the feed-in capacities for new systems. This situation also partly explains the increasing demand for privately operated battery storage systems. Compared to other options, however, PV batteries have a significantly less favourable overall assessment.

BASIC DATA

Project title:	Exploring and understanding the socio-technical implications of the energy transition (ExTRA)
Project team:	Ornetzeder, M.; Udrea, T.; Bettin, S.; Sinozic-Martinez, T.
Duration:	11/2020 – 06/2023
Funded by:	FWF

KEY RESULTS

Comparing different PV grid integration options reveals not only technical, organisational, and economic differences in operation, but also their associated unintended consequences and risks for operators, the environment, and society, some of which differ significantly.

We compared three typical configurations: households with PV systems and battery storage (PV battery), local community batteries that store electricity from several PV systems (community battery), and a third configuration in which as much solar power as possible is consumed locally, for example to charge electric cars (demand response).

Bild: Energie Steiermark/Symbol

Community battery in Heimschuh, Styria

The systematic comparison has shown that the PV battery option is associated with the highest financial risk and maintenance costs for end users, requiring the highest material costs overall whilst also posing the highest risk in the event of a fire. In addition, studies have shown that households with battery storage systems tend to have higher electricity consumption and that there are regressive distribution effects, as households with PV batteries draw less electricity from the grid overall and therefore contribute less to the costs of the public grid.

Community batteries tend to lead to greater grid independence and better support for local grid usage. Studies have also shown positive effects on the building of local communities. However, this can also lead to regressive distribution effects and power shifts in the electricity market. Demand response solutions are characterised by the greatest environmental benefits because of the elimination of battery systems, but there may be reserverations regarding the fair distribution of costs and benefits.

WHAT TO DO?

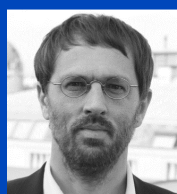
The expansion of photovoltaics in Austria is experiencing very significant growth. In order to broaden the range of alternatives, socially and ecologically favourable options must be given greater consideration in the future.

- Individual battery storage systems are becoming very common as a result of the existing framework conditions (subsidies, feed-in tariffs, feed-in restrictions). To better exploit the benefits of alternative options, appropriate legal and economic frameworks should be created, facilitating the operation of community batteries and demand response solutions.
- Community batteries have already been tested in pilot projects. The main issue here is the lack of a suitable framework for implementation.
- Demand response solutions still require considerable research and development to make them technically and economically feasible in practice.
- With the strong increase in distributed PV systems, the issue of grid integration (or grid compatibility/ usefulness) will continue to gain in importance. The subsequent development of suitable solutions should not only take into account the functional requirements of system and grid operators, but also the respective impact on the environment and society.

FURTHER READING

Ornetzeder, M.; Udrea, T.; Bettin, S.; Sinozic-Martinez, T. (2023). Assessment of Socio-Technical Configurations: Towards a new framework for studying societal implications of energy innovations (ITA-manu:script 23-01). doi:10.1553/ITA-ms-23-01 *epub.oeaw.ac.at/?arp=0x003ea448*

CONTACT



Michael Ornetzeder
Email: tamail@oeaw.ac.at
Phone: +43 1 51581-6582

IMPRINT: Owner: Austrian Academy of Sciences; Legal person under public law (BGBl. 569/1921 i.d.F. BGBl. I 130/2003); Dr. Ignaz Seipel-Platz 2, A-1010 Vienna; Editor: Institute of Technology Assessment (ITA); Bäckerstraße 13, A-1010 Vienna; *www.oeaw.ac.at/ita/en*. | Frequency: The ITA Dossiers are published irregularly and publish the research results of the ITA. The ITA Dossiers are exclusively made available open access to the public via the Internet portal "epub.oeaw": *epub.oeaw.ac.at/ita/ita-dossiers* | ISSN: 2306-1960 | ITA Dossier no. 75en February 2024 | *epub.oeaw.ac.at/ita/ita-dossiers/ita-dossier075en.pdf*