GREEN POWERED FUTURE
MISSION

Pillar 2

System Flexibility and Market Design

Factsheet P2-01

Tools and solutions for flexible power systems

Power systems flexibility is crucial to allow integration of high shares of Variable Renewable Energy (VRE) sources. Exploiting and managing flexibility requires a broad set of technologies and solutions, as well as innovative components able to measure not only electrical but also environmental variables, allowing optimal use of the grid infrastructure. Markets for ancillary services, local flexibility and Demand Response (DR) also need to be implemented, considering VRE characteristics, storage and electric vehicle capabilities in providing flexibility.

This factsheet highlights relevant case studies from GPFM members addressing Innovation Priorities aimed at developing tools and solutions to enhance power systems flexibility.

GPFM Innovation Priorities in scope:

- **IP 2.3.2** - Enhanced TSO-DSO coordination platform for flexibility markets optimisation
- **IP 2.3.4** - Tools and solutions for DSO flexibility management
- **IP 2.7.1** - Flexibility markets for innovative ancillary services by VRE and storage

6 Case studies reported in this factsheet

31 Projects covering these IPs are included in the GPFM National Pilots report

National Pilots Report

For further details on **GPFM Innovation Priorities (IPs):**

GPFM Roadmap **Action Plan 2022-2024**

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Case studies

Case Study #1 Massive deployment of DR for grid operation optimization, with focus on energy communities

Energy communities are revolutionizing local energy management by enabling residential, commercial, and industrial users to collaborate on efficient energy generation and consumption.
By integrating advanced technologies, innovative market mechanisms, and active community participation, Areti Pilot #1 aspires to set a benchmark for sustainable urban energy management. The project not only tackles immediate grid management challenges but also lays the groundwork for a resilient and inclusive energy future for Rome. Moreover, it could serve as a model for other cities facing similar energy transition challenges.

Link to case study's detailed description

Areti

Case Study #4 Edge

The pilot project Edge has the aim to the test of 'local ancillary services'- i.e. flexibility related to distribution grid criticalities management. It was required by the National Regulatory Agency to Italian DSOs to assess planning methods, products definition, procurement and operational procedures. The project is set by e-distribuzione in 2024 within 4 areas. Services can be offered by any connected user or aggregate set of users that complies with the technical requirements and will be compensated according to the contract conditions coming from 'pay-as-bid' competitions performed in third party market platform (Piclo). The software in use is the Enel DERMS, in charge to foresee criticalities and allocate flexibility to resolve them.

Link to case study's detailed description

Enel Grids

Case Study #2 Smarter homes for South Australia

South Australians are enthusiastic adopters of distributed energy resources (DER). Over 40% of homes in South Australia have rooftop solar installed and around 10% also have batteries. Rooftop solar has at times fully met the entire electricity demand of the state. Achieving secure operation of this GW scale region with extensive distributed energy has required a range of measures – including inverter disturbance ride through; remote connection capability; dynamic export limits, upgraded smart metering & tariff reform. Measures such as enhanced voltage management have allowed the transition to progress while coordinated DER control schemes are developed and implemented.

Link to case study's detailed description

Australia

Installed solar PV capacity by 2050 according to 1.5°C scenario

14000 GW

Installed wind capacity by 2050 according to 1.5°C scenario

8100 GW

Source: *IRENA*

Case Study #5 Blockchain for local energy communities

The progressive engagement of final users, thanks to the wide spreading of distributed resources, calls for the deployment of technologies to support local energy management systems and energy markets. Blockchain can be exploited in this context and particularly within energy communities as a distributed ledger to enable reliable management of energy transactions. RSE implemented a blockchain market architecture, integrating it with a final users' emulator, to enable study of market mechanisms applicable for energy and flexibility services trading. The architecture is based on a "trading agent" for each end user that automatically generate buy or sell orders and match them with the ones submitted by other users.

Link to case study's detailed description

Italy

Key metrics

To manage large-scale VRE, flexibility must be exploited in all sectors of the energy system, from production to stronger electrical systems, storage and more flexible demand.

Well-developed grid infrastructure allows the system to access existing flexibility

Improving system operations make possible to reduce requirements for grid flexibility

https://www.irena.org/publications/2018/Nov/Power-system-flexibility-for-the-energy-transition

Case Study #3 Market-based approaches to securing local services from DERs

The project demonstrated the first distribution-level Non-Wires Alternative market for DER providers in North America based on a full DSO model, interoperable with participation in the wholesale market. The project held two auction periods securing 10 and 15 MW of DERs to provide grid services (capacity, energy, reserve) over 6-month summer periods. The amount of DERs registered exceeded procurement targets, with clearing prices lower than the ceiling price. Resource categories consisted of demand response and distributed generation. Participating DERs were activated on 15 occasions, providing a total of 366 MWh in energy services. The project found that DER availability, reliability, and cost-effectiveness were sufficient to consider scaling the concept.

Link to case study's detailed description

Canada

Case Study #6 Data-driven operation of distribution networks to unlock flexibility services / FlexOnGrid

The FlexOnGrid project aims to enhance the operation of distribution networks using flexibility services from third parties. Despite proven benefits, technical challenges persist, such as the vast data from smart meters, low real-time monitoring, lack of detailed network models, poor communication between stakeholders, and the unbalanced nature of grids. FlexOnGrid addresses these by demonstrating that data-driven techniques can provide the needed flexibility, working on distributed and autonomous local control with partial network information, and testing model-free solutions to integrate renewable sources effectively.

Link to case study's detailed description

Spain

Key findings

The case studies reported in this factsheet highlight the opportunities for system operators to procure flexibility services from distributed energy sources, through aggregators in the case of small units, to solve congestion and maintain high levels of security and quality of supply. To optimally manage this new sources of flexibility, coordination among TSOs and DSOs as well as with other system level actors like aggregators and market operators is crucial.

Another significant outcome from the case studies is that to enable the trading of innovative flexibility services, the implementation of suitable platforms for local flexibility markets aimed at optimizing the exploitation of distributed resources potential is key.

Two case studies also highlight the opportunities opened by energy communities that allow local energy management by enabling residential, commercial, and industrial users to collaborate on efficient energy generation and consumption. In this view, blockchain has been proposed to implement a reliable system to manage local energy transactions.

- DERs demonstrated the ability to provide grid services to DSOs without safety incidents, meeting activations signals and fulfilling grid distribution needs
- TSO-DSO coordination is needed to ensure that services from DERs are activated without affecting grid security
- Off-grid microgrids can support local renewable energy use and self-consumption thanks to storage and dedicated energy management systems

About GPFM

The Green Powered Future Mission (GPFM), launched within the second phase of the global initiative Mission Innovation (MI2.0), is a public-private partnership with members from MI countries, private sector companies and international organisations. It aims to demonstrate that by 2030, power systems in different geographies and climates can effectively integrate up to 100% variable renewable energies, like wind and solar, in their generation mix, and maintain a cost-efficient, secure and resilient system.

https://explore.mission-innovation.net/mission/green-powered-future/

GPFM Coalition