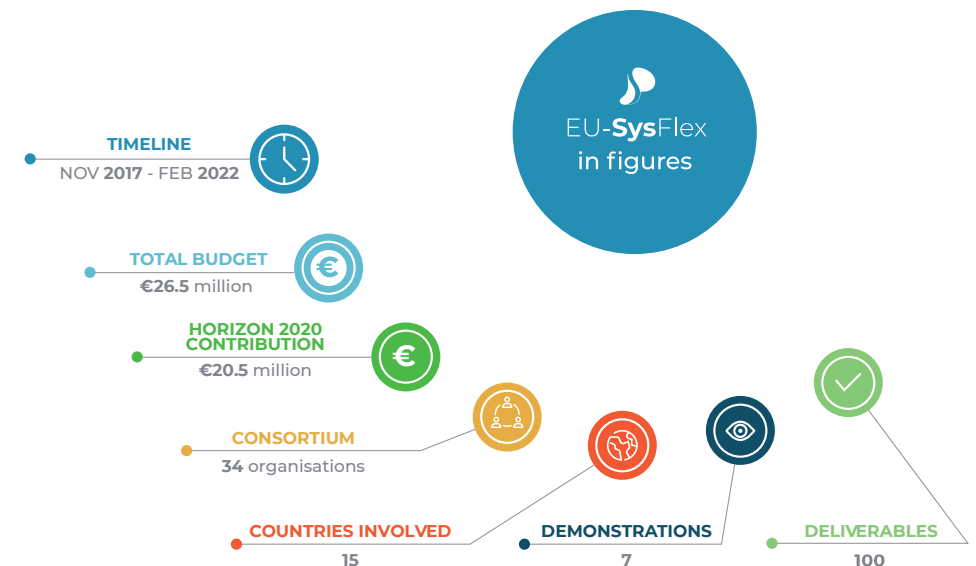


**System operation and flexibility  
solutions for integrating 50%  
renewables by 2030**

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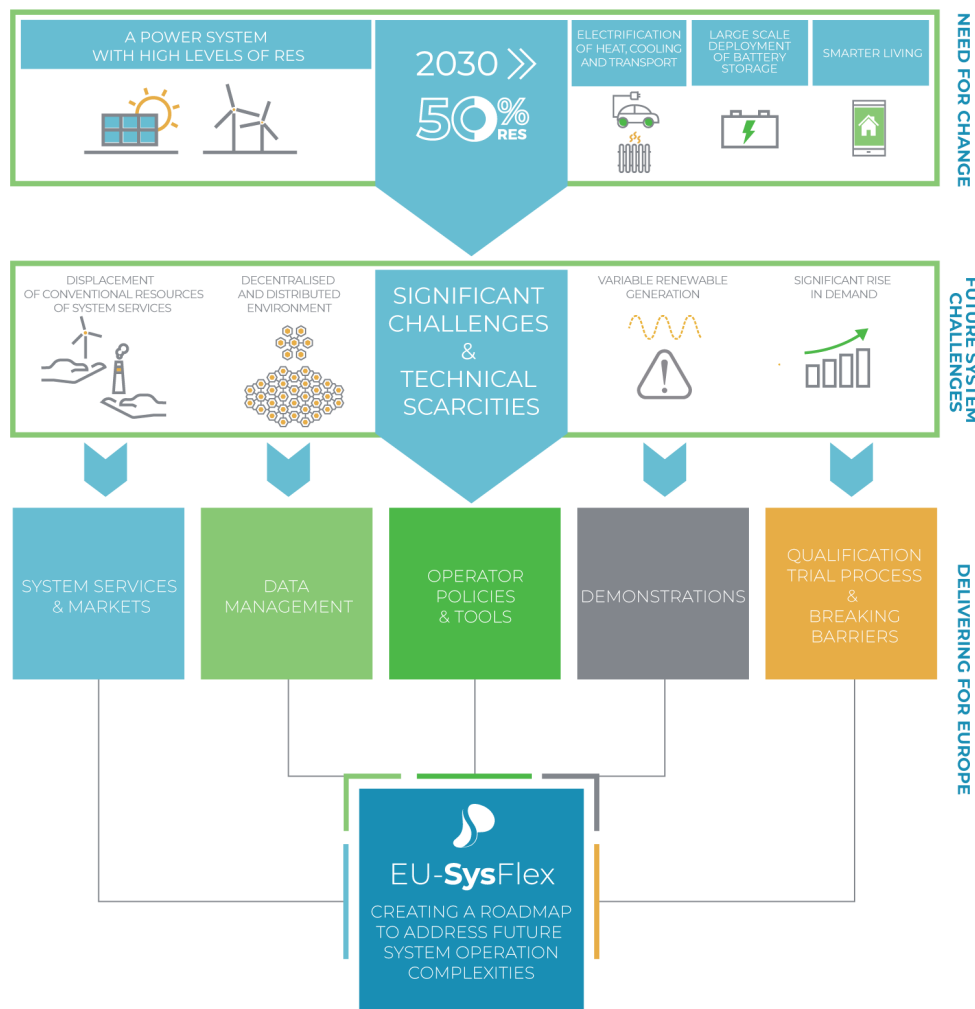
By 2030, the European Union has committed to deliver at least 50% of its electricity consumption from renewable sources of electricity (RES-E), much of this will come from wind and solar. As a result, power system operation is becoming more complex, creating uncertainties and technical challenges not previously seen in the pan-European electricity system.

EU-SysFlex is a Horizon 2020-funded project which addresses these challenges by identifying and demonstrating new types of system and flexibility services.



Based on analysis of ambitious EU renewable scenarios, the project identified the technical scarcities on the future power system, market and regulatory enhancements required to incentivise investment in System Services and through seven demonstration projects and trials explored the capability of a suite of technologies and solutions to deliver much needed flexibility.

The project team has designed a system operation flexibility roadmap for Europe to facilitate the large-scale integration of renewable technology and flexible capability.



Meeting Europe's renewable ambition will require a transformation of the energy system. In the not too distant future our electricity grid will consist of a high share of wind and solar.

Wind and solar are what we call variable technology, in that their output varies with respect to weather conditions, they also perform differently from an electrical perspective to traditional conventional power stations. As the percentage of wind and solar increase with respect to traditional sources of electricity generation we begin to see an impact on how the electricity grid performs.

This together with other changing dynamics on the power system such as the electrification of heat and transport, a shift towards a more decentralised and distributed environment as well as greater consumer participation in the energy space all culminate in further power system operation complexities and technical scarcities.

EU-SysFlex has analysed much of these challenges over a four-year period culminating in the publication of the European power system flexibility roadmap. Its aim is to help guide stakeholders in addressing changing system operation dynamics and complexities. The roadmap provides a framework to ensure Europe delivers a more flexible, dynamic and reliable power system while delivering on our renewable ambition.

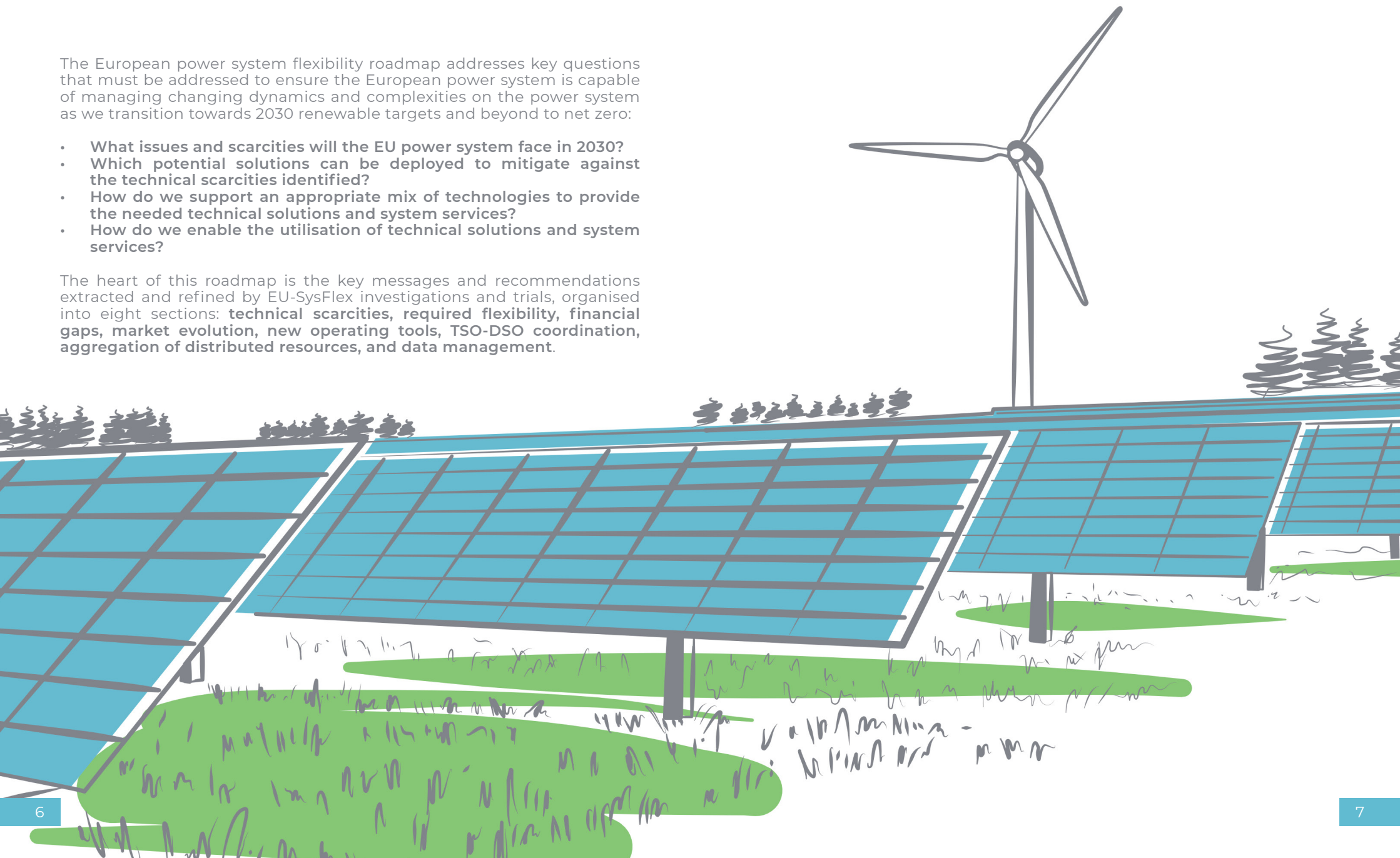
The European power system flexibility roadmap incorporates the findings and results of the EU-SysFlex project. It is built on the scalability and replicability analysis (SRA) of solutions from the analysis and investigations on technical scarcities, system services, market design, system operator procedures, and data management, as well as the results from seven demonstration projects and qualification trials.

## THE EUROPEAN POWER SYSTEM FLEXIBILITY ROADMAP

The European power system flexibility roadmap addresses key questions that must be addressed to ensure the European power system is capable of managing changing dynamics and complexities on the power system as we transition towards 2030 renewable targets and beyond to net zero:

- What issues and scarcities will the EU power system face in 2030?
- Which potential solutions can be deployed to mitigate against the technical scarcities identified?
- How do we support an appropriate mix of technologies to provide the needed technical solutions and system services?
- How do we enable the utilisation of technical solutions and system services?

The heart of this roadmap is the key messages and recommendations extracted and refined by EU-SysFlex investigations and trials, organised into eight sections: **technical scarcities, required flexibility, financial gaps, market evolution, new operating tools, TSO-DSO coordination, aggregation of distributed resources, and data management.**



**As we transition to a European power system with a high share of variable renewables significant technical scarcities in flexibility appear.**

Some technical scarcities represent emerging areas of concern, while others are well-known, but are exacerbated by the transition to high levels of renewables. The non-synchronous nature of wind and solar resources represents a particular challenge. All scarcities require mitigation measures to ensure continued safe, secure and efficient power system operation to support Europe's renewable and net-zero ambition.



**Existing energy market structures will not guarantee the required flexibility and volume of system services to address the identified technical scarcities and support investment in low carbon generation.**

Relying on existing energy market structures will result in future financial shortfalls for all generating technologies, due to reduced energy revenues in the long-term horizon.



**Enhanced services will be required from a wide range of technologies in order to mitigate the identified technical scarcities and ensure the required system flexibility.**

In addition to enhancing the system services provided by existing resources, new resources, such as variable renewable technologies, energy storage, and demand-side response, can offer the required system flexibility. Active participation from all technologies, new and existing, is required.



**New flexibility products and market evolution are required to ensure the provision of sufficient system services capability to mitigate the identified technical scarcities.**

In addition to creating new flexibility products, unnecessary entry barriers to flexibility markets must be removed, to embrace new and emerging technologies, based on reviewing existing specifications for flexibility products and their incorporation in electricity markets.



New operator decision support tools with enhanced forecasting, state estimation and optimisation capabilities are required for the future power system to activate new flexibilities.

Demonstrations were successful in showcasing the potential of a range of emerging technologies. However, rollout trials are required to fully understand their reliability and their ability to provide all of the flexibility required for an environment with high shares of wind and solar generation.



Aggregation of decentralised resources enables access to a wider range of flexibility options, including the participation of residential customers, and a range of distribution-connected assets.

Aggregating several decentralised resources, e.g. wind turbines, energy storage, electric vehicles, heat pumps, including as part of a virtual power plant (VPP), and using a combination of coordinated controls and optimisation, can greatly enhance the overall reliability, performance and profitability of the system services provided.



Efficient coordination between transmission system operators (TSOs) and distribution system operators (DSOs) is critical given the significant share of future resources connecting to the distribution network.

Extensive trials and demonstrations, supplemented by scalability and replicability analyses, provide validation that a dedicated coordination approach is required, so that all assets connected at any layer of the power system can be utilised to the mutual benefit of both TSO and DSO.



A customer-centric approach including standardised access to data and data-driven services is crucial to guarantee stakeholder and information system interoperability for effective data exchanges at the European level.

Interoperability is a key requirement for the future power system in which new and numerous players will handle and share large volumes of energy-related data. Data platforms based on standardisation can progressively achieve secure and privacy-respecting cross-border and cross-sector data exchanges.

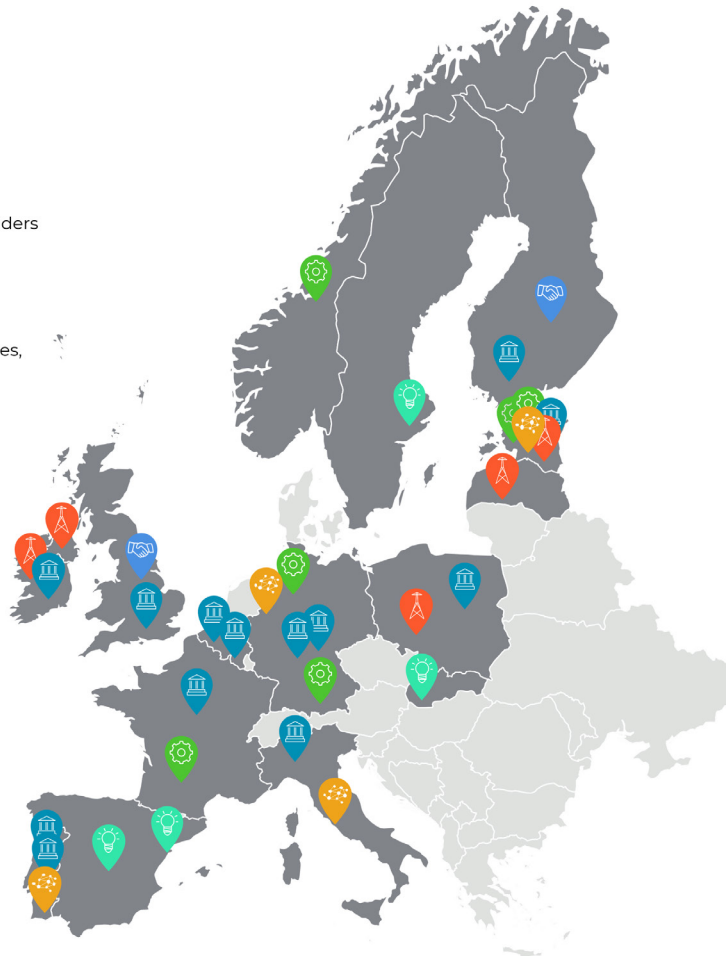




## THE EU-SYSFLEX CONSORTIUM

EU-SysFlex is a **unique consortium of 34 members** comprising transmission and distribution system operators, aggregators, technology providers, research and academic institutions as well as consultancies. They are located in **15 countries** across Europe.

-  TSO
-  DSO
-  Aggregators
-  Technology providers
-  Consultants
-  Research institutes, universities



## PROJECT MANAGEMENT BOARD

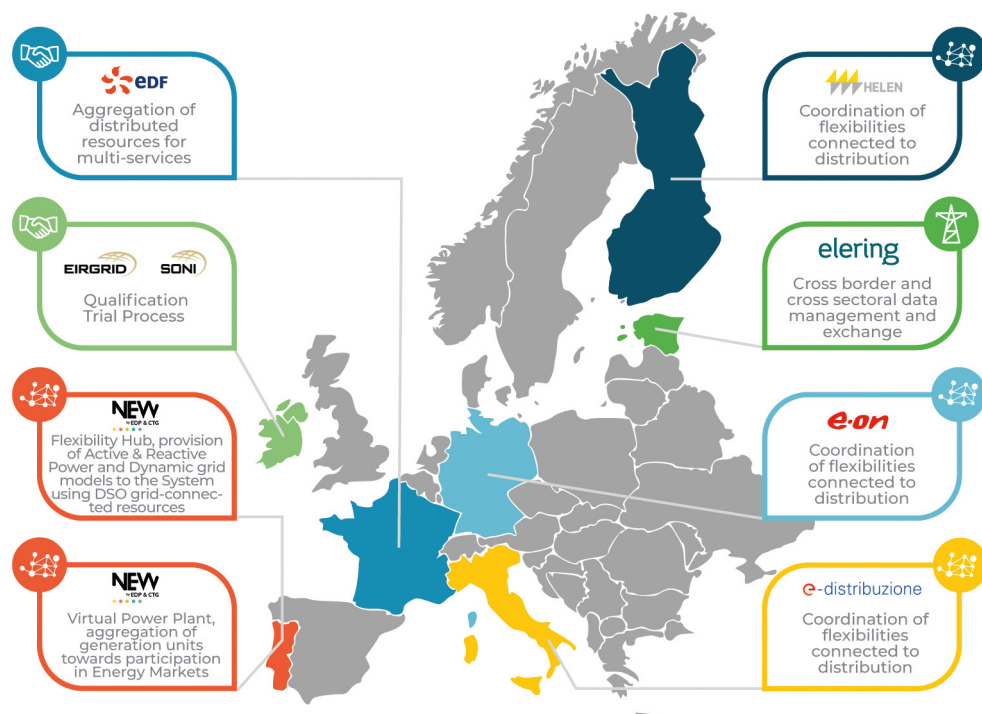


## PARTNERS



Increasing the flexibility of the pan-European system requires a comprehensive and all-encompassing vision that extends across a **broad portfolio of new approaches, solutions and technologies**. EU-SysFlex provides this by demonstrating different business use cases in seven field tests at all system levels and across Europe: **Portugal, Germany, Italy, Finland, France, Poland and Estonia** as well as a qualification trial process in **Ireland** and **Northern Ireland**.

The demonstrations and trials provide evidence of how the timely provision of required system services will be achieved using new approaches to coordinate the resources, actors and new technology mixes that will be present in the future European system. This involves testing **new concepts, tools and a wide range of flexibilities** including centralised pump storage plants, batteries, wind and photovoltaics (PV), heat loads, electric vehicles (EV). The interaction between the **system layers and actors, and the replicability of concepts and approaches** is also addressed.



Find more information on the demonstrations and trials [here](#).

The Advisory Board is a **consultative body** set up to help further develop the value of EU-SysFlex's findings and ensure a wide EU impact, facilitate their implementation by TSOs not directly participating in EU Sys-Flex, provide external and independent support, facilitate replicability and scalability, and to cooperate in disseminating and exploiting the results. Below is a list of the companies and organisations represented on the EU-SysFlex advisory board.



EU-SysFlex project is also part of the **BRIDGE** Initiative. BRIDGE is a European Commission initiative which unites Horizon 2020 Smart Grid and Energy Storage Projects to create a structured view of cross-cutting issues which are encountered in the demonstration projects and may constitute an obstacle to innovation.





**Mark Foley**  
EirGrid Group  
Chief Executive

"At the end of any successful project, it is important that we celebrate our successes. In this case not just the technical progress made but more importantly to recognise this as a celebration of ingenuity, capability and expertise within Europe. It is a celebration of the coming together of people from across Europe and across the sector to collaborate on some of the key challenges facing Europe on our journey towards 2030 targets and beyond to net zero."



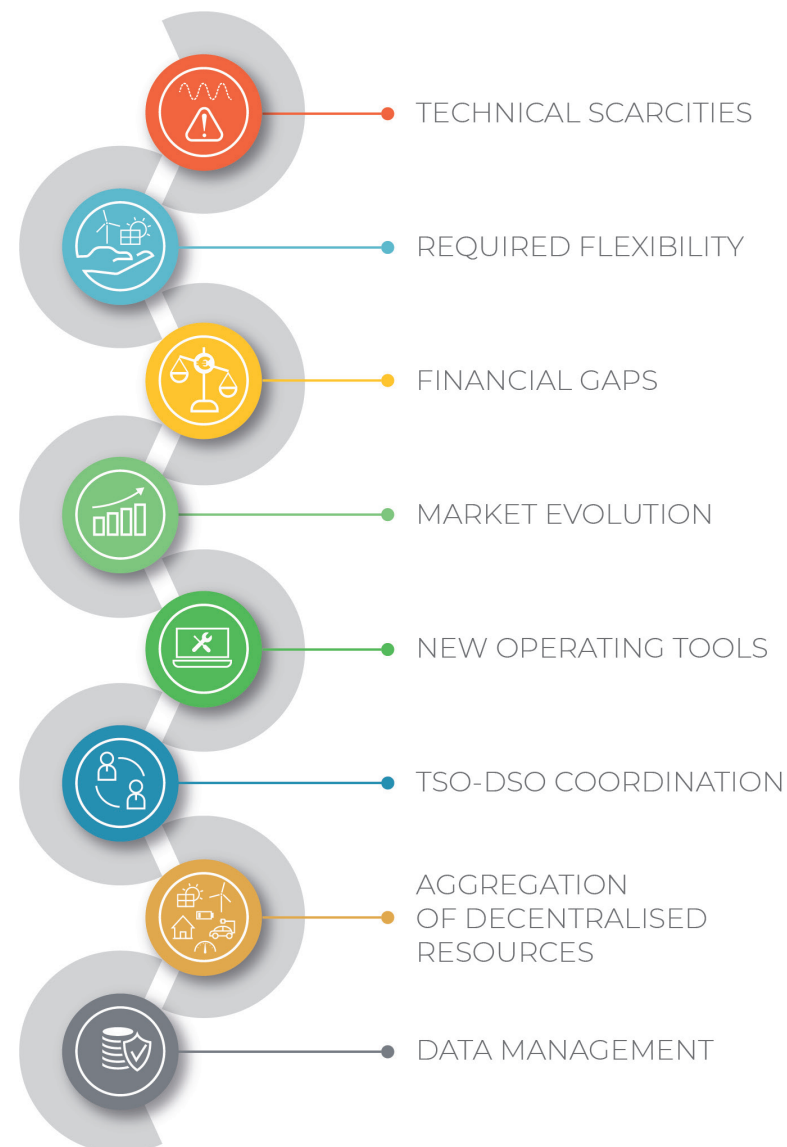
**Carmen Munoz Dormoy**  
R&D Deputy Director EDF

"With the right mix of technologies in generation and storage in addition to new flexibilities in the demand side and networks, we will tackle the challenges arising in the European Power System. My thoughts and a special thanks to our teams at EDF and to our European partners for their involvement and support to this exciting project, and in spite of the crisis. Over the last four years our industrial-size demonstrations have shown the significant potential of innovative technologies and tools to support the power system. We will continue to work on their development and enhancement in the future as implementing low-carbon generation and flexibilities at European scale is key to achieving our Net-Zero ambition."



**Vera Silva**  
Chief Technology Officer  
GE Grid Solutions

"The electricity system will be critical to Europe's 2030 low carbon energy targets and beyond to net zero. Supporting energy transition pathways with a stable, secure, and resilient grid is a problem worth solving for all stakeholders in Europe and around the globe. EU-SysFlex helps solve this problem with incredibly talented teams working together on a broad and comprehensive approach to power system flexibility. The ambitious and innovative industrial scale demonstrators increase confidence in new approaches and technologies and provide relevant inputs to technology providers working on the grid of the future."



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