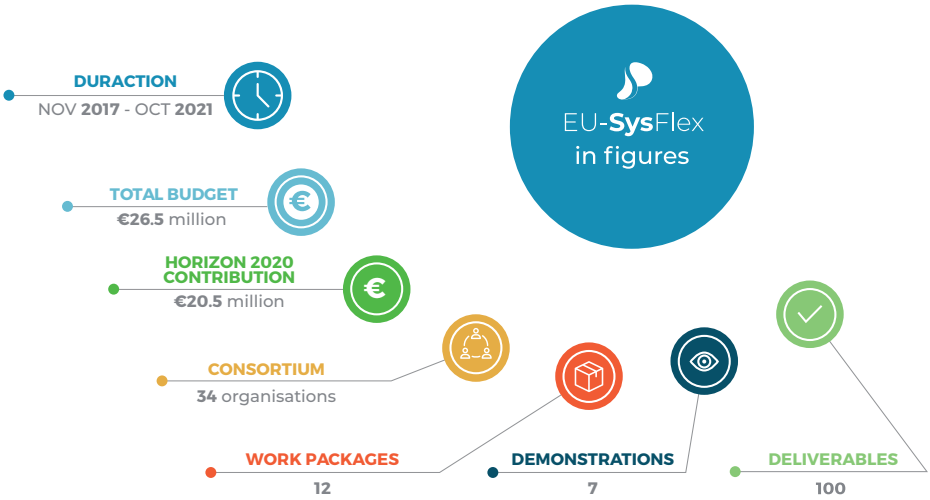
EU-SysFlex

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

EU-SYSFLEX IN A NUTSHELL

By 2030, the European Union has committed to cover at least **50%** of its electricity consumption from **renewable energy sources** (RES). As a result, the electricity supply is becoming more variable, creating uncertainties and technical challenges not previously seen in the pan-European electricity system.

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

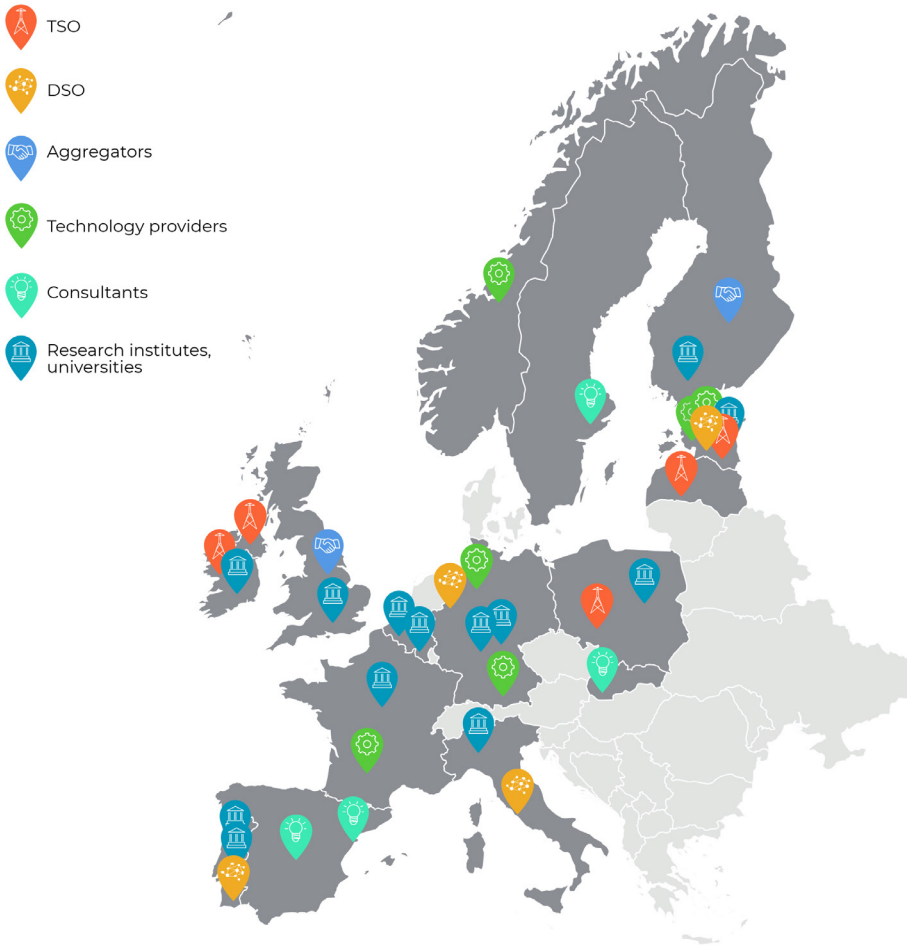


The project aims to identify the long-term **needs** as well as the technical **scarcities** of the future power system. EU-SysFlex is working to enhance the **market** and **regulatory framework** through its efforts to propose system and flexibility solutions. This includes making practical improvements across all system sectors.

The project will ultimately create a **long-term roadmap** of actions to facilitate the large-scale integration of new technologies and capabilities.

THE EU-SYSFLEX CONSORTIUM: EUROPE WORKING TOGETHER

EU-SysFlex is run by 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.



PROJECT MANAGEMENT BOARD

PARTNERS

THE CHALLENGE:
ELECTRICITY SYSTEM CHANGING OVER TIME

Given the ambitious target set by the EU, the electricity system will have to undergo **transformational change** over the next decade. There are several key factors affecting the system alterations that will lead to a more complex environment.

OVERALL INCREASE IN SYSTEM COMPLEXITY

...2030 >>

50% RES

MIX AND SCALE OF RES

GREATER RELIANCE ON VARIABLE SOURCES OF ELECTRICTY

SYSTEM STRUCTURE

BECOMING MORE DECENTRALISED AND DESTRIBUTED

NEW DIMENSIONS

ELECTRIFICATION OF HEAT, COOLING AND TRANSPORT

LARGE SCALE DEPLOYMENT OF BATTERY STORAGE

SMARTER LIVING

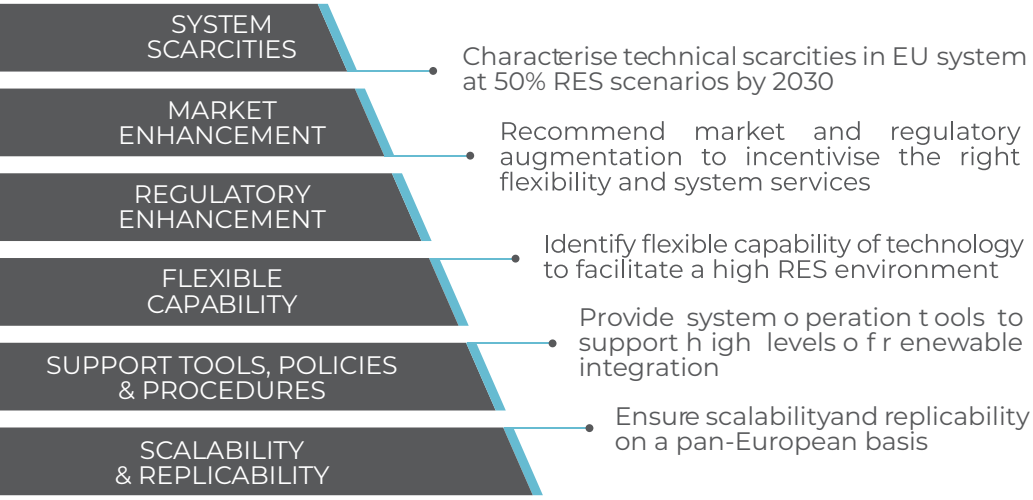
Overall increase in system complexity:

- *an almost doubling of renewables by 2030, more prominent role for decentralised and variable sources like **wind and solar** and the deployment of **storage solutions**;*
- *partial replacement of large conventional and centralised sources **with smaller decentralised renewable capacities** on the distribution level, shift to greater distribution and decentralisation in system;*
- *changing demand, electrification of **heating & cooling production and transport**, growth in smarter living and e-mobility;*
- *greater consumer participation and choice in meeting and managing energy needs, rise of **prosumers**.*

As a result, the electricity supply **will become more variable, creating uncertainties and technical challenges** not previously seen in the pan-European electrical system. In terms of system operation, this increasingly complex environment will require **a flexible and responsive system** that is far more dynamic, yet remains resilient, stable and cost effective for citizens.

THE SOLUTION: EU-SYSFLEX'S DIMENSIONS

EU-SysFlex will first identify the **needs** of the future power system with a high share of renewables. It will then make **recommendations** for enhancing market design and regulation to enable new **business solutions**. Seven industrial-scale **demonstrations** will be conducted testing new **flexibility and system services.** Drawing on the replicability and scalability analysis, the research and innovation project will ultimately come up with a **roadmap of change** for Europe.



The need for system services

The availability of information technology and advanced power electronics provide grid operators with information on short-term demand and variability as well as control over power flows. Having the capacity to analyse the costs and benefits of enhancing flexibility from conventional generation and developing financial incentives to improve plant performance is a critical step for power system planners and operators. Ultimately, the overarching goal is to create consumer savings and increase the level of renewable energy at any given time.

The need for flexibility

In order to fully utilise the potential of low-carbon technologies while balancing the need for a dynamic and reliable supply and electric grid demands, system operators need to develop new tools and market structures. There is some degree of flexibility already in place. However, the need to meet variable electricity demand and the increasing variability and ramping created by the use of renewable energy sources brings new challenges and requires visualisation of an increasingly important flexible system.

TOWARDS A NEW MARKET DESIGN AND RECOMMENDATIONS FOR THE EU SYSTEM

EU-SysFlex assesses the **technical scarcities** of the European power system that has high levels of renewable use combined with the large-scale deployment of new technologies to enable the electrification of heat production and transport. The system scarcities range across a wide spectrum from frequency, voltage and rotor angle stability to increased congestion and limited restoration capacity in the event of a power system collapse or system inadequacy.

By performing a **financial and economic analysis** of the simulation results we can assess the value of the flexibilities, identify whether there are sufficient revenues to support the type of investment required by EU policy and maintain the resilient power system that society has come to expect.

Finally, EU-SysFlex provides an **improved market design** and the technical flexibilities that make it possible to evaluate the effectiveness of the solutions for mitigating or even removing the technical scarcity.

Developing innovations for existing and new system services goes hand in hand with the analysis of **different options** for market design. Advanced modelling techniques are used to assess product characteristics and corresponding market design. In addition, business use cases are provided for the services and tested by the different demonstrations within EU-SysFlex.

EU-SysFlex provides recommendations for an IT perspective on data management in flexibility services and develops a **customer-centric data exchange model** for flexible market design, aimed at all stakeholders (transmission and distribution system operators, suppliers, flexibility providers, energy service companies etc.) and enables cross-border data exchange. The model does not indicate a single data exchange platform, but allows for the interoperability of different platforms across Europe.

NEED FOR CHANGE

A POWER SYSTEM WITH HIGH LEVELS OF RES

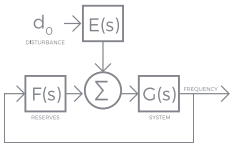
2030 >>
50% RES

ELECTRIFICATION OF HEAT, COOLING AND TRANSPORT

LARGE SCALE DEPLOYMENT OF BATTERY STORAGE

SMARTER LIVING

FUTURE SYSTEM NEEDS



SIGNIFICANT CHALLENGES & TECHNICAL SCARCITIES

FREQUENCY STABILITY **VOLTAGE STABILITY**
ROTOR ANGLE STABILITY **CONGESTION**
SYSTEM RESTORATION **SYSTEM ADEQUACY**

SYSTEM SERVICES & MARKETS

DATA MANAGEMENT

OPERATOR POLICIES & TOOLS

DEMONSTRATIONS

QTP & BREAKING BARRIERS

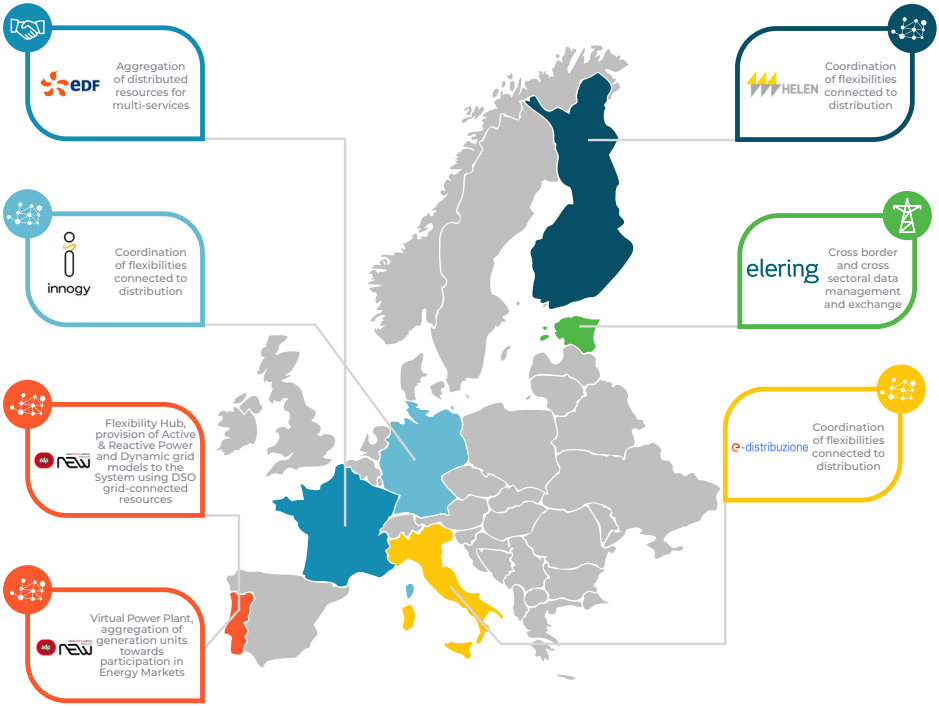
EU-**Sys**Flex

CREATING A ROADMAP TO ADDRESS FUTURE SYSTEM OPERATION COMPLEXITIES

TESTING INNOVATION IN SEVEN DEMONSTRATIONS

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**.

The demonstrations provide evidence of how the timely provision of these 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) and super-capacitors. The interaction between the **system layers and actors, and the replicability of concepts and approaches** is also addressed.



GERMANY:
Flexibility of active and reactive power from HV distribution grid to EHV transmission grid

Partners
MITNETZ STROM, innogy, INESC TEC, Fraunhofer IEE, University of Kassel

Technical aspects
- Location: Eastern Germany: Parts of Brandenburg, Saxony and Saxony-Anhalt
- Supply area: 2.720 km²
- Installed capacity: 10.2 GW DER; > 8.5 GW RES
- Share of RES in consumption: 104%
- Grid connection points in scope of demo: 374 HV/MV substations, of which 99 with RES infeed; 16 TSO/DSO interfaces with 40 transformers
- Available flexibilities in the demo: 5.3 GW in HV grid, of which 2.9 GW wind and 1 GW solar
- Potential reactive power flexibility useable in demo: -350 Mvar to +280 Mvar

Innovative aspects of the demonstration

- Integrates new and improved forecasts for RES generation and load
- Schedule based co-optimising of grid in active and reactive power management
- Includes RES in schedule based congestion management and reactive power management coordinated between TSO and DSO
- Transforms optimisation results into control signals within automated processing for reactive power management

Main challenges

It is expected that by 2030 the share of RES will have increased by up to 65%. There is already a high RES share (~40% RES in Germany and ~100% in the demo region since 2017), especially wind power in north eastern Germany, which requires substantial redispatch measures to avoid overloading transmission and distribution assets. In 2017 congestion management costs reached a record €1.4 billion.

The redispatch potential in the transmission grid is reaching its limits due to the minimal capacity of conventional power plants and decreasing level of installed capacity in conventional plants. Therefore, emergency measures are used to curtail RES in the distribution grid. Redispatch potential can be increased by utilising DER and RES in the distribution grid.

This exacerbates the need for more efficient and coordinated congestion management processes for TSOs and DSOs. Otherwise, the DSOs may adopt congestion solutions that conflict with those put in place by the TSOs.

There is also an increasing requirement for reactive power management. A coordination mechanism is therefore needed that would enable the TSO to use reactive power flexibilities from the distribution grid.

ITALY:
Provision of flexibility services from resources connected to the MV DSO network

Partners
e-distribuzione,
Enel Global Infrastructure and Networks S.r.l., RSE

Technical aspects
- Location: Forlì-Cesena area (Emilia Romagna region)
- Provision of flexibility services from resources connected to the MV DSO network
- System operation and flexibility solutions required to meet the ambition of 50% renewables in the European electricity grid by 2030
- The demonstration site is located in an area with strong renewable generation penetration (mainly PV), with low consumption of the energy generated, and frequent back feeding from MV to HV

Innovative aspects of the demonstration

- Includes RES, Storage and STATCOM in congestion management, balancing and voltage support
- Set up of new coordinated process for ancillary service provision to the TSO
- Automated tools for Network State Analysis, Network Optimisation and Reactive Power Management
- Integrates improved forecasts for RES generation and load

Main challenges

The current national scenario including the continuous increase in distributed generation limits the potential of the TSO to regulate the frequency and voltage within the transmission network, increasing the probability of overloading. This represents both an external challenge and an opportunity for the DSO, which can facilitate the use of local resources in the ancillary services of the transmission network. This could be achieved by improving the observability of the power system and adopting advanced control systems capable of aggregating the distributed energy resources for use in the ancillary service market through virtual aggregation and the use of the DSO's assets to contribute to the regulation of power flows at the DSO/TSO interface. Another crucial challenge is ensuring the DSO can operate securely and safely within the distribution network. Improved monitoring systems and satisfactory integration with the devices will help improve the reliability and safety of the distribution network.

FINLAND:
Demonstration of provision of flexibility services from distributed LV or MV assets

Partners

Helen Ltd., Helen Electricity Network Ltd. (third party), VTT

Technical aspects

- Aggregation of small distributed assets to the TSO's ancillary markets and for DSO's balancing needs
- The low voltage flexible resources in the demonstration are customer scale batteries, public EV charging stations, electric heating loads via AMR meters
- The medium voltage flexible resources in the demonstration are industrial scale BESS, PV power plant
- Development of a forecasting tool to estimate the available flexibility of the LV/MV assets for various markets
- Development of suitable interfaces to connect the small distributed assets to the aggregation platform
- Mechanism for optimising the reactive power procurement in the DSO market place

Innovative aspects of the demonstration

- Development of forecasting, optimisation and aggregation of flexibility capacity from manifold small resources to be traded on the ancillary markets.
- Proof of concept for a new market mechanism to manage the reactive power balance in the TSO/DSO connection point
- Increased use of market driven concepts to balance network

Main challenges

In the Nordic electricity system, the amount of intermittent capacity is rapidly increasing and greater flexibility and applicable solutions for high voltage grid stability are needed. In the Helsinki demo, a novel approach is demonstrated where small distributed resources are aggregated to be traded by a retailer on the TSO's existing market places and for the DSO's balancing needs. To respond to the increasing RES penetration in the Nordic power system, more flexibilities are needed. The main objective is to demonstrate full value chain performance and cost competitiveness of harnessing small distributed resources for the benefit of power system stability.

PORTUGAL:
Flexibility Hub, provision of active and reactive power and dynamic grid models to the system using DSO grid connected resources

Partners
Inesctec, EDP Distribuição, NEW ENERGY WORLD, EDP Renováveis

Technical aspects
- Location: North Portugal
- Grid: ~50 km HV grid; 20 MW substation HV/MV (demonstration)
- Grid connection points: ~8000 fed by the HV grid
- Installed capacity: ~90 MW installed RES in the HV grid
- Share of RES in consumption: >100% could feed the demonstration
- Grid in scope of demo: HV distribution grid
- Grid connection points in scope of demo: 1 distribution HV/MV substations; 1 TSO/DSO interfaces with 40 transformers
- Available flexibilities in the demo: in HV distribution grid: ~46 MW
- Active power ~46MW wind power
- Reactive power between -50 Mvar and +50 Mvar

Innovative aspects of the demonstration

- Local market for reactive power provision from the DSO grid in a close to real-time intraday market to provide reactive power to the TSO
- Redesign of the replacement reserve market as a close to real-time intraday market with a traffic light qualification system to validate the activation of bids involving resources from the DSO grid
- Equivalent Dynamic Model of the DSO grid for analysis of voltage and frequency disturbance

Main challenges

Share of RES is expected to increase. The redispatch potential in the transmission grid will reach its limits with the closure of conventional thermal plants and incremental distributed generation, so new methods are needed to provide system services. These will increase the need to use distributed resources to provide both active and reactive power management and require the design of new flexible mechanisms. In turn close TSO-DSO coordination will be required so these services can be provided without causing additional problems for the distribution grids. In addition, the traditionally passive nature of the distribution grid is evolving and grids are becoming much more dynamic and complex, therefore require proper modelling should be considered by the TSO in both voltage and frequency disturbance analyses.

PORTUGAL:
Virtual Power Plant, aggregation of generation units for participation in energy markets

Partners
EDP New R&D; EDP Renewables; EDP Produção; EDP UNGE; Siemens

Technical aspects
- Variable speed pump storage Hydro Plant – 756 MW (2x378)
- Altoda Coutada Wind Park– 115 MW (57 turbines)
- Falperra Wind Park – 50 MW (25 turbines)
- Resources connected to transmission grid

Innovative aspects of the demonstration

- Real time management of storage and generation portfolio: based on mathematical models including short term balancing operations
- Integrating forecasting modules for prices, energy supply and demand
- Market bidding suite for the different markets, respecting medium term strategies for storage management

Main challenges

In a scenario where the RES share is above 50%, new strategies will need to be demonstrated in order to ensure maximum flexibility at minimum cost, and secure and stable operation. Furthermore, RES intermittency, in this scenario (> 50%), will mean there is greater need for frequency regulation and balancing reserves. Finally, in the near future the wind parks will lose their feed-in tariffs.

FRANCE:
Aggregation approaches for the provision of multi-services from a portfolio of distributed resources

Partners
EDF, ENERCON

Technical aspects
- Demonstration facilities: EDF Concept Grid – a private distribution grid dedicated to the testing and validation of smart grid equipment, systems and functions
- A 12 MW wind farm of 6 x 2000 KW turbines, type ENERCON E82, located in the department of Marne, south east of Paris
- A full storage system including a 2.3 MW/1h lithium-ion battery as well as an ENERCON E-Storage 2300 power conversion system
- Photovoltaic panels and a variable load test bench installed at the EDF Concept Grid, combined with power amplifiers

Innovative aspects of the demonstration

- Development of a VPP (Virtual Power Plant) platform, integrating advanced forecasting and scheduling
- Demonstration of the approach to multi-service provision, through optimal management and coordinated control of multi-resources.
- Performance assessment of different services and flexibility solutions that can be procured from the multi-resource aggregator (VPP).

Main challenges

Bigger reserves and new flexibility requirements will be necessary at high RES penetration. Additional system flexibilities and ancillary services will be procured from renewables and distributed storage systems. However, questions arise regarding the performance and reliability of the services provided by the variable resources, and the uncertain profitability of providing a single service. The VPP will address the capability to manage the portfolio of resources, in order to provide efficient and optimised multi-services for the future system.

ESTONIA:
Demonstration of cross-border data exchanges

Partners
Elering, UPSIDE, PÖYRY, EDF, AKKA, PSE, Guardtime, UTartu, AST, innogy, EDIS, Enoco, Cybernetica, Elektrilevi

Technical aspects
The objective of the data exchange demos is to test more than 20 data management use cases facilitating flexibility services as well as many other business processes. Several demonstrations will focus on aspects of data management, including cross-border communication between different data exchange platforms and with different stakeholders in order to facilitate the cross-border exchange of flexibility services with the following elements:

- Cross-border data exchange between different stakeholders – system operators, market operators, end customers, data hubs, service providers, etc
- Handling of personal and commercially sensitive data
- Affordable application for smaller distributed DSR
- TSO-DSO flexibility data exchange application
- User interface – single access point to data, services and applications
- Combined access to metering and operational data
- Cross-sectoral data usage
- Big data collection, storage, processing
- Cyber security and data privacy requirements

Elering's data exchange platform, Estfeed, will be used to demonstrate data exchanges. Estfeed connects various data sources, applications and market participants. It provides secure access to consumption and generation data in the electricity and gas data hubs.
When developing data exchange demonstrations the aim is to ensure they fit with the Smart Grid Architecture Model, Common Information Model and Harmonised Role Model.

Innovative aspects of the demonstration

- Customer-centric cross-border data exchange model for flexible market design serving all stakeholders (TSOs, DSOs, suppliers, flexibility providers, ESCOs, etc.).
- Interoperability of different data exchange platforms.
- Application for flexibility marketplace to support TSO-DSO flexibility data exchange.
- Tool for aggregator to aggregate smaller distributed flexibility sources enabling affordable access to market.

Main challenges

Data exchange demonstrations are designed to tackle access issues. First, more or less any business process in the energy domain requires easy and secure access to data and facilitation of data sharing in line with the Clean Energy Package and GDPR principles. Second, and more specifically, market access for smaller flexibility providers has to be considered as they may face barriers like high initial investments and lack of single market places. Further challenges involve TSO-DSO cooperation and coordinated actions as well as neutrality of system and market operators.

Qualification Trial Process and breaking barriers in IRELAND AND NORTHERN IRELAND

Partners
EirGrid, SONI

Technical aspects
The Qualification Trial Process (QTP) acts as a platform to trial system services from new technology providers. It is a mechanism for new technologies to prove technical capability and ultimately provides a route to market.
The QTP will help IRE/NI in meeting its renewable integration objectives. Today IRE and NI is capable of operating the system at 65% of electricity demand from renewables, primarily from wind.
In meeting our renewable energy target of 70% by 2030 (Ireland) EirGrid group is creating a new initiative which will further enhance the QTP process and remove barriers to renewable in**tegration. This new initiative, The Flex Tech Integration Initiative**, is to provide a platform for engagement between industry, TSO, DSO, and regulators. The initiative will inform the QTP as well as new industry solutions.

Innovative aspects of the demonstration

- Provenability Trial: The System Operator trials new technologies on the system in real time in response to system disturbances, this provides confidence that new technologies will work as expected when system conditions require services from RES.
- Standards and Compliance Trials: Service providers whose technology classes are considered proven, but wish to demonstrate novel approaches to current compliance and standards
- Distribution Impact Trials: With more RES and new technologies embedded on the distribution system, the TSO must access their capabilities while respecting the operational limits of the distribution system
- Addressing key barriers to renewable integration across a range of technologies such as hybrid, DSM, storage, flexible demand, small scale generation and other renewables.

Main challenges

'Behind the meter' technologies such as rooftop solar PV, battery storage, vehicle to grid charging and energy management systems are changing the power system – and the pace of change is likely to increase in the future. The need for greater transparency of data and information will drive further change across the sector. As variable renewable generation displaces conventional generation on the system, new technologies must provide system services to make up any shortfall. At system level, however, there is little indication as to how these technologies will perform or to what extent a system operator can rely on them. The Qualification Trial Process, or QTP, provides the technical platform for testing services from new technology providers and identifying the operational complexities associated with new technologies.
Thus, the QTP gives confidence to system operators that the technology works as it should when the system needs it most – and facilitates a route to market for service provision by new technologies. Lastly the QTP allows the system operator to control centre tools and procedures to manage large scale deployment of new technologies.

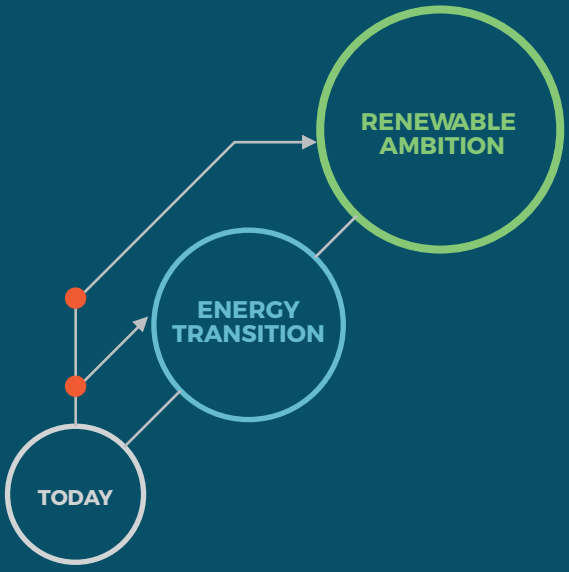
CREATING A ROADMAP FOR CHANGE

Building on the **scalability and replicability analysis** (SRA) of the results from the demonstrations and the project deliverables, a clear vision and strategy will be developed at the end of the project that will take the form of a roadmap. It will provide recommendations for the development and deployment of **the system services** needed by TSOs to support RES integration, storage and flexible demand technologies. The aim is to enable fulfilment of Europe's ambitious **carbon reduction targets**, while maintaining **security of supply** and **applying downward pressure on consumer electricity costs**.

In order to maximise output, **members of the EU-SysFlex consortium** are participating in the drafting of the roadmap. The work is being done along two paths:

1. Technical, economic and regulatory flexibility analysis: this work is supported by the analysis of the performances measured in the demonstrations and the evaluation of the scalability and the replicability of the project use cases. The results will be extrapolated to the pan-European system and the scalability and replicability analysis (SRA) will address all the technical, economic, regulatory and stakeholder acceptability factors that could limit and favour the deployment of solutions. The technical analysis will include an evaluation of the reliability of system services provided by distributed resources on the distribution grid.

2. Flexibility roadmap for Europe and implementation guidelines: the previous analyses will feed into a European flexibility roadmap containing a set of recommendations along with policy guidelines for implementation. This work will be carried out by all stakeholders including the advisory board who will provide support from the expert viewpoint.



STRUCTURE OF EU-SYSFLEX

The EU-SysFlex project is structured into twelve work packages, covering different aspects of the innovation process, from the development of new approaches for integrating large-scale renewable energy and testing pilot installations, to an analysis of the regulatory requirements and the development of viable business models and policy recommendations.

ADVISORY BOARD

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.

bridge HORIZON 2020

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

LEADERS ENDORSED EU-SYSFLEX

"We are hugely excited to be leading this important European research and innovation project. EU--SysFlex will lay the foundation for a future power system with significant levels of renewables. As the European power system goes through significant change, there is no doubt that system flexibility will become an integral part of how we operate it. Understanding future needs and identifying operational, technical and market solutions are all part of the work which this broad consortium is undertaking. We are very proud of the progress made to date and look forward to further results in the coming years. "

Mark Foley
CEO of EirGrid
March 2019

"The key word of this project is flexibility. As the generation changes on one side and the demand changes on the other side, we need to find the right flexibility in order for the sector to move to a greater engagement with the consumers. And we need to keep the lights on with much greener generation connected to the grids. EU--SysFlex will look at all the challenges."

João Torres
CEO of EDP Distribution
November 2018

"The EU-SysFlex project partners have already accepted that our energy system will continue to have more and more renewable energy, and are now looking to develop the measures that will allow our grid to handle it. The project looks at how we manage the integration of such a level of renewable energy into the system. It will identify the needed improvements to the market design to cater for this increase, introduce new practices, and enhance system--modelling tools. Additionally, the project will put forward a roadmap for the European energy system and outline how it can meet the challenges ahead – this is extremely important."

Seán Kelly
Irish Member of the
European Parliament
March 2018

EU-SysFlex was introduced by Maroš Šefčovič, Vice-President of the European Commission, in November 2018

EUSysFlex
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Following

.@MarosSefcovic paid us visit! Among hot topics of #renewables integration & interconnection, #EUSysFlex was presented by @EirGrid's CEO @markfoleyce, #JonOSullivan, @lowryireland. #EUSysFlex will enable Europe 2integrate RES massively into grid thx 2new services. #energyunion

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