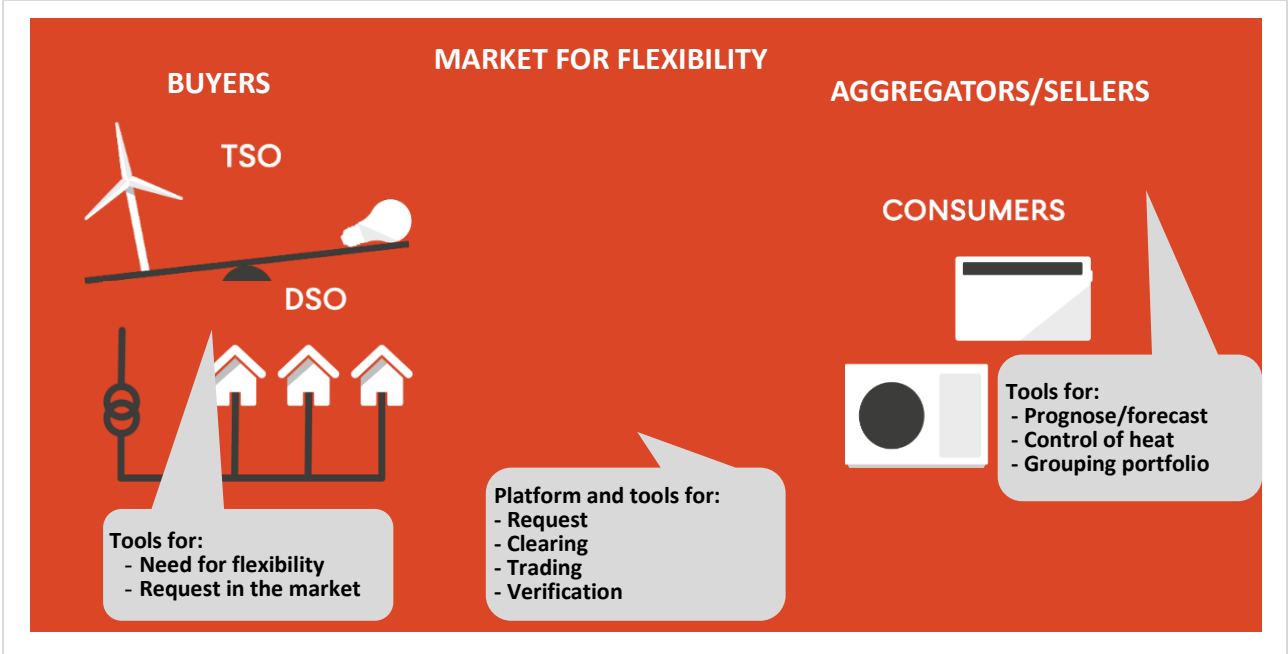
Smart Energy Grids

Lighthouse Projects for an Efficient and Climate-friendly Power Supply in Europe

EcoGrid 2.0

EcoGrid 2.0 is unique because we have not only developed a market and the necessary tools for identifying and utilising flexibility from 800 private households and summer houses. We have demonstrated it with real consumers for three years – from the involvement of private consumers, management of flexible consumption, design and implementation of a market on which flexibility is traded, to development and implementation of tools for power system operators, as well as the aggregators, who identify flexible consumption, pool it and manage it in accordance with market demand. The results we have achieved are among the best seen in a demonstration project.



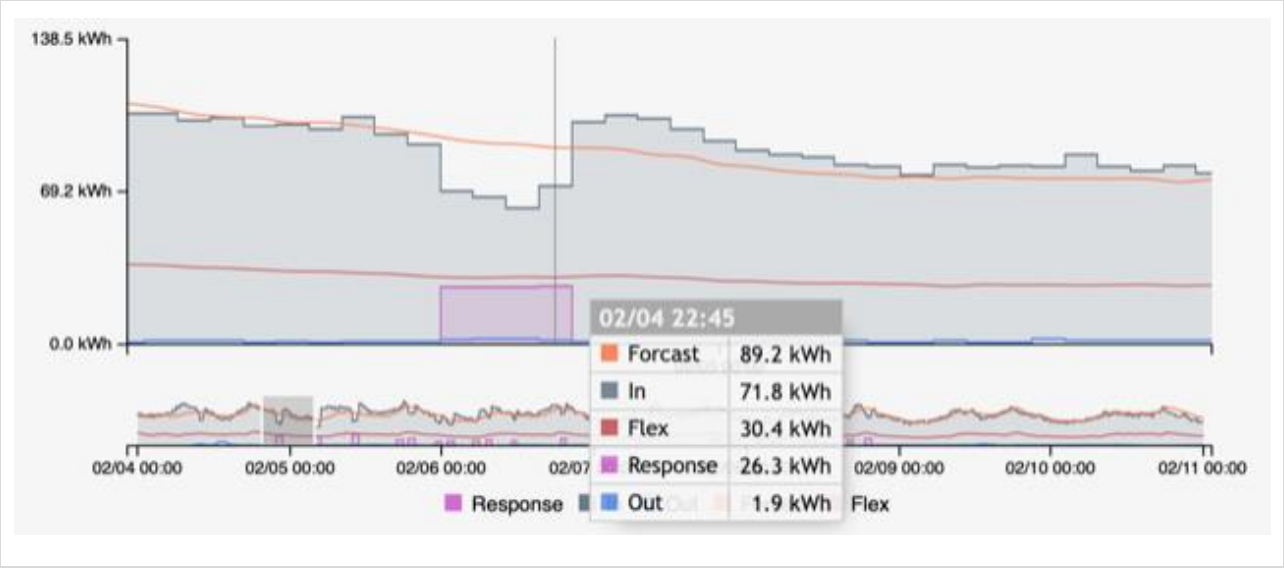
Illustrations of actors in the EcoGrid 2.0 market

In EcoGrid, we have developed and demonstrated a possible solution for the green electricity market of tomorrow where flexible electricity consumption is traded as a commodity. We have managed flexible consumption in private households and municipal buildings and provided services to the power system, so that we can help the power system to:

- integrate more renewable energy and reduce CO2 emissions.
- reduce costs through better utilisation of power system capacity, by keeping consumption below the load limits in the transmission and distribution grids, and thereby reducing the need for investments in the power system.
- maintain a balance between production and consumption.

We have demonstrated:

- that we can control heat pumps and electric heating panels without compromising comfort limits in households and sell it as flexibility to the power system.
- that we can deliver upward and downward adjustment of electricity consumption, both as planned services and conditional services:
  - we have reduced the consumption by 300 kW for an hour, equal to 124 MW at national level[1].
  - we have increased consumption by 559 kW for an hour, equal to 560 MW at national level.
- that we can control the rebound effect, so that start-up of heating, after it has been 'forced off', does not create new voltage or bottleneck problems in the power system.
- that we can trade, activate and verify the flexible consumption using a market platform
  - 209 trades and activations with services to the transmission grid.
  - 36 trades and activations with services to the distribution grid.
- that we can use data from the smart meters, together with machine learning, to make reliable forecasts for consumption, and use these for verification of delivered flexibility.



Load reduction execution on a set of 200 households.

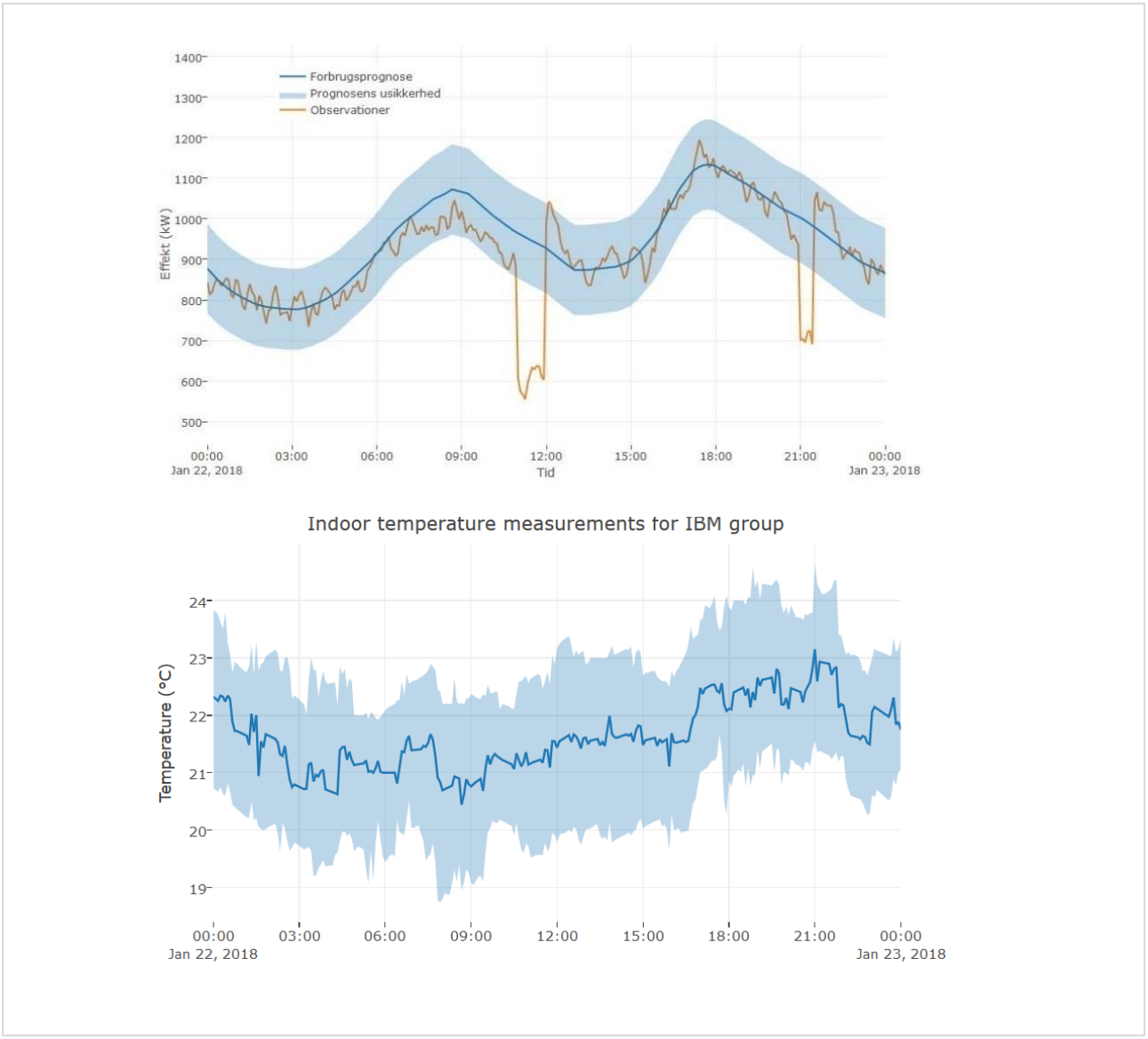
The project's findings are:

- Digitalisation and machine learning give new opportunities for monitoring and utilising the capacity of the power system.
- Green transition and flexibility on the electricity market from private households can be achieved if consumers become involved. Private households are willing to let others manage their heating to provide flexibility, but confidence in those managing the consumption plays a key role. Relinquishing control over the heating in your house is partly relationship driven.
- It is difficult for consumers to relate to the role of aggregators and trading of flexibility. Consumers are generally interested in their own consumption, comfort, and finances, and not in the needs of the power system. In order to convince consumers to sell their flexibility, they must be offered something that has value for them, for example professional help with configuration and optimisation of their heat pump.

[1] Scaling to the national level is done scaling the results from our 800 participants to the entire population of heat pumps and electric heating panels in Denmark.

- Utilisation of existing data through new software and technology (e.g. machine learning) is an important factor in the digitalisation. With data from smart meters, machine learning and digitalisation we can utilise data to do more than we initially believed – move consumption, integrate more renewable energy production, monitor consumption, optimise grid operation, identify future bottlenecks, and improve the utilisation of power grid capacity.

Many people talk about harnessing flexibility from private households. In EcoGrid 2.0, we have demonstrated that it is possible to use flexible electricity consumption in private households to integrate more renewable energy production, reduce CO_2 emissions and reduce costs in the power system. We reached the stage where the market and the developed tools are ready for commercialisation. Our objective has been to develop solutions that can be integrated into the current market model using existing technology. We have succeeded in developing such a solution. We have not relied on solutions that could become available 10 years from now, but on solutions that are commercially available today.



The first diagram shows two demonstrations of load reduction,
the diagram below shows the indoor temperature at the private households the same day.

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GOFLEX

Generalized Operational FLEXibility for Integrating Renewables in the Distribution Grid (Aim: Automatic Trading of Flexibility)

Scope

The European Commission presented a package of measures aimed at keeping the EU competitive as the clean energy transition is changing global energy markets. A new electricity market design, which also foresees better demand participation and an important role for storage is part of this package. Additionally, the package foresees that consumers and communities will be empowered to actively participate in the electricity market and generate, consume, or sell electricity back to the market, while taking into account the costs and benefits for the system as a whole.

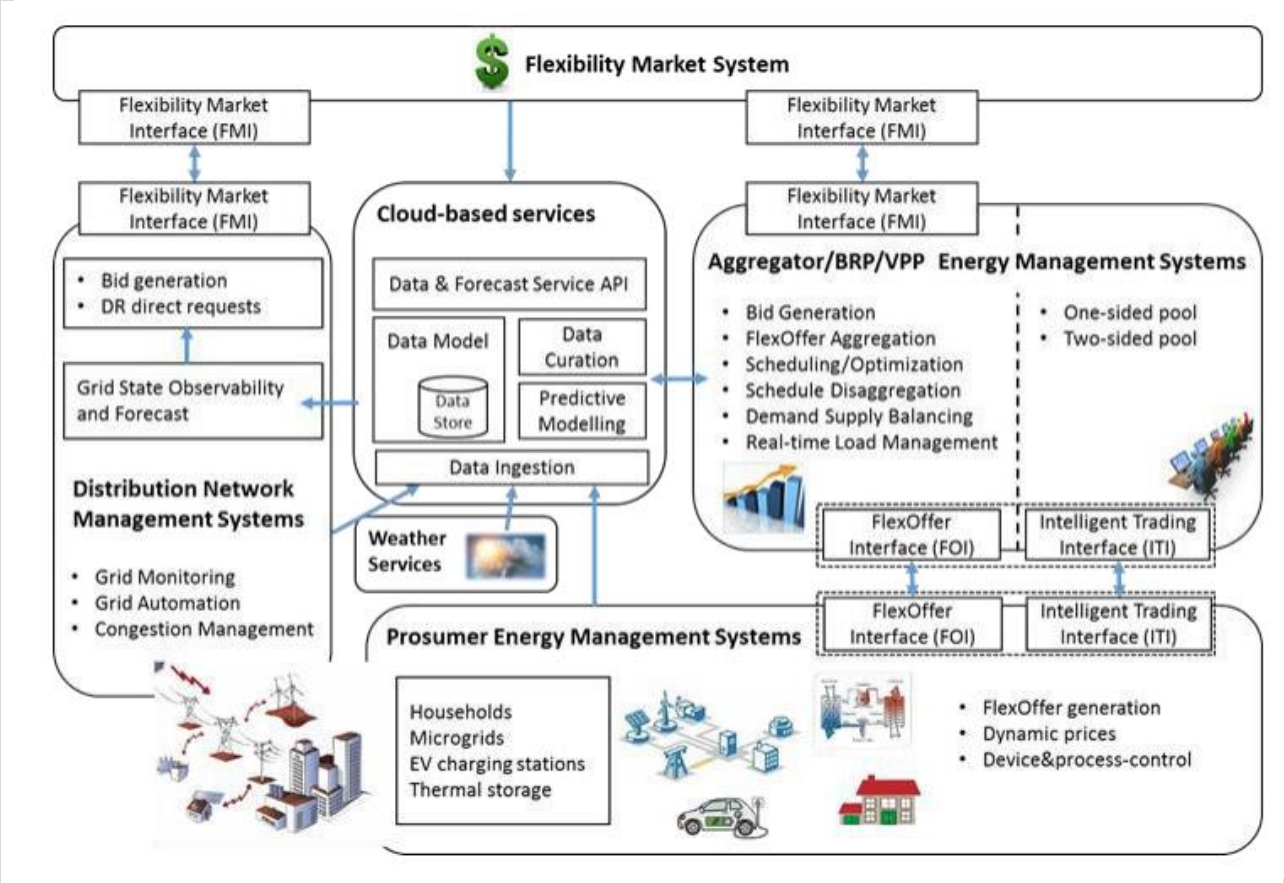
Therefore, GOFLEX goals were

- accelerate the energy trading technology solution in Europe by developing and demonstrating mature and commercially viable, scalable and easy-to-deploy solutions for distributed flexibilities and automated dynamic pricing enabling sustainable and flexible and
- establish a market for distributed flexibilities and automated dynamic pricing to improve the secure energy supply at local level and increase the economic efficiency of the overall energy system.

Consumers' distributed flexibilities and automated dynamic pricing are a cornerstone for the transition towards a more flexible energy system facilitating a higher penetration of distributed renewable energies on regional level. A holistic approach for Smart Energy solutions that are easy to integrate in existing eco systems which are open for new services and new players is an enabler for transformation process of the energy market.

Delivering general and operational flexibility

The GOFLEX project, innovated, further developed, integrated, and demonstrated a group of electricity smart-grid technologies, enabling the cost-effective use of demand response in distribution grids, increasing the grids' available adaptation capacity, and safely supporting an increasing share of renewable electricity generation. The GOFLEX smart grid solution delivered energy flexibility that is both general (across different loads and devices) and operational (solving specific local grid problems).



The technologies considered in the project include automatic trading and dynamic pricing of energy, demand-response augmented with storage including electric vehicles (EVs), and distribution grid observability. These technologies exist at different levels of maturity within the project partners. In the project the improvement and integration of the component parts - from energy management systems to cloud platforms for cognitive analytics - to enable trading of energy flexibility.

Three demonstration sites

The project, which last three years with a two-year extended phase for demonstration, includes three demonstration sites in

- Germany the local utility SWW Wunsiedel aims to utilise prosumer flexibility as a next step towards a 100% self-supply with regional and green energy,
- The University of Cyprus will use the campus as a microgrid to explore the provision of flexibility services to the DSO and
- In Switzerland the local utility ESR will use flexibility management to reduce peak loads on the distribution grid in areas where decentralized PV production is increasing

All three sites tend to involve over 400 prosumers from the industry, building and transport sectors. The demonstration projects focus on the use of flexibilities by distribution system operators (DSOs) in different national environments. The project's goal is to show that GOFLEX as a solution can work in different electricity systems and regulatory frameworks. One focus area that is common across the demonstration sites is the use of flexibility - especially demand side management (DSM) - to reduce peak loads in parts of the distribution grid where photovoltaic production is increasing. Successful demonstrations in this regard would reduce the need for infrastructure upgrades.

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SMILE

Discover Smile

A large-scale smart-grids deployment

A program tackling a wide range of issues:

- Integration of renewable energy sources,
- Demand management,
- Flexibility for local/national needs
- Electric vehicles (e.g., V2G/V2H, smart charging)
- Energy data management
- Smart building
- Self-consumption

A programme with various stakeholders

SMILE aims at supporting emergence, implementation, and deployment of collaborative projects in smart grids & energy management

More than 300 stakeholders:

- Public authorities
- Clusters, chambers of commerce & innovative centers
- Research centers
- NGO
- Finance organization
- Companies: from start-up, SMEs to national companies, DSO & TSO (electricity & gas)

A showcase of new energy systems

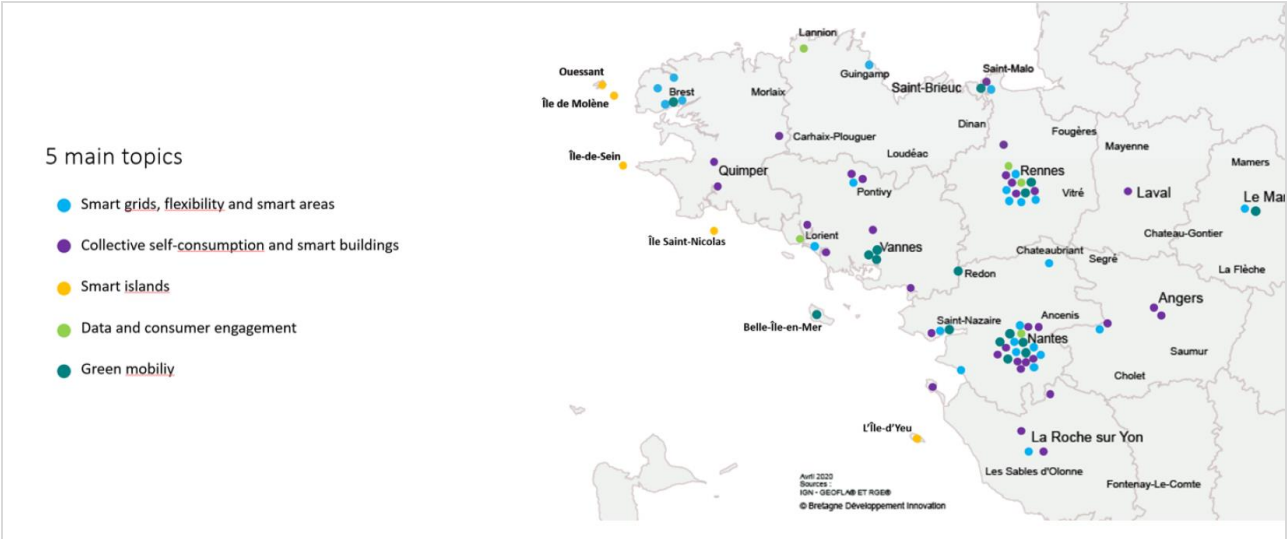
The SMILE showroom features the innovative solutions developed by businesses in Western France to address energy transition and sustainable growth issues.


Two showroom places to welcome visitors

Since the opening in May (Rennes) and June (Nantes) 2019:

- 3 000 visitors
- 170 events
- International visitors from China, Japan, United States, Poland, Tunisia, England, Brazil, Finland, Malaysia, Sweden…

99 smart grids projects, up to now



Close to 270 million euros of investment

270 million euros => a 50/50 public-private investment
And 51 million of investment from the DSO and TSO for electricity grids

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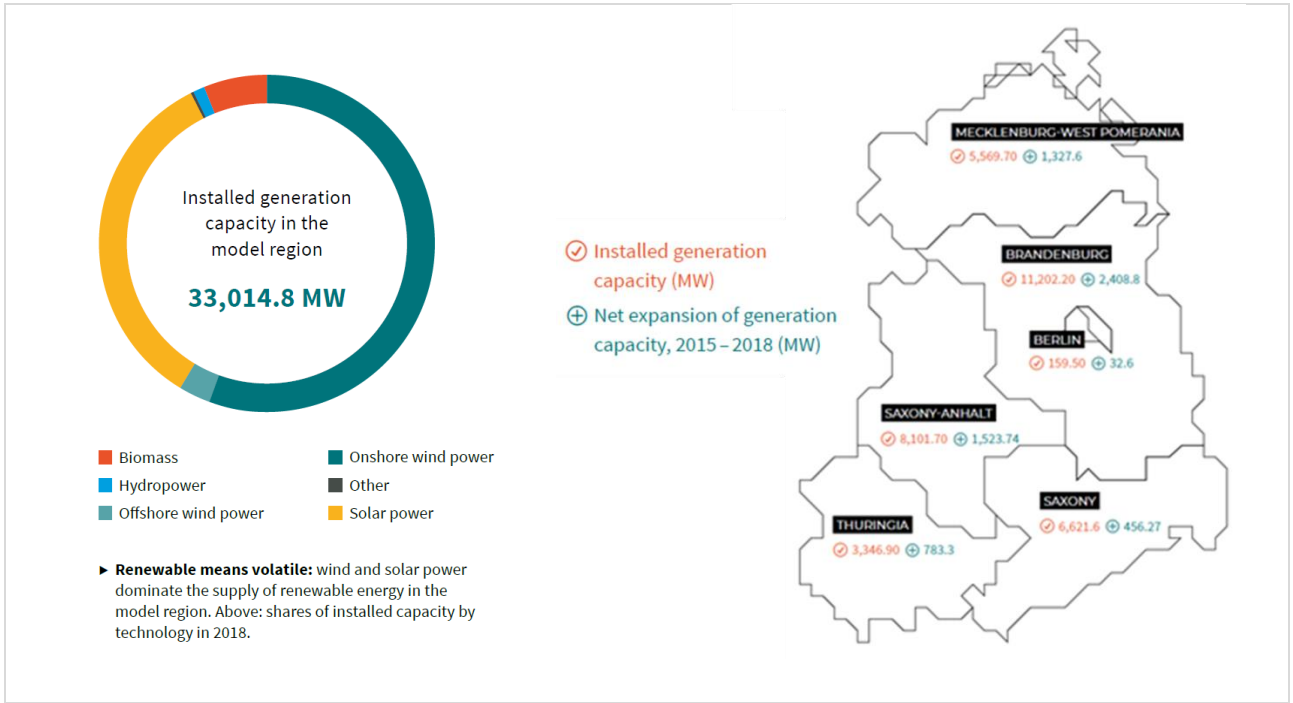
WindNODE

Regionalisation and transmission

Combined-power-plants can help balance the decentralised supply of power from renewable sources with the regional energy demand as a first step to relieve the grids. Transmission and distribution systems create flexibility if the load and generation centres of different regions can be interconnected. To this end, the secure, efficient and ICT-supported grid infrastructure and its interfaces, for instance between the distribution and transmission system operators as well as to the customers and market players, have to be developed further so that they can meet the challenges and demands of the future.

Load shifting

One possibility to react to the fluctuating feed-in of renewable energy is to selectively shift electricity demand in time. We have systematically described the approach to locating flexibility options with different model users, considering load shifting as well as battery storage and sector coupling. Our industrial, commercial, and residential partners have identified flexibility potentials and assessed their usability for grids, systems, and markets.



▸ **Renewable means volatile:** wind and solar power dominate the supply of renewable energy in the model region. Above: shares of installed capacity by technology in 2018.

Use of data

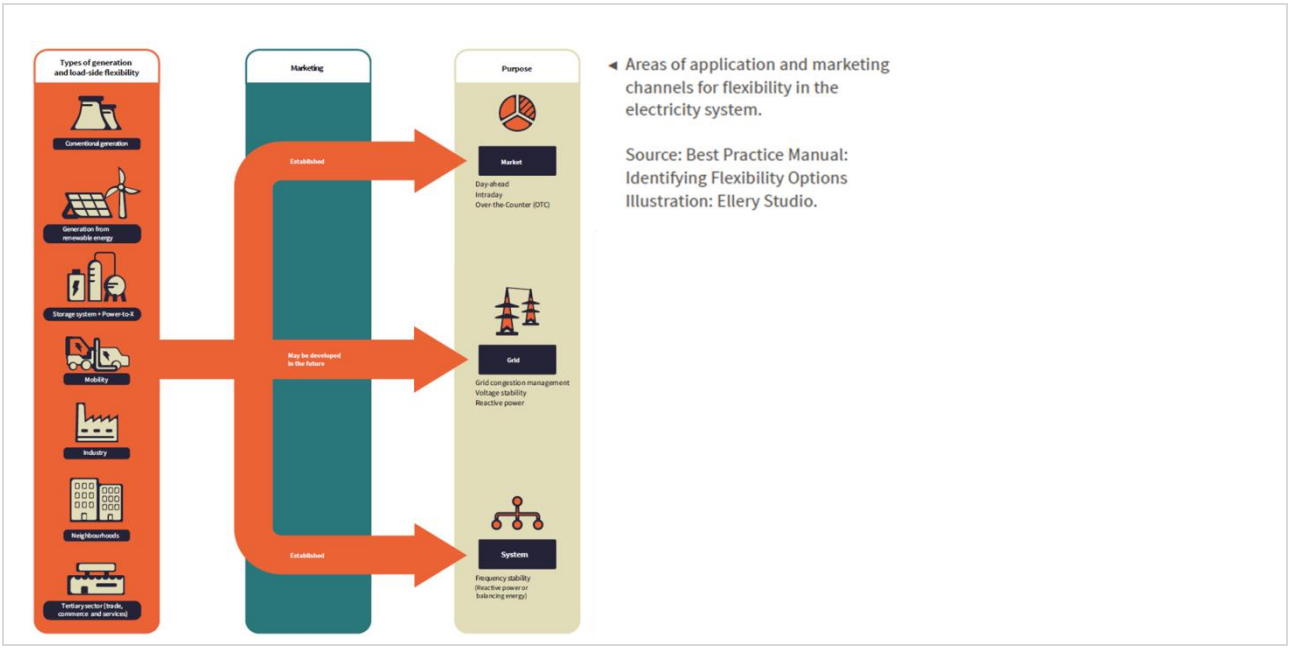
Germany is leading the way by already having almost two million renewable generating units. The efficient system integration of these installations will require new ICT solutions and give rise to a growing data volume. This leads to far-reaching questions: how can data security be guaranteed? What standards do we need? Which new stakeholders, roles and services will arise In the field of ICT? And not in the least: what can we gain from the data? WindNODE has sought to answer these questions, including by gathering a wide range of creative input through 'Energy Hackdays' and the 'WindNODE Challenge'.

Market roles and business models

As a Living Lab, WindNODE not only wanted to demonstrate technical solutions that offer flexibility, but also to develop and test the necessary "rules of the game". After all, the efficient system integration of renewable energies has consequences for business models and the current distribution of roles between market participants. We were particularly interested in the "yellow traffic light phase" of the grid traffic light concept of the German Association of Energy and Water Industries (BDEW), i.e. the transition between the free play of the electricity markets and the physical limits of the electricity grids. With the flexibility platform, we have been working on an innovative approach to efficient grid congestion management.

New flexibility options

The energy transition is more than just an 'electricity transition'. There is enormous potential for flexibilisation and decarbonisation in the heating and mobility sector. The increased interconnection of these sectors with the electricity system can help balance the generation and consumption of electrical energy. The idea of sector-coupling is not new. Nevertheless, it faces at least as great regulatory and economic challenges as technical development needs. For Power-to+Heat (PtH) and Power+to+Cold (PtC), WindNODE demonstrated a wide range of model solutions, from small, decentralised installations to the 100 megawatts category. Furthermore, various approaches were tested within WindNODE for the system integration of electric vehicle fleets.



◂ Areas of application and marketing channels for flexibility in the electricity system.

Source: Best Practice Manual: Identifying Flexibility Options
Illustration: Ellery Studio.

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