

PROJECT SUMMARY

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ESTIGATES EVF ٦ THE PROJECT EXPLORES NEW SOLUTIONS TO FOSTER THE DEVELOPMENT OF DISTRIBUTED ENERGY **RESOURCES AND** PREPARE THE ELECTRIC SYSTEM FOR NEW USES INCLUDING E-MOBILITY

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EDITORIAL

The energy sector is currently facing a **historic opportunity**. Decentralization, decarbonisation and digitalisation constitute global trends that are massively changing our societies, including the energy industry. Combined, they can help us achieve an energy system that empowers customers and reduces carbon emissions - not only in the electricity sector but also in the mobility and heating domains. By seizing this opportunity, the energy industry can reinvent its business models and operational practices and stay on top of tomorrow's challenges.

Meanwhile, the energy sector must face a number of **obstacles and challenges**. A mix of regulatory instability, operational inertia and non-harmonized development strategies could lead to sub-optimal or stranded investments. Insufficient policy updates might prevent promising new business models or technical innovations from deploying their full potential. That is why it is important to keep up the dialogue between regulation, technology and business players - and to disseminate new insights and innovations.

In order to **address these challenges**, the InterFlex project consortium investigated a wide range of innovations to procure and use flexibilities for the local benefit of the distribution grid.

Six industry-scale demonstrators were set up in five EU Member States (Czech Republic, France, Germany, The Netherlands and Sweden) in order to gain deep insights into the market and development potential of the investigated innovations.

We are proud to present hereafter a summary of the main learnings and results of the project and its demonstrators.

The InterFlex consortium

LOCAL USE OF FLEXIBILITIES TO FOSTER THE ENERGY TRANSITION

InterFlex investigated the INTERactions between stakeholders and the technical and economic potential of local FLEXibilities to relieve existing or prevent future grid constraints.

The project thereby contributes actively to the energy transition, fostering both the development of renewable energy resources and the decarbonisation of the historically fossil-based heating and transport sectors.





3 YEARS

Launched in January 2017 for a period of 3 years, InterFlex explored a wide range of solutions to procure and use flexibilities for the local benefit of the distribution grid.



6 DEMONSTRATORS

The project relied on six industry-scale demonstrators in five European countries: The Netherlands, Germany, Czech Republic, Sweden and France.



20 PARTNERS

DSOs, energy retailers and service providers, equipment manufacturers, IT experts and research centers were collaborating in order to test smart grid technologies at an industrial scale.



22.8 MILLON EUROS

The cumulated project budget reached nearly 23 million Euros including funding provided by the European Commission's H2020 research and innovation programme.

DIFFERENT LEVERS TO INCLUDE LOCAL FLEXIBILITIES IN THE DSO BUSINESS

InterFlex explored the use of local flexibilities in order to address existing or future DSO needs – by developing and applying innovative technical solutions, processes and activity models.

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GRID OPERATION

The DSO is in charge of keeping the grid free of congestion problems, and guaranteeing the power quality for all users in its service area. InterFlex explored to what extent the activation of flexibilities could help to **solve operational grid constraints** due to network incidents, extreme weather conditions or planned maintenance. As such, the flexibilities provide potential **operational savings**.

In specific situations as for example in the German InterFlex demo, flexibilities could also serve to compensate for grid reinforcements that could not be realised in time. In this case, local flexibilities contributed to manage power quality issues and provide an **alternative to forced curtailment measures**.

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GRID DEVELOPMENT

One of the objectives of the InterFlex demos was to avoid or to postpone grid reinforcement in a context of constraints caused by the high shares of renewables or the massive development of specific uses (e- mobility, heating).

InterFlex evaluated how the sourcing and use of local flexibilities could be included ex-ante in the grid design process and thereby provide **capital expenditure savings**.



BALANCING

Balancing of the energy system generally forms part of the TSO's responsibilities. However, in specific cases, for instance when running **islanded microgrids** as a backup solution during a grid incident, the DSO becomes responsible for local balancing.

In this specific case, local flexibilities don't primarily serve to manage grid constraints but as a local optimisation lever for the durable islanding operation.



COMPLEMENTARY PATHS TO ACCESS AND USE LOCAL FLEXIBILITIES

InterFlex relied on the central observation that there has to be an identified need for flexibilities to generate a corresponding offer. DSOs and market players – flexibility service providers, aggregators or power producers – were exploring pathways to introduce local flexibilities as an optimisation lever into the distribution grid management. The DSO, as a flexibility customer, emitted signals to the stakeholders – power producers, consumers, prosumers (consumers & producers), or their aggregators – which in return offered generation and/or consumption flexibilities.

Different procurement and activation paths have been investigated within the respective InterFlex demonstrators, covering flexibility market models, DSO-steered flexibility activation channels and autonomous functions ϑ grid automation. The different approaches are not exclusive: their choice depends on the importance of the observed grid congestion, national regulation and economic principles.

While InterFlex made the choice to focus on the use of local flexibility for the benefit of the distribution grid, it shall be recalled that flexibilities also serve other markets and purposes. As part of the developed local market mechanisms of the project, the flexibility service providers evaluated competing or complementary value pockets, including TSO-, balancing- or wholesale markets, to optimise the flexibility procurement and trade. The explicit development of communication interfaces between the different markets did not form part of InterFlex.

INNOVATIVE BUSINESS MODELS BASED ON MATURE TECHNOLOGIES

The project followed a three-fold approach:

- New business models were identified for the local use of flexibilities.
- Innovative technologies were tested in the six demonstrators and the potential for large- scale implementation was evaluated across different environments.
- Wherever useful or necessary, recommendations for regulatory or policy evolutions were formulated.







INTERFLEX RELIED ON SIX INDUSTRY-SCALE DEMONSTRATORS

With Enedis as the global project coordinator and ČEZ Distribuce as the technical director, the project explored a set of 18 innovative use cases.

NL Enexis' demonstrator in Eindhoven in the Netherlands investigated a local market approach to prevent future grid constraints. Stationary storage assets, controllable PV panels and controlled public charging stations for electric vehicles constituted the major flexibilities, provided by commercial and technical aggregators.

DE Avacon's demonstrator, located in the region of Lüneburg in northern Germany, served to develop an IT-control chain bound to the Smart Meter Framework to provide the DSO with direct access to local flexibilities to relieve grid constraints and improve DSO operations. Flexibilities included smart PV curtailment and load control of residential storage heaters and heat pumps.

SE1 E.ON was running 2 demonstrators in Sweden, the 1st one located in Malmö, where synergies between different energy carriers were investigated, and flexibilities were provided by the storage capacity of heat networks and the thermal inertia of buildings.

SE2 E.ON's 2nd demonstrator was located in the village of Simris in southern Sweden and explored customer's

demand response while islanding a Local Energy System and its distribution grid, run on 100% renewable energy sources.

CZ The Czech demonstrator led by ČEZ Distribuce used grid automation and energy storage in various areas of the country to increase the RES hosting capacity of the distribution grid. Flexibility was provided by autonomous Volt-VAr control, decentralized residential batteries and smart functions of EV charging stations.

FR Enedis' demonstrator (called Nice Smart Valley), located in the metropolitan area of Nice on the French Riviera, implemented a local flexibility market to prevent future grid constraints, investigated a multi-service approach for storage systems and operated remote islanding of a Mediterranean island to enhance the local grid resilience.

By means of the different demonstrators, InterFlex evaluated innovative technical approaches, business models and contractual relationships involving the various stakeholders: DSOs and market players, municipalities and the end customers.





THE PROJECT'S FIVE INNOVATION STREAMS

The variety of the approaches investigated by InterFlex reflects the diversity of the European energy systems and particularly of the grid infrastructure. The project's use cases, tested in its six demonstrators in five countries, have provided their individual input to the following innovation streams:

Local Flexibility Markets: procurement and activation of flexibilities in response to DSO's demand through local mechanisms based on open market principles.

Demand Response & Customer Empowerment: different types of customers own and provide access to exploitable flexibilities. Both individual involvement and Local Citizen Communities have been evaluated.

Smart Functions ϑ Grid Automation: digitalization and automation of the distribution grid or of devices connected to the grid constitute a complementary approach to provide flexibilities.

Cross Energy Carrier Synergies: historically the various energy carries (electricity, gas, heat) have been managed without general interaction. Sector coupling released unexploited flexibilities, comprising great potential.

Multi-Service Storage & Islanding: storage constitutes a valuable source of flexibility that approaches technological maturity. Multi-service models have been tested to make stationary batteries economically exploitable.

Those five InterFlex innovation streams are described in more detail in the following sections.

LOCAL FLEXIBILITY MARKETS

In today's energy world, national electricity markets are in place and are run by proven mechanisms in order to guarantee the security of supply and avoid congestion in the high-voltage grid.

Tomorrow, it could become similarly common to implement local flexibility markets in order to manage grid congestion and avoid or postpone reinforcements on the low or medium-voltage distribution level.

BUSINESS CASE

InterFlex experimented the local trade of flexibilities for distribution grid purposes. In the French and the Dutch demonstrations, the respective DSOs developed dedicated IT platforms to share actual and potential flexibility demands with commercial service providers, the aggregators. The DSOs aimed at sourcing flexibilities on local markets to optimize the operational performance of the grid management.

In the frame of both demonstrators, the actual degree of DER or EV development does not yet cause grid congestion problems. Prospective studies have therefore been conducted based on different scenarios to evaluate the potential DER and EV development. Forecasting tools on DSO and aggregator level have been developed and used to determine the expected impact on the distribution grid. The market mechanism tested in the French and the Dutch demonstrations is described hereunder.

When congestion was forecasted on the distribution grid, a flexibility request was sent via the IT platform to the aggregators. A flexibility request contains the requested flex power (up or down) for a given congestion point and the corresponding time slot. In the Dutch demo, the DSO also sent to aggregators the price it was willing to pay for such a request.

Flexibilities in the Dutch demo comprised a stationary battery, a controllable PV system as well as smart functions to manage the charging sequence of EVs in the demo area. In the French demo, a variety of flexibilities and activation channels were tested, including residential appliances, dual-fuel assets (gas/electric), industrial process control, stationary batteries and one EV with V2G capacities. Upon receipt of a flexibility request, aggregators evaluated corresponding availabilities and sent bids based on their customer flexibility portfolio and the arbitrage opportunities on other markets or mechanisms considering their flexible capacity commitments towards the DSO.

The DSO analysed the offers from several aggregators and selected the most suited one(s). If there was a match between DSO demand and aggregator bids, the DSO sent its activation requests to the aggregators who dispatched them through specific activation channels to their flexibility providers. By doing so, the aggregators provided the expected flexibility service at the minimum cost.

The DSO's formulation of flexibility requests, the bidding process as well as the flexibility activation process was channelled through both DSO and aggregator platforms and the corresponding interfaces.



DSO: Grid constraint management

Constraint forecast, flexibility service request, offer selection-settlement, service check after activation

Aggregators: Flexibility service providers

Customer recruitment, Forecast–portfolio optimization and balance, Procurement–dispatch between value pockets, Flexibility offer & activation

Customers: sources of flexibility

Technical offer specification–constraint criteria Contractual or spontaneous spot market offers

MAIN ACHIEVEMENTS

Flexibility mechanisms have been successfully set up, defining the roles of the respective stakeholders. IT tools have been developed, including forecasting engines, market platforms and aggregator interfaces, some of them based on open protocols (USEF, EFI or CIM).

Concerted efforts on the market design of the traded products allowed to define formats to match the DSO's requests with the aggregator offers, while identifying adequate time frames for the activation process.

CHALLENGES & RECOMMENDATIONS

The demonstrators highlighted that flexibility sourcing remains a critical element, especially at the early stage of the market development when flexibility value is low and the DSO's flexibility demand remains sporadic and not easy to predict, thereby leading to potentially fragile aggregator business models and a lack of liquidity on the market.

The degree of both the local availability and the reliability of flexibilities represents a potential risk for the DSO who needs to rely on predictable means to achieve its performance objectives. Depending on the nature of the DSO's flexibility request, there will most likely be a need for complementary markets: spot markets for opportunistic offers on the one side, versus reserve markets based on procurement contracts on the other side to secure the needed capacities.

In the current situation, conditions are not yet met in the demonstration areas to set up durable business models for local flexibility markets, as the distribution grid presents a very small number of constraints.

How can the local flexibility offer be stimulated? If the use of flexibility was to be generalized to foster an economically efficient and fair grid management, some temporary incentives may have to be put in place to allow aggregators and DSOs to move forward towards industrialised processes.

Meanwhile the DSO is not the only user of flexibilities. Multiple buyers can enhance the development of flexibility offers, whether they are local or not. As such, investigating the DSO-TSO coordination on flexibility procurement and the possibility of value stacking through sales on different markets and for different uses is a necessary next step.

In order to facilitate the generalized use of flexibility, market offers need to be standardised and regulation needs to be adapted and applied, in the perspective of an enhanced exploitation of the current and future electricity system assets. Regulatory frameworks are needed, defining simple mechanisms to foster the development of industrialised flexibility markets in the short term. Changing the taxation and tariff system including for instance variable network tariffs could in some countries be part of the measures to be taken to pave the way to the future use of (local) flexibility.



DEMAND RESPONSE & CUSTOMER EMPOWERMENT

Demand response is a specific form of flexibility. It involves the active customer and seeks to modulate controllable loads while taking into account the user's needs and expectations (e.g., comfort).

Different types of Demand Response (DR) schemes were tested in the frame of InterFlex. They are generally characterized by the following key elements:

- The nature of the flexibility asset with its associated temporal availability and/or capacity constraints.
- The operational activation channel which can rely on control boxes or smart meters, but also on the end customer as an active contributor to the activation process.
- The specification of the activation criteria as well as the associated remuneration (flat rate and/or fixed for each activation) for the flexibility service provider via reserve mechanisms or by means of opportunistic market offers.

BUSINESS CASE

InterFlex experimented the use of a wide range of demand response flexibilities, through different activation channels and based on country-specific needs. In the German demonstration, the effective need for frequent curtailments gave preference to the direct DSO-control of flexible loads. Flexibility activations by service providers, through local flexibility markets, have been tested in France and The Netherlands, whereas the Swedish demonstration in Simris has looked into the specificities of a Citizen Energy Community. In the Czech Republic, the charging power of electric vehicles connected to the DSO's charging stations could be curtailed in case of distribution grid constraints.

The comparative analysis provided insights into the respective advantages and challenges.

Direct DSO Activation

In the case of direct activation, a contractual agreement between DSO and customer allows the DSO to control flexible loads directly. This was the approach taken in the German InterFlex demonstrator where Avacon steered residential loads (storage heaters and heat pumps) through its IT platform called Smart Grid Hub (SGH). Similarly, in the Swedish InterFlex demonstrator, E.ON directly steered flexible assets at customer households to support prolonged islanded operation. This flexibility could be provided to increase or decrease the household power consumption, thus making the residents direct contributors and part of the solution by adding balancing flexibility to the microgrid.

- Advantages: Cuts down on transaction costs, allows reactive strategies and reduces complexity.
- Challenges: Difficult to ensure efficient allocation of flexibility and to identify adequate remuneration rates.

Market-based Approach

In the case of a market-based approach, as tested in the Dutch and French demonstrators, flexibility requests and offers are matched on a market platform, usually with aggregators handling the bidding and end-customer activation.

- Advantages: Ensures adequate pricing and efficient allocation. Potentially more access to flexibility and possibly value-stacking. Facilitates customer enrolment by allowing offer bundling with other value proposals for customers.
- Challenges: Complex system with numerous interactions and a minimum number of market participants for liquid transactions.

In the French Demo, behavioural flexibility has been tested with a specific panel of residential and professional customers. When Enedis activated such flexibility offers, the aggregator sent an email and a text message to the customers asking for flexibility during the required time slot. The customers remained the master of the activation and could decide without penalties to reply or not to the activation request. Other kinds of flexibilities, also tested with residential and professional customers, involved global offers including automatic remote control and value stacking.

Customers in the Dutch Demo were empowered by using an app for controlling the amount of flexibility their EV could offer to the grid. Flexibility provided by EV was made accessible through smart charging algorithms managed by the aggregator (Jedlix). The EV driver got a reward of 5 cents per charged kWh using the smart charging routine. He could track the generated savings via the registered Jedlix app available in the PlayStore (Android) and App Store (iOS).

In Germany Avacon focused on a contemporary interpretation of existing rules for flexible loads. New technology such as the smart meter in combination with a powerful central management and control platform allowed the DSO to control flexible loads individually and directly. Avacon relied on existing agreements in the German regulatory framework that empower the DSO to define charging slots for storage heaters and to curtail heat pump operation for limited periods of time to transfer the heating load towards time windows of high DER-production or slots of expected high prices for balancing energy.

The Swedish demo in the village of Simris used distributed flexibility provided by its inhabitants and active customers to extend the islanding periods and diminish curtailment of renewable energy. The flexibility arose from Demand Response, controlling residential assets: batteries, heat pumps and water boilers. This process was fully automated and based on E.ON's control algorithms. The main battery in Simris played a central role in this control algorithm. The households in Simris received remuneration for the flexibility provided by the Demand Response steering. Through a dedicated user interface the customers could follow their provided flexibility.

MAIN ACHIEVEMENTS

InterFlex demonstrated the successful implementation of direct DSO-control and of local flexibility platforms and their technical functionalities. The ex-post validation of the flexibility activation has been obtained through dedicated service check routines.

There is an immediate potential for the use of the InterFlex project results in areas with grid constraints, such as certain regions in Germany with a high share of intermittent renewable energy. The technology used in the German InterFlex demonstrator is fully integrated with the national smart meter framework and offers superior scalability and immediate large-scale implementation potential across the German market while guaranteeing a very high degree of privacy and cybersecurity for connected customers.

For future developments, these achievements can be used as a blueprint for the coupling of infrastructure and IT-systems, integrating both grid control and smart meter rollout. It is also noteworthy that InterFlex's Demand Response experiments and solutions provide tools to facilitate the development of Citizen Energy Communities (CECs). Indeed, InterFlex successfully attracted a large number of pilot customers for these DR solutions. Other features include an end-user platform that has been developed to display household energy balances, and a real-time simulated P2P-market where citizens could trade privately produced energy with their neighbours.

CHALLENGES & RECOMMENDATIONS

Among the remaining challenges for the tested DR solutions, the financing of control infrastructures still needs to be addressed, and the technical implementation of certain tested solutions requires a full commitment from the regulator and industry to accept new direct-control standards. Indeed, direct-control mechanisms rely heavily on a well-defined enabling regulatory framework. Another challenge is that financial incentives do not always meet the customers' expectations, considering both the lack of maturity of the flexibility market, particularly in the B2B and residential segments, and the complexity of the offers which are not addressing essential customer needs. In order to reach cost-effective mechanisms, the flexibility products should be designed to allow value stacking, i.e., have sales potential on different market places or through parallel sales channels.. Benefits beyond financial remuneration are still to be explored. DR is indeed an enabling technology for CECs, but it is also the CEC's task to drive the availability of local flexibilities.

The use of flexibility for grid investment deferral seems to lead to the most promising use cases. The latter could translate into a fixed remuneration for the flexibility provider and thereby secure the profitability and foster the development of new flexibilities for use at a local scale.

Data privacy and General Data Protection Regulation (GDPR) rules constitute an important issue for grid optimisation. While the project stakeholders agreed on the importance to strictly respect all data privacy rules, the respective demonstrators showed that access to data and particularly smart metering data is critical, considering that it forms an essential input to grid constraint forecasts and flexibility procurement. For instance, under the current rules the customer consent forms that need to be signed prior to any access to metering data have to specify in a very detailed way all services the data will be used for.

The complexity of those consent forms is too high for residential customers and should be simplified without lowering the level of awareness on how the data are to be used. Besides, accurate forecasting by the DSO on localized portions of the grid is required for flexibility management and led within InterFlex to the complementary deployment of sensors, as the currently applied aggregation threshold to ensure the smart meter data anonymization was not reached. Further investigations are required to evaluate how the rules for data aggregation could be adjusted, while guaranteeing data protection, in order to avoid such additional sensor deployment.



SMART FUNCTIONS & GRID AUTOMATION

Grid automation relies on a set of technologies that can enhance distribution grid management, for example by stabilizing the grid voltage through autonomous power control, by remotely managing distributed generation units and by deploying control boxes associated to smart meters that can contribute to relieving grid constraints.

BUSINESS CASE

The Smart Functions and Grid Automation experimented in the different InterFlex demonstrators aimed at improving the monitoring and control of both power distribution and generation through regulation schemes including reactive and active power flows. The approach evaluated to what extent grid reinforcements could be avoided or postponed, and the DER hosting capacity be increased.

Grid automation was also an enabling technology for the other InterFlex innovation streams, enhancing for example Local Flexibility Markets, Demand Response, and islanding capabilities.

The Swedish and French demonstrators included Smart Functions and Grid Automation elements in order to achieve their microgrid and islanding targets, based on 100% RES supply in Sweden. Such microgrids require several system balancing services for successful islanding where frequency and voltage control are vital. The seamless switching to and from islanding constitutes an automated function with a direct impact on power quality and customer comfort. In the village of Simris in Sweden the automated functions also stretched into residential homes where battery-state-ofcharge dependent Demand Side Management algorithms helped to modulate the power of customer assets. This was done within set boundaries to ensure residential comfort. Similarly, wind and solar resources could be automatically curtailed during islanding, if power output exceeded the consumption and the batteries were fully charged.

The German demonstrator achieved fully automated control of distributed renewable energy resources connected to low voltage networks. The newly developed "Smart Grid Hub" connected directly to the DSO grid control system and served to disaggregate flexibility requests by the DMS. In this architecture the main DMS system is not burdened with the required large number of decisions to be taken when small scale flexibilities are involved. Instead the Smart Grid Hub takes the burden of controlling small flexibilities in response to bulk-requests from the DMS. Use cases that have been investigated include an integrated approach to smart curtailments across voltage levels and dynamic steering of flexible loads in response to price signals or stress on the grid.

The Dutch demonstrator achieved a forecasting model based on historical and real-time asset data which provided autonomous input to the algorithms of the demo's EV charging stations, thereby procuring a source of flexibility and enriching its Local Flexibility Market.

The Czech InterFlex demonstrator combined several Grid Automation technologies and Smart Functions to increase the DER hosting capacity. This included:

- Autonomous active and reactive power regulation (Volt-VAr) in LV networks: smart PV inverter functions - without any communication with the DSO - were tested together with the consortium's inverter manufacturers in order to stabilize voltage levels and thus significantly increase the DER hosting capacity in LV grids.
- Volt-VAr control in MV networks: voltage control functions have been implemented in 5 existing renewable power systems – two small hydro plants, a PV, CHP and Wind Park. The DERs received voltage set points from the DSO's Distribution Management System depending on grid conditions.
- Residential PV systems with storage batteries: the main tested function was the permanent feed-in limitation of active power into the grid which was set to 50 % of the installed PV capacity. The systems were furthermore designed to support the grid by discharging the battery in case of under-voltage, under-frequency (autonomous control) or based on a ripple control signal sent by the DSO through one way simple PLC.

MAIN ACHIEVEMENTS

The French and Swedish demonstrators successfully implemented the control of islanded microgrid operation and assets via an islanding master. Another successfully tested smart function was related to the control of the islanding switch designed to perform seamless MV islanding for enhanced power quality for local customers.

The Czech InterFlex demonstrator successfully increased the distribution grid's DER hosting capacity at close to zero equipment or marginal cost, allowing also to establish recommendations for global replication and large-scale implementation, as well as for an integration of the results in the regulatory framework or grid code. This can also be a valuable contribution to standardize new autonomous functions, for example in the field of EV Smart Charging.

The German demonstrator could deliver the blueprint for the operational integration of grid control and a smart meter infrastructure. This approach enables more flexibility in distribution networks with very low installation costs and delivers efficiency gains in several areas of operation, for example reduced curtailments and improved balancing capabilities.

CHALLENGES & RECOMMENDATIONS

ČEZ Distribuce's work on the autonomous Volt-VAr functions in LV networks and Volt-VAr control in MV networks has already been translated into national grid codes in order to secure smoother integration of the smart solutions in the future.

The implementation of these solutions at a wider scale could avoid massive investments in the distribution grid reinforcements, while most regions are expected to have insufficient DER hosting capacity.

However, some results also need to be adapted to countryspecific parameter settings for autonomous solutions, in order to optimize the specifications that manufacturers need to integrate. Furthermore, it might be necessary to foresee country-specific rules for the activation of PV inverter's smart functions depending on the installation site.

CROSS ENERGY CARRIER SYNERGIES

In the energy world of the past, different energy carriers operated separately with distinct boundaries. In the future, the complementarities of electricity, gas or heat will be a supporting element to provide greater flexibility to the global energy system.

BUSINESS CASE

InterFlex investigated the use of cross-energy carrier synergies to relieve distribution grid constraints in an efficient and cost-effective way. Through sector coupling, InterFlex supported the transition of the energy sector towards the decarbonisation of traditionally fossil fuelbased sectors such as heating and transport, which also helps to facilitate the overall integration of a higher share of renewable energy.

Gateways between networks can be exploited to increase the combined system efficiency and release new flexibilities and thereby reduce grid investments.

Steering of HVAC (Heating, Ventilation and Air-Conditioning) building assets to manage thermal peak demand: In the mornings and evenings, the heat demand is higher than at other times of the day, resulting in peak loads in a district heating network. At the same time, the building temperature often increases due to social behaviour so that there is no real need for extra production. E.ON, in its role as operator of Malmö's heat network, exploited in the Swedish demonstrator the thermal inertia of the building's envelope, i.e., the inbound heat in the building. Heating devices of the buildings (HVAC) could be controlled and the corresponding thermal loads be shifted in time without impacting the customers' comfort.

Coupling of two urban thermal networks to enhance the global system efficiency and provide flexibilities to the electrical distribution grid: E.ON operated a commercial heat pump in Malmö, where waste heat from a data centre was upgraded to a useful temperature and delivered to a local heat network, providing thermal energy to commercial customers. At the same time, cooling was produced and provided to the data centre and surrounding commercial buildings, showing an overall high efficiency. In case of high electricity demand in the distribution system, the heat pump could be switched off, and the buildings and facility could be supplied by conventional district heating, and by using redundant cooling installations. **Use of thermal household storage devices** to provide flexibility to the distribution grid: The efficient use of thermal energy storage to relieve distribution grid constraints was implemented in the French demonstrator Nice Smart Valley and the Swedish demo in Simris. Distributed powerto-heat assets, such as heat pumps and hot water boilers were steered according to DSO's needs. In the case of the heat pumps, the operation of these assets was optimized by considering the thermal inertia of the buildings and household envelopes. In case of a local renewable overgeneration in an islanded microgrid, the surplus energy was used to heat the water tanks, instead of curtailing the RES production (balancing).

Dual-fuel (gas/electricity) hybrid heating systems to relieve distribution grid constraints: In the French demonstrator household and commercial hybrid heating devices were implemented to provide flexibility to the electrical distribution grid. Residential heaters as well as a hybrid roof top unit for large commercial buildings, both containing condensing gas boilers and an electric heat pump, were used during winter demand peaks, when switching from the heat pump to gas, providing reliable remote controlled flexibility in the form of a reduced electricity demand.

Gas-fuelled micro-CHP units to provide additional electric production and thereby flexibility to the grid: Nice Smart Valley experimented an Internal Combustion Engine micro-CHP that produced power and heat thanks to a gas engine coupled with an electrical power generator. Flexibility (electricity production) could be activated according to grid needs.

The gas/electrical flexibilities have the advantage of being reliable, programmable, quick to activate and long lasting. This makes it an interesting type of asset for long-lasting flexible capacity, which is highly valuable for winter peaks or for network incident management. In addition, the tested solutions had no impact on the gas network because of its high capacity; no gas grid constraints exist today, neither are they expected in the near future.

MAIN ACHIEVEMENTS

The InterFlex demonstrators on Cross-Energy Carrier Synergies successfully implemented innovative equipment and IT-solutions, for a global cost optimisation beyond the electric system. For this aim, thermal networks were integrated in order to work side by side with the electric system, for example to absorb DER production peaks. In particular, the Swedish demonstrator in Malmö developed efficient tools for load peak shaving, and market-ready solutions for certain small-scale district heating sectors, thereby sustaining the decarbonisation of the heating sector.

Hybrid residential and commercial assets fuelled by both electricity and gas were tested in the French InterFlex demonstrator and have shown their performance. The gas resource provided easily controllable flexibility as an alternative to batteries or curtailment.

CHALLENGES & RECOMMENDATIONS

District heating constitutes a strong asset for crossenergy carrier synergies where the corresponding thermal networks are in place. However, the latter are not equally well developed in all parts of Europe and still need to be promoted.

Another challenge to be underlined is linked to business and profitability aspects. The driver for enrolment of multi-fuel customers and more globally the incentive for the use of cross energy carrier flexibility will be inherently bound to the price spread between the various sources of energy.

In most InterFlex countries, the flexibility service provider monetizes the flexibility and will manage the risk bound to fluctuating asset profitability.

MULTI-SERVICE STORAGE & ISLANDING

Single-service stationary battery applications still face major economic hurdles. The various battery storage technologies have reached a high degree of maturity whereas most projects are still struggling with cost-effectiveness.

BUSINESS CASE

InterFlex investigated the combined implementation of complementary services in dedicated storage assets in the aim of making the battery a competitive system asset. Combined services covered local grid congestion management, islanding support, customer services such as renewable self-consumption as well as ancillary services.

Islanding of 100% renewable energy microgrids is a specific sub-section of this business case, since batteries remain the central grid forming and supporting element of an islanded system. InterFlex examined the seamless transition between grid-connected and islanding mode, in order to increase the resiliency in specific locations (rural areas, islands), or in response to local initiatives (Local Energy Communities).

The abovementioned economic considerations equally apply: InterFlex explored the combination of several storage services in order to approach the economic break-even.

The implementation of combined services for the use of stationary batteries formed part of the French and Swedish demonstrators.

In the village of Simris in the south of Sweden, E.ON implemented a microgrid able to run in an islanded mode with 100% renewable generation: a wind turbine as main generation, supported by a ground-mounted PV power plant and two stationary batteries (Li-ion and Redox-flow technologies). The central battery system was in charge of the instantaneous balancing of the microgrid in islanded mode (voltage and frequency control). When connected to the main grid, the batteries offered ancillary services to the TSO including constraint management, peak lopping, and voltage control.

In the French demonstrator Nice Smart Valley, two different sites were equipped with batteries to test the multi-service approach, while depending on the nature of the service, either the DSO itself or market players (ENGIE) were operating the respective batteries. On Sainte Marguerite, a small Mediterranean island near the coast of the French Riviera, Enedis, ENGIE and Socomec implemented a microgrid with islanding capacities based on two batteries. A first battery was remote-controlled by Enedis from its Regional Control Centre and served to guarantee the electric system stability in case of islanding. A second battery was deployed by ENGIE primarily to provide self-consumption to local customers, whereas the battery also served to support the DSO's battery during islanding operation.

In Carros, a municipality in the metropolitan area of Nice, Enedis and ENGIE shared the exploitation of a single battery for grid constraint management and collective selfconsumption respectively.



Simris microgrid, Sweden

2 local microgrid batteries operated by the DSO:

- 1. Seamless MV islanding by the DSO to reinforce the resilience of areas where power supply is critical
- Citizen Energy Community: maximizing village selfconsumption while the grid serves as a backup - vrtual islanding & active customer involvement (P2P) to reduce battery sizing
- 3. Ancillary services in grid-connected mode

Sainte Marguerite Island, France

2 interconnected Battery storage systems: one microgrid-forming battery (owned & operated by the DSO for the demonstration):

- Remote-controlled seamless MV islanding system for the DSO to ensure the continuity of supply in areas were no backup is provided by the grid
- Contractual exploitation agreement with an aggregator for storage monetization outside islanding periods - ancillary services

and one commercial battery (aggregator asset)

- 1. Grid-support to the DSO during islanding periods
- 2. Remote steered operation by the aggregator for ancillary services and markets
- 3. and local self-consumption contracts

Carros, France

Shared ϑ alternating use of a single battery by both the DSO and aggregator:

- Local use of the battery by the DSO to relieve peak loads on the distribution grid
- Battery state of charge optimisation by the aggregator to maximise the customer benefit in a collective selfconsumption operation: several customers make use of the same centralised battery

MAIN ACHIEVEMENTS

Multi-service storage and islanding can help to avoid the GHG emissions of fossil-fuelled gensets, by replacing them with local renewable energy that can be used to ensure electricity supply in case of an incident on the main network. Enedis and ENGIE explored potentially innovative business models including the shared use of a common battery for both commercial and grid services.

Among the achievements of the InterFlex demonstrators on multi-service storage and islanding shall be cited:

- Successful technical multi-service & multi-battery storage operation through IoT/Cloud remote control
- Multi-service offers and potential value stacking (collective self-consumption, ancillary services, local grid support)
- Multi-service & multi-battery contractual framework between regulated and market players (DSO-aggregator)
- Seamless MV islanding for enhanced resilience
- Microgrid operation in Island mode: power quality and grid stability (frequency, voltage control) thanks to advanced inverter functions
- Electrical safety (protection management during islanding)
- Sizing method to design an island system, including the evaluation of customer flexibilities to reduce the size of central batteries

CHALLENGES & RECOMMENDATIONS

Remaining challenges include the following elements:

- Despite considerable progress, most stationary battery storage business models are not yet economically viable. However, battery storage system costs are constantly decreasing and there are potential cost savings bound to adapted grid connection fees and reduced tax schemes. Moreover, the price volatility on global markets is expected to increase in the future, thereby fostering the development of storage systems.
- Matching business-related battery services generally leads to technically complex and expensive solutions, particularly when dealing with different power and energy characteristics and diverging requirements regarding the time response of the power electronics.
- Few off-the-shelf battery system solutions exist, which limits scalability in general and economies of scale in particular.
- Batteries and battery-bound flexibilities will be essential constituents of tomorrow's energy system. Important national and local administrative hurdles have been experienced during field implementation (risks, authorizations, environmental & fire protection) and should be lowered considering the interest of the batteries for the energy transition.
- Similar conclusions apply to the administrative authorizations needed for photovoltaic installations, hindering the further development of local renewable generation and associated business models.





INTERFLEX WORKPACKAGE BY WORKPACKAGE

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TOWARDS EXPLOITABLE ESULTS AND FUTURE-PROOF SOLUTIONS

A dedicated transversal work package, so-called WP3, aimed at gathering and consolidating the solutions and results from the six InterFlex demonstrators in order to achieve exploitable results and future-proof solutions.

WP3 focused on four main streams:

- 1. Interoperability analysis: this analysis specified the possible architectures, the relevant standards and the resulting interoperability and cyber-security requirements.
- 2. Laboratory tests: these tests successfully assessed and compared the relevancy and the performance of several functional and telecom architectures with respect to two use-cases: congestion management and voltage support.
- 3. Cost-benefit analysis: this appraisal of the demonstration use cases from an economic perspective showed uncertainties in the investment life time and the long term benefits.
- 4. Scalability and replicability analysis: this analysis assessed and highlighted the potential bottlenecks for proper scale up and replication of the project results, from functional (grid operation), ICT and regulatory viewpoints.

In addition, WP3 contributed to disseminate and promote the project results in particular through:

- The contribution to BRIDGE, a European initiative gathering a large number of EU-funded Smart Grid projects
- The definition and publication of an interoperable API for flexibility, including an open source reference implementation and a conformance test suite



| WP3 | Impact and deployment analysis of the innovative solutions | |
|------------------|---|--|
| PROJET SCOPE | Support the demos on interoperability and cyber-security topics | |
| | Identify architecture patterns and study cross-demonstrator ICT interoperability | |
| | Evaluate the technical impact of scaling-up and replicating a solution, to identify | |
| | drivers and barriers | |
| | Contribution to the ongoing cross-project BRIDGE initiative | |
| | Demonstrate and showcase interoperability and interchangeability in laboratory | |
| | Define and specify interoperable APIs for offering flexibility | |
| | Cost/benefit appraisals of the demonstrated use cases | |
| PROJECT PARTNERS | RWTH Aachen University - work package leader | |
| | Austrian Institute of Technology | |
| | - Trialog | |
| | All other project partners (analysis of all demonstrators) | |
| | Scientific: | |
| PERSPECTIVES | Propose a methodology for interoperability analysis with cyber-security | |
| | constraints | |
| | Cross-demo analysis of ICT architectures and ICT clustering (upper bound: | |
| | Market driven & lower bound: direct DSO activation/ Automation) | |
| | Methodological interoperability laboratory testing based on the EU Joint | |
| | Research Center approach | |
| | - State-of-the-art of barriers, approaches and recommendation for data handling | |
| | in smart grid projects | |
| | Open-source reference implementation of API | |
| | Incorporating technical, economical, and regulatory issues while scaling and | |
| | replicating demo solutions | |
| | Technological: | |
| | Identification and knowledge of relevant standards for flexibility, storage, smart | |
| | appliances (USEF, SUNSpec, SAREF, OneM2M,) | |
| | Provide recommendations for future interoperable implementations | |
| | Economic/competitive: | |
| | Quantification of the long-term benefits of the innovation streams in accordance | |
| | to the proposed JRC methodology | |
| | Addressing the regulatory dimension of the business models | |
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Being at the forefront of the German energy transition Avacon has been challenged by a fast growth of decentral generation. Particularly in rural regions grid operators are dealing with low- and medium voltage networks that are exporting a significant surplus of locally produced energy.

This influx of decentral generation has been a challenge for the existing networks, to an extent where investments in additional network capacity cannot always keep up with the growth of decentral generation. A well-known fact is that today large amounts of renewable energy have to be curtailed in times of high stress on the grid to maintain safe and secure network operation.

Flexibility could help DSOs to reduce curtailments, by implementing strategies that allow for more precise control of generation and a local granularity of control signals. But how could DSOs implement these new strategies?

InterFlex has allowed to develop a control platform that makes it possible for DSOs in Germany to directly connect to smart meters in households. This enables DSOs to identify critical situations earlier and better. It also allows direct control of LV-connected generation through the smart meter. With this, DSOs can carry out inevitable curtailments on a smaller regional scale and with a higher granularity and precision.

In addition, this new technology, dubbed the "Smart Grid Hub", also enables a new approach for DSO-control of flexible loads. During the cold season electrical heating accounts for a large share of network load and this represents a potential source of flexibility. The Smart Grid Hub enables DSOs to carry out existing double-tariff switching via the smart meter infrastructure.

And with this, advanced strategies for the management of flexibility become viable. For example, the double-tariff scheme in place today operates at fixed hours, activating all heating customers at once. The Smart Grid Hub allows DSOs to switch each customer individually and to implement dynamic switching. This leads to a better distribution of the load during peak hours and enables additional use cases that could potentially lead to a reduction in grid balancing costs.

The Smart Grid Hub is designed to be a part of the DSO grid control with a direct ICCP-interface to the DSO SCADA and ADMS. It also integrates seamlessly with the national smart meter framework in Germany and creates a direct connection between DSO and LV connected customers.

Lüneburg, Germany LOCATION **PROJET SCOPE** 60 private households offering flexibility (PV, storage heaters, heat pumps) equipped with smart meters and connected control device Development, implementation and field test demonstration of Smart Grid Hub, fully integrated with grid control and smart meter backbone. - Avacon AG **PROJECT PARTNERS** – Avacon Netz GmbH — E.Kundenservice Netz – E.ON Digital Technology IMPLEMENTED USE CASES UC1: Decentral Energy Resources Curtailments in Low Voltage networks UC2: Ancillary services provided by low voltage connected flexibility - UC3: Demand response of LV connected flexibility **DEMO SPECIFICS & ACHIEVEMENTS** First demonstration of DSO direct control of low voltage connected customers via smart meter in Germany Successful demonstration of alternative ways to exert control in LV networks Powerful data collection capabilities and improved network visibility

avacon

THE CZECH DEMONSTRATOR



ČEZ Distribuce as a European Distribution System Operator (DSO) with more than 3.6 million customers prepares for the expected future development of renewables and charging stations in the Czech Republic. The official government document called Czech National Action Plan for Smart Grids published in 2015 by the Czech Ministry of Industry and Trade presents a reference scenario of the expected future development of renewables where PV installations have a major share. In order to find a cost-effective solution for renewable energy integration, reliable power supply and high power quality for customers, ČEZ Distribuce focused on testing innovative smart solutions with a strong potential for large scale development under the InterFlex project. The Czech demonstration project was located in several areas in the Czech Republic where ČEZ Distribuce operates its distribution grids. The demonstration was focused not only on one area in order to prove replicability and interoperability of designed solutions and was divided into 4 use cases:

- UC1: Increase the hosting capacity for renewables in LV distribution grids through smart PV inverters equipped with autonomous Q (V) and P (V) functions
- UC2: Increase the hosting capacity for renewables in MV grids through Volt/VAr control (control of reactive power based on voltage set points)
- UC3: Smart EV charging (autonomous charging power curtailment in case of under voltage or under frequency)
- UC4: Smart energy storage (autonomous discharging of batteries in case of under voltage or under frequency)

The Czech demonstrator focused on the implementation of solutions which are not yet common in distribution grids, but which have a strong potential for future roll out. The tested solutions cover the most urgent challenges for DSOs: increasing the renewable energy hosting capacity of the grid and implementing EV charging stations and energy storage. Beyond the technical developments, the Czech demonstrator also aimed to propose grid codes and standard updates in order to secure future smoother integration of selected smart grid solutions. The demonstration confirmed the expected increase of the DER hosting capacity in LV and MV grids, as well as the added value of Smart EV charging and Smart energy storage concepts to introduce increasing flexibility in the distribution grids.



THE DUTCH DEMONSTRATOR IN EINDHOVEN

The partners of the Dutch InterFlex demonstrator were Enexis, TNO and Elaad. Enexis is the second largest DSO in the Netherlands, TNO is a Dutch research and development organisation and Elaad is a knowledge centre on smart mobility. The Strijp-S area in Eindhoven is one of the focus areas within the city for design & technology innovations.

The goal of the demonstration was to explore how a DSO can use flexibility for a cost- effective grid infrastructure. To do this, the following set of project goals was formed:

- Use flexibility for grid management purposes
- Scalable solution & architecture
- Design and implement functional & business layers: flexibility trading
- Implement an open market architecture for flexibility
- Determine the merit order for flexibility.

To achieve these goals, a model was designed to describe the systems and mechanisms on operational, enterprise and market levels, which enable the provision of ancillary services to the distribution grid via a flexibility market.

The model aimed at testing:

- Technical innovations on ICT systems and communication,
- Organizational innovations regarding market mechanisms, contractual agreements and business models.

The system architecture was based on modules that were interconnected through a set of open interfaces and protocols. These subsystems facilitated the different role attributions and functions that structured the open flex market. The systems were developed or adapted together with different market parties – technical and commercial aggregators - who see the deployment as a business opportunity.

In the model different roles and functions were described in relation to the flexibility market model.

Roles:

- Distribution System Operator (DSO)
- Commercial Aggregator (CA)
- Local Aggregator (LA)
- Charge Point Operator (CPO)
- DER owner

Functions:

- Grid Management System (GMS)
- Flexibility Aggregation Platform (FAP)
- Local Infrastructure Management System (LIMS)
- Charge Point Management System (CPMS)

Eindhoven Strijp-S area, The Netherlands LOCATION Deployment of a stationary battery for flex delivery. **PROJET SCOPE** Installation and deployment of smart charging EV stations for flexibility. Building ICT systems based on open protocols for delivering flex on a market place model. - Enexis - demo leader **PROJECT PARTNERS** - ElaadNL - Jedlix – Sympower – Croonwolter&Dros IMPLEMENTED USE CASES - UC1: Enabling ancillary services, congestion management, voltage support for PV integration using centralized, grid-connected storage systems to improve grid observability of prosumers, promoting batteries in multi-service approach. - UC2: Enabling the optimal activation of all available local flexibilities offered by the locally installed EVSE's for congestion management. UC3: Validating technically, economically and contractually the usability of an integrated flex market based on a combination of stationary battery storage and EV chargers. **DEMO SPECIFICS** Forecasting algorithms for DSO Interflexperience game on flexibility awareness: http://interflexperience.eu Research scenarios for investigation of different flex situations WEBSITE Demo website for customer recruitment and information:







E.ON in Sweden, as a DSO and heat network operator, is focused on renewables, energy networks and customer solutions, following its conviction that these foundations are the building blocks of the new energy world. The Swedish Energy market and market players, especially the DSOs are currently facing challenges, e.g. congestion management, curtailment, peak shaving, with only some local and limited services available today. At the same time, there is an increasing need for flexibility services and for the introduction of a new market for energy communities. The Swedish InterFlex team set out to achieve the following objectives:

To demonstrate as an electricity and heat network operator the optimal use of a local energy system flexibility arising from local heat production (incl. power2heat) alternatives and consumption (Use Cases 1-2).

The use case 1 demonstration, located in Malmö in southern Sweden, investigated synergies between different energy carriers, to provide flexibilities through the storage capacity of heat networks and the thermal inertia of buildings. E.ON exploited in the Swedish demonstrator the thermal inertia of the building's envelope, i.e. the inbound heat in the building. Heating devices of the buildings (HVAC) could be controlled and the corresponding thermal loads be shifted in time without impacting the customers' comfort. This increases the flexibility of the system making it more resilient, which is an important feature as intermittent power increases in the national mix.

E.ON also operated a commercial heat pump in Malmö to increase the energy efficiency at a local energy centre. The energy centre contains a substation for district heating, cooling machines with cooling towers. The heat pump was utilizing waste heat from a data centre to provide heating to commercial customers and at the same time produced chill to the data centre to decrease the need of cooling machine operations. In case of high demand for electricity the heat pump could be switched off, and the buildings could be supplied by the conventional district heating and by cooling installations. This enhanced the overall system efficiency and provided flexibility to the electrical distribution grid. If a large number of heat pumps are aggregated, the platform will be able to offer substantial volumes of capacity to the DSO. The demonstrator provided evidence that there will be a large market for thermal flexibility.

| | Malmö, Sweden |
|-------------------------------|--|
| | |
| PROJET SCOPE | Development of technology and business models for efficient cooling and |
| | heating solutions with cross energy carrier synergies |
| | Development of a scalable platform where customers demand can be visualized and managed in an automatic or manual manner |
| | Development of alarm functions |
| | Possibility to visualize savings and contract models to share savings |
| | Enable aggregation of heat pumps and enable participation in a future marketplace |
| | - Peak shaving for the district heating system by using building inertia to avoid |
| | activation of peak load boilers and enable distribution of district heating to remote parts of the grid |
| | - Building a demonstration which shows how the system works and which allows |
| | to explain benefits and advantages |
| PROJECT PARTNERS | - E.ON Sverige - demo leader |
| | - MKB |
| | — EON Fastigheter |
| | — Medicon Village |
| | Developed by: Glaze, Block Zero, AF, Skillfully, Sweco, Kvantum |
| | - RWTH Aachen University |
| IMPLEMENTED USE CASES | Power control and smart net in district heating |
| | Total efficiency and enhanced COP |
| DEMO SPECIFICS & ACHIEVEMENTS | — Power control (district heating) |
| | Integration of an energy system with BEMS from various suppliers |
| | igsquire – Possibility to add new customers to the platform and visualize the connection ir |
| | map structures |
| | Visualization of power and heat consumption in correlation to savings |
| | Peak shaving |
| | Digital district heating |
| | Customer engagement |



THE SWEDISH DEMONSTRATOR IN SIMRIS

E.ON in Sweden, as a DSO and service provider, aimed at demonstrating that a DSO is able to actively observe and in a smart way use the rural microgrid's ability to respond to merit orders for flexibility. In Simris, E.ON also tested a flexibility market and performed simulations of a Peer-2-Peer market based on real values (Use Cases 3-5).

The demonstration, located in the village of Simris in southern Sweden, encompassed operating a local microgrid with islanding capability and the ability to power the system by using only renewable energy sources and using distributed Demand Response assets, placed at the local customer households.

Operating the local energy system and the microgrid within it, E.ON showed that a specific combination of power electronics, storage and renewables allowed to achieve stable system operation. Additions like Demand Response have been included and aided to improve the system flexibility and thereby the system resilience based on the high penetration of renewables, at the same time, new challenges have been introduced with respect to customer engagement.

The customers were participating with their own local residential energy resources or appliances, such as heat pumps, PV installations, batteries and hot tap water boilers. These assets were controlled by E.ON with the help of demand response, depending on the current needs in the local energy system. There has also been a platform where E.ON has implemented a flexibility market for active customers, based on their flexible contribution of energy resources. The customers have joined the flexibility market through a separate agreement, called Flex Agreement, for which they individually received a remuneration based on their actual contribution. The Peer-2-Peer market has been simulated from a Collective Self-Consumption perspective, all done with the customers in focus and based on real operational data.



| LOCATION | Simris, Sweden | | |
|-------------------------------|--|--|--|
| PROJET SCOPE | Development of a Local Energy System with islanding capabilities and Demand Response Business models, Flexibility and Peer-2-Peer market concepts Customer engagement | | |
| PROJECT PARTNERS | E.ON Sverige - demo leader Coromatic, Lumenaza, Encorp, Loccioni, Enerox, Iconics, Netcontrol, Holtab, Fronius, NIBE, Ngenic, Comsel, M Climate RWTH Aachen University | | |
| IMPLEMENTED USE CASES | Active power and frequency control, peak reduction, microgrid, balancing Active customer participation, recruitment rate, shifted demand, customer energy awareness Apparent power control, improved islanding, activation of flexibilities | | |
| DEMO SPECIFICS & ACHIEVEMENTS | Seamless transition to and from islanding, of a MV microgrid with high share of renewables, with a battery system without a high- speed transfer switch (economic optimization) Frequency-controlled operation of a redox flow battery Battery SoC-controlled DSO-steering of customer assets via Demand Response Development of Demand Response solutions for steering of customer assets: retrofitted and new heat pumps, water boilers, residential batteries Demand Response solution via Smart Meter communication Simulation of a Peer-2-Peer market from a collective self-consumption perspective based on real values Customer flexibility solution with a visualisation tool Customer engagement with proven increased citizen satisfaction | | |
| | | | |



THE FRENCH DEMONSTRATOR NICE SMART VALLEY

Context

Electric distribution networks are undergoing many changes: the increasing development of renewable energy generation and the evolution of electricity end-uses including electric vehicles.

In order to anticipate these changes, Enedis has formed a project consortium for the French InterFlex demonstrator called Nice Smart Valley, with the participation of GRDF, ENGIE, EDF, Socomec and GE Grid Solutions to demonstrate and define new solutions and business models fostering the energy transition.

Nice Smart Valley focused on three main objectives:

- Implement and analyse mechanisms and a local flexibility market for the DSO to solve electrical grid constraints.
- Find viable business models for stationary battery storage based on a multi service approach combining ancillary services, electrical grid constraint management, self-consumption and cloud storage.
- Provide automatic MV islanding based on a storage battery system in order to provide security of supply and resilience as an
 additional service for the DSO in areas where power supply is critical.

Test locations and principles

The demonstrations were located in different areas:

- Lérins islands: The islanding demonstrator has been implemented on the Lérins islands located at a short distance of the city of Cannes on the French Riviera. The islands comprise 5 secondary substations supplying 57 customers. Two storage systems have been installed by Enedis and ENGIE on one of the islands, Sainte Marguerite, in order to demonstrate the technical feasibility of running the island grid independently from the continental grid. Islanding has been performed seamlessly by means of a specific MV-switch, with no power cut for local customers. The islanding operation has been remotely steered from the DSO's regional control room. The electrical security for people and goods has been guaranteed through a specific protection scheme. During non-islanding periods, storage systems were operated by ENGIE to monetize them on several value pockets to make those investment as profitable as possible.
- Metropolitan area of Nice: Aggregators have recruited residential and industrial flexibility in the close vicinity and in two villages in the north of Nice. The DSO simulated electrical grid constraints leading to a flexibility requests to aggregators. The latter replied with flexibility bids to the DSO via a local market place. Selected flexibilities have been activated by the DSO and the impact has been evaluated. Forecasting tools, used to predict and anticipate electrical grid constraints, have also been developed and assessed.
- A third storage system has been installed in Carros in the Var plain and participated in the flexibility market. It also served to simulate a multi-service approach (cloud storage, flexibility, ancillary services, etc.) to economically maximize the value of the storage asset.

| LOCATION | France: Carros - vicinity of Nice, several locations in the north of Nice, Lérins islands – Cannes. Around 200 flexible customers distributed over the 3 demonstration areas (from behavioural residential, to remote-controlled industrial flexibilities) 12 dual fuel hybrid systems (10 residential hybrid boilers, 1 CHP in commercial building and 1 hybrid rooftop on a commercial building) 2 battery storage systems installed on Lérins island connected to the LV grids 1 storage system installed in Carros connected to the LV grid 1 customer for V2X experiments | |
|------------------------------------|---|--|
| PROJECT CUSTOMERS AND EQUIPMENT | | |
| PROJECT PARTNERS | Enedis – demo leader GRDF ENGIE EDF Socomec GE Grid Solutions | |
| IMPLEMENTED USE CASES | Provide seamless resilience islanding on the MV level, while exploring viable microgrid models involving the DSO and market players (UC1) Implement stationary battery storage based on a multi service approach. Develo contractual principles to share the use of a single storage system between a DSO and an aggregator. Explore viable business models (UC2) Simulating a cloud storage offer optimizing energy community self-consumption using real values for economic assessment (UC2) Implement and analyse mechanisms and a local flexibility market for the DSO an aggregators to solve electrical grid constraints (UC3) Test a bi-directional electrical vehicle to support power supply to an office building in case of constraints in the electrical system. | |
| WEBSITE | <pre></pre> | |



INTERFLEX CONSORTIUM MEMBERS

InterFlex combined among its consortium members the key competences along the value chain of the distribution grid and electricity markets.

| 5 EUROPEAN ELECTRIC DSOs | Enedis E.ON Avacon ČEZ Distribuce Enexis | Distribution System Operators in charge of the project's demonstrators |
|--------------------------------------|--|--|
| 1 GAS DSO | GRDF | Solution provider for gas- electric hybrid assets |
| 2 FLEXIBILITY SERVICE PROVIDERS | EDF ENGIE | 2 retailers-aggregators |
| 1 RENEWABLE ENERGY DEVELOPER | ČEZ Solarni | Installation of solar systems and batteries |
| 4 EQUIPMENT MANUFACTURERS | Schneider Electric Siemens Fronius Socomec | Smart inverters, power electronics and smart grid solutions |
| 2 IT SOLUTION PROVIDERS | GE Grid Solutions Siemens | Development of forecasting tools and optimization algorithms |
| 3 RESEARCH CENTERS | RWTH Aachen University AIT TNO | Scientific and research institutions |
| 1 KNOWLEDGE AND INNOVATION CENTER | ElaadNL | EV development and related services |
| 1 EXPERT SME | Trialog | Interoperability, cybersecurity and ICT scalability |
| 1 CONSULTING COMPANY | Accenture | Dissemination of the project results |

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