#8 Spotlight on the Network Energy Manager

Type of solution
• Information system • Process
Work Stream considered
• Active Demand • DER integration • LV Innovation
Location / Topology (with regards to distribution grid)
• HV/MV Substation • MV • LV • DER • Other Centralized system (calculations, information system)
Thematic(s)
• Grid Monitoring / state estimation • Active demand / DSM • DER Integration / increased grid capacity
Use Case(s)
• Peak demand reduction • Integrate massive PV production on LV network • Encourage resident to adopt smarter habits according to network state
Key figures
• Alleviating grid constraints through Demand Response (DR) and Energy Storage flexibilities • The NEM: microgrid information at the operator's finger tips • NEM functional overview: Managing microgrids using a flexibility marketplace • TSO and DSO user interface examples – bringing Distributed Energy resources situation awareness to operators.

Table- 14 – Technical table of the Network Energy Manager implemented in the Demo6

Introduction

The **NEM (Network Energy Manager),** developed by GE, is the software component in the heart of Demo6. This is a set of applications developed by GE and used by the **DSO** (ERDF) to achieve the objectives of Demo6. It allows to perform D-1 planning, MV an LV power flow calculation, exchanges between the **DSO** or **TSO** and the flexibility suppliers (**aggregators**) and real time supervision.

GE has also developed the infrastructure of supervision and management of network storage systems, which is presented in a spotlight dedicated to network storage (S2)

Objective and technical requirements

Context

Demo6 focuses on the role of microgrids in enhancing system reliability and congestion management, while being interconnected with the main grid. As the brain behind the microgrids, GE is implementing the **Network Energy Manager (NEM)**. The **NEM**, using solar generation and load forecasts, tests a new model of interactions between different energy actors: consumer, commercial **aggregators**, battery aggregator, **Distribution System Operator** (**DSO**) and **Transmission System Operator (TSO).** The **NEM** consists of a **state-of-the-art**, **cyber secured IT platform** that organizes a **market mechanism for localized flexibility**. It brings together actors in their role as **flexibility aggregators** for their **prosumers** with the grid operators (**DSO** and **TSO**) that buy **flexibility** for operating their grids. The **flexibility** offers, proposed by **aggregators**, allow **mitigation of network grid constraints** such as over voltage and backfeed on the distribution grid in summer or alleviation of circuit overload during winter peak load situations.

Figure 100 - Alleviating grid constraints through Demand Response and Energy Storage flexibilities

A highly innovative solution

The **NEM** within Demo6 introduced several innovations:

- Enabling the operator to take corrective actions to alleviate grid constraints when and where they occur, based on real-time situation awareness and look-ahead visibility.
- A unified platform enabling a fully transparent mechanism for system operators to contract and activate flexibility services provided by various types of **aggregators** (residential, commercial & industrial, batteries).
- A high-performance platform providing high level of automation for actors, business processes and **network constraints** detection.

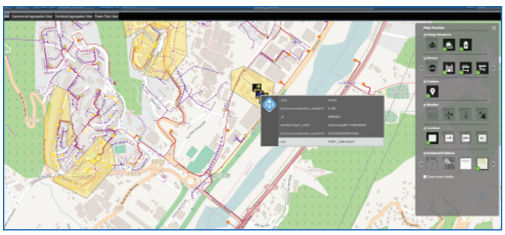

Figure 101 - The NEM: microgrid information at the operator's finger tips

Development and implementation

From concept to real-life experiments

Since the **NEM** concept's inception, the goal has always been to demonstrate through real-life experiments the value added by interconnecting various energy actors to leverage the **DER** and load **flexibility** as an alternative to more traditional strategies such as **grid reinforcement** when operating the grid in the presence of **high-intermittent renewable resources**:

- Understanding the monolithic distribution grid as interconnected public utility owned microgrids, that can be reconfigured to alleviate forecasted grid constraints is the most efficient way.
- Large diversity of use: load shifting during winter peak periods, distribution grid constraint management following a massive deployment of PV, islanding of a single microgrid.
- Moving from day-ahead to a closer to real-time (intraday) operation (including connection to real-time data feed from meters).
- Large diversity of **aggregators** and DR response.
- Network battery scheduling and operation.
- End-to-end connection of IT systems enforcing high level of cyber-security with fully automated interfaces.

Architecture

The **Network Energy Manager** provides an integrated **flexibility** marketplace for the **TSO** and **DSO** to specify their **flexibility** needs to solve their respective grid operational constraints. These needs can be automatically computed by the **NEM** based on renewable production forecasts and individual load forecasts. The **NEM** also provides a portal for various **DER** and **flexibility aggregators** to offer their **flexibility** services to satisfy the requests. As a result, the **NEM** performs a global optimisation to address needs in the most economical way while still enforcing the technical constraints. This fully automated process notifies the **aggregators** of their awarded **flexibility** for implementation and activation for demand response, load shifting or storage device dispatch.

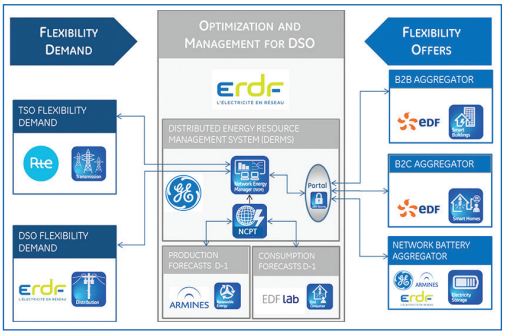

Figure 102 - NEM functional overview: Managing microgrids using a flexibility marketplace

Deployment

The **Network Energy Manager** is deployed in the data center of ERDF interconnected with the IT systems of the **aggregators** over the Internet. Operated by ERDF, it analyses the network conditions in the Carros region on a daily basis to identify situations where corrective actions can contribute to reduce grid constraints.

One day in Demo6

A typical operating day in Demo6 is scheduled as follows:

- *Before 11:00 AM:* **TSO** and **DSO** determine their required power needs. The latest weather forecast and metered data are used to forecast the individual loads and PV production in each microgrid for the next day.
- *Until 1:00 PM*: The **NEM** determines the power requests and publishes them for **aggregators.**
- *Until 3:00 PM*: Aggregators re-optimize their asset portfolio and post their **flexibility** offers.
- *Until 3:30 PM*: the **NEM** matches **flexibility** demand and offers. The operators can either manually select what they need or ask for fully automated selection.
- *At 6:00 PM*: All aggregators are informed if their **flexibility** offers have been reserved.
- During the delivery day **flexibility** is called by the grid operators when needed. **Aggregators** adapt the load of their assets accordingly.

Figure 103 - TSO and DSO user interface examples – bringing Distributed Energy resources situation awareness to operators.

Technical results

- Deployment of the **whole architecture** in the IT environment of a leading **DSO** in Europe.
- **Connection with the aggregators** fulfilling the **cyber security requirements** of ERDF.
- Operation of the platform **since January 2014**, running seasonal winter and summer experimentations. Regular update of the distribution grid using **CIM** export from ERDF
- Process in place to register **flexibility** by aggregator and metering point, followed by the publication of defined commercial locations by ERDF to **aggregators**.
- **Fully automatic process** of the **NEM** control loop without required operator interaction for the summer use case.
- Deployment of a DSO UI allowing to monitor the distribution network, the **DER** forecasts and production and the **flexibility** market process
- Deployment of a **distributed control architecture** for effective **distributed network resources management**

Conclusion and key messages

• **Local flexibility market**
The **Network Energy Manager** (**NEM**) was a cornerstone for the setting up of the local **flexibility** market, putting in place a **structured, reliable, non-discriminatory** and **transparent process**, which allowed all the stakeholders to have a clear set of rules to guide their participation in the **flexibility market**. The **NEM** structures the business processes into **steps** (also called market gates), handles the **information exchange** efficiently by relying on standard messages and calculates optimal solutions for **flexibility** requests solving related network constraints by **Commercial Location**. The operation of the **NEM** by ERDF allowed the execution of the seasonal demonstrations of Demo6 use-cases since the winter 2013/2014 experimentation.

• **Network Battery Aggregator (NBA)**
The **NBA**, operated by ERDF, was integrated in the **NEM** IT environment for the sake of simplifying its implementation. Nevertheless, the designed architecture can be implemented in an independent actor's enterprise IT. The implemented architecture provides the ability for an aggregator to **operate a set of network batteries in an efficient way**, with minor supervision and taking into account the physical and operational constraints of the batteries. Frequent runs of the calculation engine allows the aggregator to ensure a resilient scheduling of the resources on a time horizon from several hours to two days, taking into account any unexpected event as soon as occurred. The NBA applications went through several stages of implementation, being fully implemented in the summer 2015 experimentation.

• **Business processes automation**
Due to the wide responsibility perimeter of **DSO**'s local operating teams, it would be time-consuming for them to analyze by themselves the local needs and to validate each steps of the local **flexibility** mechanism, substation by substation. The handling of requests to the **flexibility** market has been highly automated, from the network constraints prediction to the aggregator's flexibilities reservation and activation. This allows the operators to monitor large areas of the network and guarantee that the necessary actions are undertaken. This requirement was fully achieved and evaluated by the **DSO**.

• **DSO-User Interface (DSO UI)**
This specialized user and operator interface allows the **DSO**'s operators to monitor the state of the network as well as the status of the **flexibility** market process. The **DSO** is also informed of forecasted constraints in the network, while being able to place **flexibility** requests in the local market. This interface has been designed following the **DSO**'s operator feedback to have a more user friendly tool to operate in the local **flexibility** market. The second version of this interface was successfully deployed during the summer 2015 experiment.

• **Standards and protocols**
One of the goals of the demonstrator was the use or adaptation of existing standards and protocols. This goal was fully achieved with the broad use of the following standards or protocols:

• **SGAM (Smart Grid Architecture Model) standard**, used to describe the global Demo6 Architecture

• **CIM/XML standard** was used to support the exchange of static network description data between different partners

• **ENTSO-E Reserve Resource Process (ERRP) standard** was used for market players to exchange information for **flexibility** tendering, bidding and activation

• The exchange of data between the **NEM** and the **MCU** (data metering, batteries information, batteries' activation plans) was made using a partial version of the **OpenADR2.0b standard** (over XMPP)

• In microgrid, several protocols were used to communicate with resources, such as the batteries inverters or the tap-changer: I**EC104, Modbus, OPC**

• **XMPP protocol** was used in order to securely exchange structured information close to real time between market participants, the **NEM** or resources

Demo6 has made it possible to use smart meters to develop innovative smart grid solutions. Smart meter-based smart grid solutions are particularly promising given that these meters will equip 90% of French customers by 2021 (source: ERDF Linky).

In Demo6, the smart metering system has been used to provide services to:

• end customers, with remote meter reading for billing purposes and daily monitoring of their consumption

• **aggregators**/suppliers, by providing the load curves of participating customers, along with price incentive and usage control features

• grid managers, for better oversight of the energy flows on the grid

Collecting these extensive amounts of data and sending commands via the smart metering system requires the installed pool of equipment to be supervised on a daily basis to guarantee a satisfactory service level. The service levels obtained in the Demo6 project – whether for data collection or sending commands – are around 95%. It should be noted that, in the NICE GRID project, the Linky smart meters installed are the same ones used in the tests run in Lyon and Tours (stage 0).

Appendix

To go further

Document	Topic
dD6.7	Technical results (•2 and 3.5)
dD6.9.1	Key messages (•2.5-2.6-2.7)
dD6.9.3	Conclusions (•2.4 and 4)

Glossary

Notion	Definition
Aggregator	The aggregator contracts with consumers/prosumers to modify their load or generation. The extent to which the load/generation can be modified constitutes its Flexibility, which it aggregates to create a block of flexibility to be offered to buyers (DSO and TSO) through the NEM. It can dispatch resources such as heaters, water heaters, storage, clients social beahaviour or any other dispatchable resource (residential, commercial or industrial).
CIM Format	CIM or Common Information Model is a data exchange model allowing application software to exchange information about an electrical network.[
DER	Distributed energy resources (DER) are smaller power sources that can be aggregated to provide power necessary to meet regular demand. As the electricity grid continues to modernize, DER such as storage and advanced renewable technologies can help facilitate the transition to a smarter grid.
Distributed Resource Energy Management System (DERMS)	Decision support system dedicated to active DER integration and control, providing facilitation services between the network operators, the commercial aggregators (suppliers , others) and the distributed flexibility resource devices.
DSO	Distribution system operator (DSO) means a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system. In France, ERDF is operating 95% of the distribution grid (medium and low voltage grid)
Flexibility	A flexibility is a mean to modify (increase or decrease) a load curve, at client or network level, in order to solve grid constraints (power or voltage).
Grid constraints	They are two types of grid constraints: power and voltage constraints. Power constraints appear when the current exceeds the capacity of existing cables. In the low voltage grid, the injection/ withdrawal of active power raises/ lowers locally the voltage: a voltage constraint appear when the voltage is close to the boundaries defined by norm EN50160, i.e. Un +/- 10%, with Un=230 V
MCU	Main controller which communicates with the NEM and the distributed network resources. It has as main functionalities: metered data and resources data collection and upload to the NEM; resources supervision and control (both manually or through NEM's program reception). It also has the capacity to locally store information and to work autonomously if the connection with the NEM is lost
NBA	The Network Battery Aggregator is an aggregator integrated in GE's platform and developed by ARMINES. It is in charge of aggregating grid batteries in ordre to respond to flexibility offers. It prepares offers to the NEM and schedules ofr the storage systems
Network Constraints Prediction Tool (NCPT)	Component of NEM for look-ahead distribution power analysis and detection of incoming constraint violations on Distribution Network, relying on a calculation engine for distribution power flow, limit monitor, (N-1) security and sensitivity analysis applications.
Network Energy Manager (NEM)	Instance of DERMS for the NiceGrid project as main control component, hosted in DSO Information System and ensuring forecast import, distribution system analysis, validation of operator requests, management of transaction mechanism with DER aggregators, publication of reservation/activation orders, reporting and web portal for network operator dispatchers.
TSO	A Transmission System Operator (TSO) is an operator that transmits electrical power from generation plants over the electrical grid to regional or local electricity distribution operators. In France, RTE is the only TSO.