Global Load Management
Interest Group

40th PLMA Conference
Nov 4, 2019-11-04, St. Petersburg, Florida
GLM Overview

Goal
Enlarge PLMA’s scale by promoting the exchange of ideas among DR and DER practitioners around the world

Chairs:
• Scott Coe, GridOptimize
• Jon Hilowitz, Orange & Rockland Utilities
• Ros Malme, Skipping Stone

Executive Sponsor:
• Michael Brown, NVEnergy
GLM Activities

- Handle requests from international organizations for PLMA membership, PLMA materials usage, PLMA conference speakers
- Track requests and report to board on international interest
- Provide venue for international topics both via webcasts and at conferences
GLM Activities: Contemplated

• On-site, overseas workshops to bring expertise to new countries
• “Utility Exchange” to pair US and international utilities with similar profiles
• Collaboration via on-line tools
• Support international training opportunities
• “Opportunity Clearing House” for international utilities to solicit solution from US providers
• Awareness training, focusing on educating policy makers on DR/DER facts
Flexible Wind Power

How European generators can earn more by producing less

40th PLMA Conference – Global Load Management | 04/11/19 | Next Kraftwerke
Evolution of European utility business

Advantages...
- Forecastable
- Dispatchable
- Reliable

...and disadvantages
- Emissions
- Large investments
- Long planning cycles
## Evolution of European utility business

<table>
<thead>
<tr>
<th>Energy sources</th>
<th>1990</th>
<th>2018</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Fossil &amp; nuclear energy sources</td>
<td>800</td>
<td>1,600,000</td>
<td>Decentralisation</td>
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<tr>
<td>Renewable &amp; fossil energy sources</td>
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<td>1,134,000,000</td>
<td>Nuclear phase-out &amp; decarbonisation</td>
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<td>Number of spot exchanges in Europe</td>
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<td>Liberalisation</td>
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<tr>
<td>Number of LTE connections (global)</td>
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<td>1,134,000,000</td>
<td>Digitisation</td>
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</table>
What is a Virtual Power Plant?
What does a Virtual Power Plant do?

Use cases

**Renewables live monitoring & forecasting**
Improving renewables trading

**Asset Dispatch & Control**
Control decentral assets based on parameters

**Balancing Services:**
Provide ancillary services to grid operators
VPP case: Monitoring & curtailing renewables with Ecotricity (UK)
Why monitoring & forecasting
The utilities’ balancing challenge

Even balancing groups: The foundation for a stable grid

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Live monitoring & forecasting
The recipe for a renewables forecast

Weather forecast

Real-time feed-in data from the assets

Master data of the asset

Information on previous days

Forecasting method

Real-time feed-in forecast
Live monitoring & forecasting
Optimized trading through forecasting based on live data

Sample calculation of a PV forecast
Ecotricity: curtailing wind power

Ecotricity is Great Britain’s first green energy utility. They...

- supply green energy to C&I and residential customers
- produce & off-take renewable electricity
- partnered with Next Kraftwerke to develop a VPP business

Mark Meyrick, Head of Trading and Smart Grids at Ecotricity: “Ecotricity is, more than any other supplier, subject to intermittency (due to our renewable generation). So flexibility is something we absolutely need for our own portfolio, as well as for providing intelligent flexibility services to a wider pool of clients.”
Ecotricity: curtailing wind power
Optimizing imbalance costs in short-term trading of renewables

Example illustration of curtailment through the VPP system, e.g. during extreme wholesale prices.
VPP Case Study: dispatching power-to-gas with Greenpeace Energy (DE)
The city of Haßfurt
The distribution grid’s components
The gas grid
Optimization through the VPP

Generation from wind + Generation from PV – consumption of municipality = excess electricity
Power-to-gas system overview

VPP integration of the power-to-gas unit Windgas Haßfurt
One of many: balancing services at scale

Example activation of DER for secondary (spinning) reserves (mFRR) in Germany
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The Next Box
Connect, collect & control

The Next Box connects the asset with the VPP

- Installed on site, connected to local SCADA
- Direct control via PLC possible
- Communication via closed user group (private APN)

Examples of exchanged data points

<table>
<thead>
<tr>
<th>Designation</th>
<th>direction</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Active power</td>
<td>receive</td>
<td>kW</td>
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<tr>
<td>Availability signal</td>
<td>receive</td>
<td>0/1</td>
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<td>Grid connect</td>
<td>receive</td>
<td>0/1</td>
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<tr>
<td>Activation</td>
<td>send</td>
<td>kW</td>
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<tr>
<td>Set point</td>
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<td>kW</td>
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<tr>
<td>SOC of battery/gas tank</td>
<td>receive</td>
<td>%</td>
</tr>
<tr>
<td>Frequency</td>
<td>receive</td>
<td>Hz</td>
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</table>
Overview

NEMOCs as platform for your VPP & DR use cases
“In 2009, we started with our vision of a Virtual Power Plant. Today, we operate one of the largest Virtual Power Plants in the world.”

Jochen Schwill & Hendrik Sämisch
(Founders & CEOs)

Our Virtual Power Plant

Aggregated Power: **6,000 MW**

Aggregated Assets: **6,500**

Providing services to: **8 system operators**
Milestones

- **2009**: Foundation of Next Kraftwerke GmbH
- **2011**: Start of power trading through the Virtual Power Plant Next Pool
- **2012**: Break Even
- **2013**: Virtual Power Plant Next Pool provides control reserve in all four German TSO areas
- **2014**: First control reserve delivery from the VPP to a TSO
- **2015**: Next Kraftwerke debuts time of use tariffs
- **2016**: First-time integration of batteries & electrolyzers
- **2017**: Trading Portal NEXTRA VPP as a service
- **2018**: Largest PV aggregator in Germany
- **2019**: MW of aggregated power in the Virtual Power Plant
What is a Virtual Power Plant?
VPP infrastructure
High level draft of example layout
Dispatching of distributed generation
Controlling of decentral assets through price based schedules

Through the NEMOCS Control Center, or via an API, your connected assets can be dispatched and controlled in real-time.

Your Benefits
Allowing for higher revenue by trading your dispatchable generation & flexible demand based on wholesale market prices.

“With his biomethane CHP, Stefan Kienz produces power when it most valuable, based on dispatch signals from the VPP.”
Demand side flexibility: pumps

Optimizing Energy Costs — Active Dispatch of Consumers

Overview - Water pumps
- Consume power when the demand at the power exchange is low and power costs less
- Price forecasts in different time intervals available

Benefits
- Harmonizing power supply and demand for the entire system
- Saving up to 30% on energy costs

Regulatory Barriers
- Grid charges for peak demand

Matthias Reimers shifts the power consumption of his pumps to times with lower power prices.
2nd life EV batteries - their role in the energy storage landscape

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Energy storage using 2nd life EV batteries

E-STOR 1200/720 installed on an industrial site in Belgium
Who we are...... a leading innovator with global reach

• Connected Energy is an award winning UK company that provides world leading energy storage systems and services.

• Dedicated to the design, manufacture and operation of world class energy storage systems.

• A business underpinned by a management team with a diverse set of skills and experience from the automotive and energy sectors.

• Backed by strategic investors Macquarie, Engie and Sumitomo to achieve ambitious international growth
The E-STOR energy storage system

- Installed, operational and proven technology
- Modular, flexible design for low cost scalability.
- E-STOR uses (second life) EV batteries.
- **Battery/OEM agnostic**
  - Integrates existing, reliable technologies.
  - Operating system monitors performance and optimises system.
- Simple, low cost installation and maintenance.
- Includes variants for niche applications
- Adds sustainability to the EV and energy value chains
Integration & product development
Projects installed and in development
Extending the usable life of EV batteries

- Increase security of supply
- Reduce embedded CO2 in EVs
- Reuse EV batteries in stationary energy storage
- Reduce cost of EVs – increase uptake
- Help decarbonise grid
- Reduce energy costs

Help decarbonise grid and reduce energy costs by reusing EV batteries in stationary energy storage, which also reduces the cost of EVs and increases their uptake. This extends the usable life of EV batteries.
2nd Life EV battery - market opportunity

- The benefits of using 2nd life batteries and further harnessing their embedded natural resources is immense when compared with manufacturing new batteries

- £18bn global energy storage market by 2023

- By 2030 the global demand for energy storage could be met by 2nd life EV batteries
Using EV 2nd life batteries: an attractive solution

- High Safety level
- Technical performance
- Affordable: lower price than a new battery
- Better environmental impact of the EV
- Less use of resources
- Excellent sustainable and circular economy credentials
Behind the Meter Battery Storage

• The 6 “C”s of Battery Storage
  • Consumption
  • Cost Avoidance
  • Cost of System
  • Choice of Flexibility Service
  • Capacity Market
  • Cycles

• Define the sweet spot capex vs return

• Additional Benefits
  • Carbon
  • UPS
  • Security
  • Sustainability

• Future Proofing
Revenue certainty in UK

- **Transmission Charge avoidance (TRIADs)** – National Grid has published tariffs until 2024, giving assets security until then
  - Risk – possibility of a reduced tariff after 2024

- **Distribution Charge avoidance (DUoS)** – Tariff published up to April 2021.
  - Risk – Future tariffs will likely have a lower spread therefore reduced revenue potential

- **Capacity Market** – Programme is just reinstated, this revenue stream has the longest guarantees.

- **FFR** – Market price has stabilised
  - Risk – As National Grid no longer procures long term contract, revenues are dependent on securing capacity in monthly tenders

- **Constraint Management** – Seasonal programme that is dependant on regional (post code) zones.

- **BM trading** – This is stream providers no guarantees and is dependant on the asset getting dispatched at appropriate strike price levels
  - Risk – Asset needs to be aggregated with others to increase dispatch frequency
Changing value in flexibility

- Eroding FFR Value
- Increasing value in real-time energy trades
- Increasing DSO Ancillary services market
- Reduction in Revenue security
- Volatility driven by intermittent generation set to increase
- A merchant approach is the way forward?
- Trans European Replacement Reserves Exchange (TERRE)
Case study - EVEREST micro-grid at Lotus Cars, Hethel UK

- Includes E-STOR system, PV charging canopy, micro wind turbine, 1 x 50kW and 6 x 22kW EV chargers

**Functionality:**

- E-STOR provides energy cost benefits by charging and discharging according to an arbitrage schedule
- E-STOR maximises the value of the renewable generation by storing when not being used on site.
- When EV chargers are in operation E-STOR fills gap between available on site generation and EV charging load.
- Active load management is employed when required – e.g. if the site has additional loads from R&D activity.
- Reactive load management is used at other times.
Case study - Grid-Load management in Kircheim, Germany

- E-STOR in operation on motorway service station in Germany. A similar system is also operational in Belgium.
- The E-STOR actively manages the loads of 1 x 50kW EV rapid chargers.
- 1 50kW charger have been installed on a 40kVA connection.
- The E-STOR actively manages the loads so the chargers do not exceed the connection capacity – which is also subject to other site loads.

The green line indicates the load that would occur if the E-STOR unit was not in place and the blue line indicates the actual load that has been managed by the E-STOR system.
Case study - EV charging hub in Dundee, Scotland

- Dundee City Council has a fleet of Nissan Leaf vehicles and these chargers are amongst the most heavily used in the UK.

- The hub is a pilot to demonstrate how EV charging can be achieved from an integrated system using PV canopies and energy storage.

- The E-STOR system is controlled to maximise the value of the PV generation by using it to feed the chargers whilst also controlling the maximum grid load.

- As utilisation continues to increase the scale of the storage system will also be increased.
Case study – industrial site in Brussels, Belgium

- Location: Brussels, BE
- Category: Industrial
- Global Battery recycler
- E-STOR 1200kW/720kWh
- Services:
  - European grid balancing
  - Dynamic frequency response
  - Power quality improvement and back-up
Large split system configuration

- Systems capitalise on the low cost of batteries and minimise logistics costs.
- Power and energy modules are separated to enable energy/duration to be increased as required.
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