Northern Demonstration

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Technical Development Engineer

Flexible Electricity Network to Integrate the eXpected “energy evolution”
EDF Energy Brochure
Flexible Electricity Network to Integrate the eXpected “energy evolution”
EDF Energy Networks selection for FENIX
Flexible Electricity Network to Integrate the eXpected “energy evolution”

Northern Scenario

Woking Borough Council
- Owned and operated by the Council
- Mixture of sizes, technologies and ages
- Already monitors the CHP it operates
- The swimming pool demand could participate in DSM

Glass Moor Windfarm
- 8 x 2MW turbines
- 33kV connection

Imperial College London
- Virtual Network
- Associated generation and demand
Woking Network

Woking Primary 33/11kV 24MVA
Civic Offices 0.11MW CHP (gas)
Town Centre CHP 1.8MW CHP (gas)

Horsell Primary 33/11kV 16MVA
Brockhill Sheltered Housing 30kW PV export

Old Woking Primary 33/11kV 12MVA
BT, Telephone Exchange 0.8MW diesel gen.
Priors Croft Nos 1-32 22kW CHP (gas)
Woking Pool in the Park 20kW PV panel
0.2MW fuel cell
0.95MW CHP (gas)

At this level of DER penetration, no real integration problems occur
Glass Moor Wind Farm

- 8 x 2MW wind turbines
- Metering at the interface and at Peterborough Grid 132/33kV
- The operator has little awareness of his operation

At this level of DER penetration, no real integration problems occur

Flexible Electricity Network to Integrate the eXpected “energy evolution”
The demonstration consisted of a cluster of loads and generators controlled from a National Instruments’ compact RIO based on the instructions received from the Fenix Box.
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Northern scenario focused on market integration

Development and test of tools enabling through aggregation a collection of various DER (and DSM) to:

- **bid on the day ahead market**;
- **bid on the next intra day gate**;
- **response to NGT balancing mechanism**.

**Diagram:**

```
WHOLESALE MARKET
Forward & Futures Market (Long term bilateral contracts)

BALANCING MARKET
Power Exchange (Short term market trading standardised products)

IMBALANCE SETTLEMENT
Balance Mechanism

2. Submission of Bids and Offers and notification of PPN to System Operator. Notification of contract volumes to Settlement

3. System operator accepts Bids and Offers for system and energy balancing

4. Imbalance calculation & settlement of cash-flows

T-1 year +

(T)= (T+1) year
```
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Northern Demonstration’s architecture
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What is really in place?

Market

Interfacing Software

Interconnections

400 and 275 kV Networks

Conventional generators

Simulated links

Bidding and optimising Software

Fenix Aggregator

Real links

Power matcher

Intelligent meters

Imperial College Fenix village

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TSO (National Grid)

DSO (EDF Energy Networks)

Market

TSO (National Grid)

DSO (EDF Energy Networks)

Imperial College Fenix village

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Local aggregation at Imperial College

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Key lines of the Demonstration
Tools developed

- **Energy Bidder Module (EB)**
  - Maintenance and submission of Bids to NGT

- **Electronic Dispatch and Logging (EDL)**
  - Reception of ancillary service and balancing instructions,
  - Submission of changes to availability or operational characteristics after gate closure

- **e-terracontrol (ETC)**
  - Receiving actual meter read and events.
  - Management of status and alarms.
  - Controls of breaker settings.

- **Asset Monitor (AM)**
  - Visualize aggregated meter reads of units

- **Intra-day Plant Optimisation (IPO)**
  - Re-optimising and rebalancing of real-time generation to reduce imbalances
## Settlement components

- **BM reporting agent (BMRA)**
  - Receives and reviews market broadcast of accepted bids, system prices, demand forecast, remaining capacity, …

- **Automated Meter Reading (AMR)**
  - Reads daily meter from Smart meters

- **Meter Data Manager (MDM)**
  - Imports, reviews, corrects and aggregates of high volume meter data

- **Shadow settlement (SS)**
  - Calculates of a shadow settlement and verifies the central market settlement.
  - Provide aggregations and drill down capability.

- **Intra Balancing Circle Settlement (ICS)**
  - Calculates invoices for parties that are responsible for imbalances.
  - Affects the imbalance costs to the different parties.
Planning and scheduling tools

- **Power Scheduler (PS)**
  - Maintenance and submission of static physical characteristics of DERs.
  - Administration of planned and non-planned outages
  - Generation Forecasts based on weather data.

- **Forecast Manager (FM)**
  - Forecasts of demand based on profiles.
  - Administrates of outages of demands.

- **Trade Manager (TM)**
  - Flexible administration of physical trades

- **Risk Manager (RM)**
  - Evaluates Value at Risk of a trade portfolio against price forward curve.

- **Contracted Volume Notification Engine (CVN)**
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### Common screens

#### Site: Fenix Village Box 1

<table>
<thead>
<tr>
<th>PV</th>
<th>CHP</th>
<th>kWp Actual</th>
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<tbody>
<tr>
<td>PV Panels</td>
<td>x</td>
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<td>x</td>
<td>1030.72</td>
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<td>x</td>
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<tr>
<td>Pool Pump 1</td>
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<td>0.00</td>
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<tr>
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<td>Pool Pump 3</td>
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<td>0.00</td>
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<tr>
<td>PEV 1</td>
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<td>0.00</td>
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<td><strong>Total</strong></td>
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#### Site: Fenix Village Box 2

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<td>Meat Fact. Cell 2</td>
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</tr>
<tr>
<td>Meat Fact. Cell 3</td>
<td>x</td>
<td>0.00</td>
</tr>
<tr>
<td>PV Panels</td>
<td>x</td>
<td>0.00</td>
</tr>
<tr>
<td>d CHP 1</td>
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<tr>
<td>d CHP 4</td>
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<td>0.00</td>
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<tr>
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<td>0.00</td>
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<td>Refrigerator 2</td>
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<td>0.00</td>
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<tr>
<td>PEV 1</td>
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<td>0.00</td>
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<tr>
<td>PEV 2</td>
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<td>0.00</td>
</tr>
<tr>
<td>Hospital CHP</td>
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</table>
HMI for re-optimisation’s of day ahead process

- On day ahead the VPP has declared a certain trading position

- Availability, Technical parameter and Bids and Offers have been submitted to NGT for the current Market period

- Set points have been calculated and are currently implemented
What will be demonstrated?

Use Case 1: Bidding phase for the ahead gate
Use Case 2: Bidding phase for the next intra-day gate
Use Case 3.

- RT Set point schedule optimization and implementation
- NG balancing market calls balancing energy
- Re-optimisation of set points and implementation
- Real time collection of meter readings
  – Total VPP generation against set point schedule
What is new? Demo highlights

1. Aggregating DER of different technologies and size
2. Communication and HMI software between actors:
   - Markets operators;
   - Aggregators;
   - DSO and TSO.
3. Access for aggregated DER to all the energy markets:
   - Day ahead;
   - Intra day;
   - Balancing.
4. Tools to re-optimise DER portfolio in real time
5. Use of intelligent agents (power matcher) for management and optimisation of local resources before integration in a wider system.

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The end

Thank you

For more information please click on
http://www.fenix-project.org/
peter.lang@edfenergy.com
Back up slides
1. Once upon a time … Explanation of the market
2. What happened so far
3. Use Case 2: Bidding phase for the next intraday gate
4. Use Case 3.
   1. RT Set point schedule optimization and implementation
   2. NGT balancing market calls balancing energy
   3. Reoptimization of set points and implementation
5. RT collection of meter readings
   – Total VPP generation against set point schedule
2. What happened so far

- Set points have been calculated and are currently implemented
2. What happened so far

- On DA the VPP has declared a certain trading position
- Availability, Technical parameter and Bids and Offers have been submitted to NGT for the current Market period
- Set points have been calculated and are currently implemented
2. What happened so far

- On DA the CVPP trader has declared a certain trading position

- Availability, Technical parameter and Bids and Offers have been submitted to NGT for the current Market period

- Set points have been calculated and are currently implemented
Flexible Electricity Network to Integrate the eXpected “energy evolution”

Story line

1. Explanation of the market
2. What happened so far
3. Use Case 2: Bidding phase for the next intraday gate
4. Use Case 3.
   1. RT Set point schedule optimization and implementation
   2. NGT balancing market calls balancing energy
   3. Reoptimization of set points and implementation
5. RT collection of meter readings
   – Total VPP generation against set point schedule
3. Use Case 2: Bidding phase for the next intraday gate (1/2)

- Power Matcher aggregates
  - Availability
  - Technical Parameters
  - Price curves from the DERs

- Power Matcher generates Bids and Offers for the next market period
3. Use Case 2: Bidding phase for the next intraday gate (2/2)

- Availability, Technical parameter and Bids and Offers are checked by the CVPP owner …

… and submitted to the NGT balancing market.
Story line

1. Explanation of the market
2. What happened so far
3. Use Case 2: Bidding phase for the next intraday gate
4. Use Case 3:
   1. RT Set point schedule optimization and implementation
   2. NGT balancing market calls balancing energy
   3. Reoptimization of set points and implementation
5. RT collection of meter readings
   – Total VPP generation against set point schedule
4.1 RT Set-Point schedule optimization and implementation (1/4)

• Challenges:
  – Implement pre-gate closure schedules
  – Minimize risk of RT market exposure by avoiding imbalances

• IPO optimizes the set points of a portfolio of conventional and virtual power plants
  – Based on latest real time information
    • Availability of the VPP,
    • Price curves of the VPP
    • Demand forecast

• VPP schedules are implemented by the PowerMatcher
4.1 RT Set-Point schedule optimization and implementation (2/4)

IPO is calculating 1 min smoothed schedule from the trading position:
- Taking into account latest availability and VPP price curves
- Avoid imbalances in the trading period

Traditional Scheduling strategy

Optimized Scheduling Strategy with IPO

- Smoothing schedules at VPP level
- Energy balance at portfolio level
4.1 RT Set-Point schedule optimization and implementation (3/4)

PowerMatcher VPP principles

<table>
<thead>
<tr>
<th>Component</th>
<th>$P_{\text{Nominal}}$</th>
<th>$P_{\text{ACT}}$</th>
<th>$P_{\text{MIN}}$</th>
<th>$P_{\text{MAX}}$</th>
<th>Incremental Costs</th>
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<tr>
<td>Refrigerator Load</td>
<td>-120W</td>
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<td>0kW</td>
<td>-120W</td>
<td></td>
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<td></td>
</tr>
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<td>250kW</td>
<td>500kW</td>
<td></td>
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<tr>
<td>CHP</td>
<td>1MW</td>
<td>0MW</td>
<td>0MW</td>
<td>0.2MW</td>
<td></td>
</tr>
</tbody>
</table>

Cluster Equivalent

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4.1 RT Set-Point schedule optimization and implementation (4/4)
Story line

1. Explanation of the market
2. What happened so far
3. Use Case 2: Bidding phase for the next intraday gate
4. Use Case 3:
   1. RT Set point schedule optimization and implementation
   2. NGT balancing market calls balancing energy
   3. Reoptimization of set points and implementation
5. RT collection of meter readings
   – Total VPP generation against set point schedule
4.2 NGT balancing market calls balancing energy

- NGT sends instruction for balancing energy to the CVPP
- CVPP get notified by the instruction screen
- CVPP accepts NGT balancing instruction
IPO dispatches the VPP

- IPO dispatches the VPP the step profile has been ramped and balanced within period following the DA trading position.

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IPO dispatches the portfolio of VPP and conventional plant

In this scenario, the VPP is cheaper than the conventional plant so it is scheduled to supply the instruction for balancing energy until it reaches its maximum capacity of 20 MW … … the conventional plant is dispatched when requirement is > VPP capacity
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