Integrating Energy Storage with Substation Monitoring
LCNF, October 2013

Alistair Steele
Project Manager
Future Networks
Overview
SSET1002 – Substation Monitoring

- Advanced monitoring equipment installed on 2 x LV feeders
- Monitors multiple parameters from volts & amps to harmonics / flicker
- Data fed to a central server over mobile data
- Project complete – closedown report available
Overview
SSET1008 LV Connected Batteries

- 3 x single phase, 25kVA batteries (CES units) connected at 240V

- Determine operational issues and benefits:
  - Peak lopping demand & generation
  - Voltage support from real / reactive power
  - Aggregated reduction in peak demand and phase balancing
Project overview

Greenwatt Way, Chalvey, Slough

http://www.ssezerocarbonhomes.com/
Project overview

Network location of the batteries monitoring equipment

Battery location

Substation with monitoring
Results

Typical sunny day demand

4th September Network Data (without storage operation)

- Blue line: Phase A
- Red line: Phase B
- Green line: Phase C

Real Power Demand (kW)

Time (00:00 to 00:00)
Results
Peak shaving Phase A – 10kW limit
Results
Peak shaving Phase A – 10kW limit

CES Operation 4th September- Peak Shaving on Phase A (5 minute averages)
Results
Peak shaving Phase A – 10kW limit

CES Operation 4th September- Peak Shaving on Phase A (5 minute averages)
Results
Peak shaving Phase B – 9kW limit

Use of CES Unit for Peak Shaving on Phase B (20th September)

- Network Demand without CES Operation
- Demand (with CES Operation)
- CES Unit Operation
Results
Reverse power absorption – Phase C

Use of CES Unit to Prevent Reverse Power Flow on Phase C (5th September)
Results
Reverse power absorption – Phase C

*Use of CES Unit to Prevent Reverse Power Flow on Phase C (5th September)*
Results
Phase balancing at 06:30 & 21:00
Results

Voltage manipulation using real / reactive power
Learning points

- System can shave peaks / absorb power on a daily / weekly basis – up to 50 amps reduction
- Schedules must be changed manually to accommodate changes in weather that hence alter demand
- Phase balancing works functionally, however can only balance when there is battery capacity
- Voltage manipulation testing is in early stages
Peak Reduction Smart Control Algorithms for DNO owned Storage Devices on the LV Network

Matthew Rowe
University of Reading
School Of Systems Engineering
Energy Research Lab (SSE - ERL)
Introduction – Storage NTVV

• Energy Storage & Management Units:

25 X 12.5 kWh 3-phase devices
12 KVA per phase rated Power Electronics

Extension Units: 16 X 12.5 kWh Storage

Total LV Storage in NTVV is 500 kWh’s

• The Low Voltage network is volatile and difficult to predict

• Can the impact of these units be improved using forecasts?
## Methodologies

### Developing Offline Plans for deployment

<table>
<thead>
<tr>
<th>Planning Algorithms</th>
<th>Plan With Set Point Control</th>
<th>Plan With Intuition</th>
</tr>
</thead>
</table>

### Real Time

<table>
<thead>
<tr>
<th>Control With Forecasts</th>
<th>Control Without Forecasts</th>
<th>Control With Intuition</th>
</tr>
</thead>
</table>

- Reducing Real Time Monitoring Has Advantages For DNO’s
Results

Set Point Control
Results

Perfect Knowledge of Demand

- Developed real time optimisation techniques incorporating forecast
Off Line Algorithm

- **Algorithm:**
  - Forecast
  - Filter
  - Develop Plan
  - Deploy Plan

- **Tested on:**
  - 500 Demand Aggregations
  - Use 12 Weeks of Historical Data
  - Validate on 5 weeks of Data
Conclusion

- Storage devices will play multiple roles:
  - Peak Reduction
  - Voltage Support
  - Frequency Control
  - Harmonic Distortion Support

- An agent based centralised control system to be deployed to make control decisions – Simulating distributed control

- Understanding our networks and customers can help us manage our networks

- Significant benefits of applying different control techniques to specific demand aggregations

More to come next year….
Thank you for your attention.

Alistair Steele
alistair.steele@sse.com

Matthew Rowe
m.rowe@pgr.reading.ac.uk