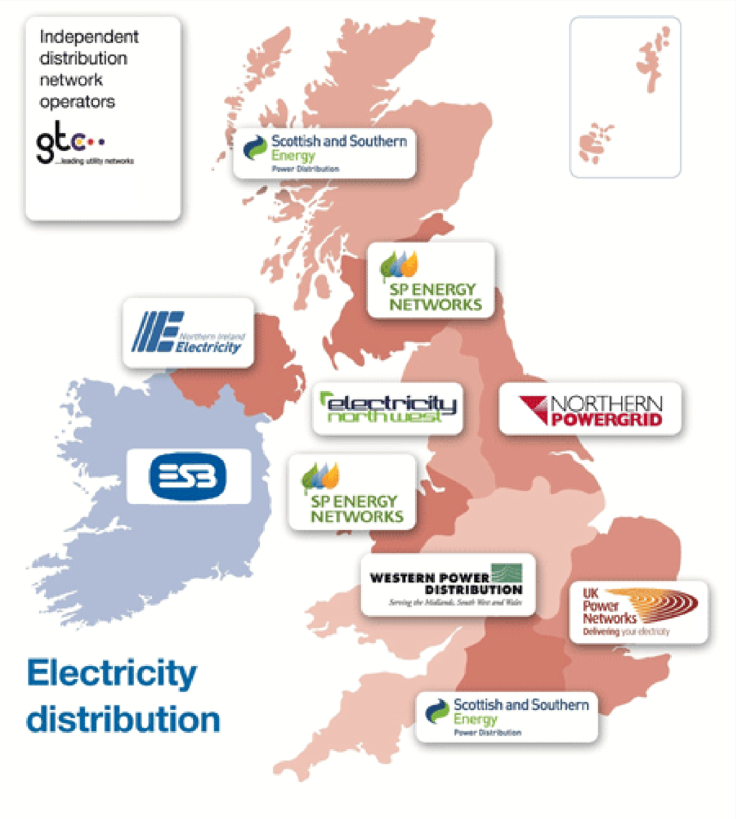
DS3
Distributed Storage and Solar study

Paris Hadjiodysseos
Smart Grid Development Engineer



Northern Powergrid key facts

2,500
employees

8 million
customers

3.9 million
homes and businesses powered

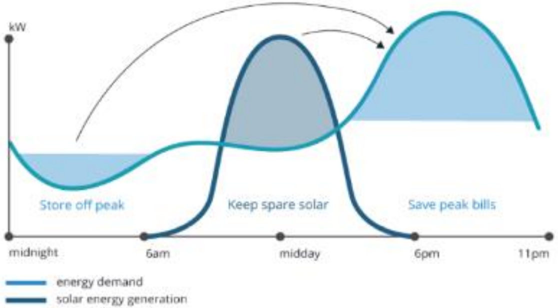
63,000
substations

60,000
miles of overhead power lines and underground cables

The Problem

- PV clusters cause
  - Thermal and voltage
  - Reverse power flow
- Stress networks
- Faults
- Poor customer service

Can batteries help?

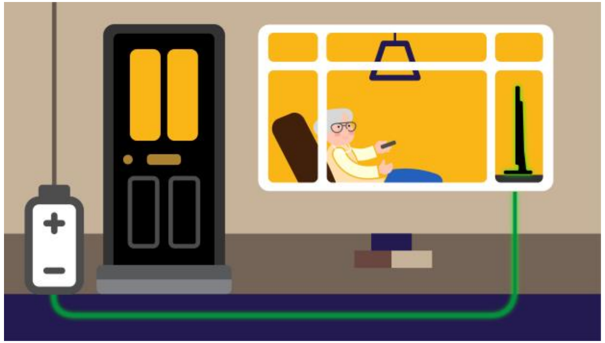


- Absorb generation
- Reduce demand

DS3 Project

DS3 Project

- 2 year NIA funded community project focusing on social housing
- £300k – batteries, monitoring, data analysis & PM



What's in it for customers

- Reduce electricity bills
- Potentially reduce reinforcement works

What's in it for Northern Powergrid

- Understand combined impact of PV & Storage on network design
- Explore the potential of aggregator-controlled behind-the-meter batteries by trialing different operating modes

DS3 Project

- 27 solar panels (2.7-3.68kW)
- 40 Batteries (0.43kW/2-3 kWh)
  - 31 with PVs
  - 9 on their own
- Data
  - Households: consumption, generation, power flow, SoC, voltage (AC)
  - Substation: feeder and transformer current and voltage, temperature

Battery Operating Modes

April	2017	July	2017

Threshold Charging

October	2017	January	2018

Threshold Charging → Maximum Impact → No Impact → Demand-Led

April	2018	July	2018

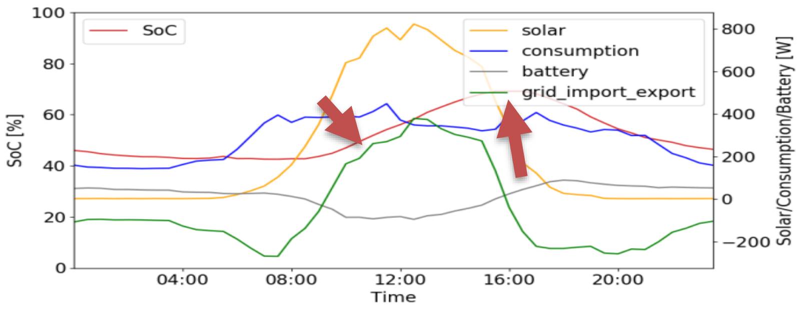
Demand-Led → Maximum Impact → Advanced Demand-Led → Predicted Generation → No Impact → Predicted Generation → Threshold Charging

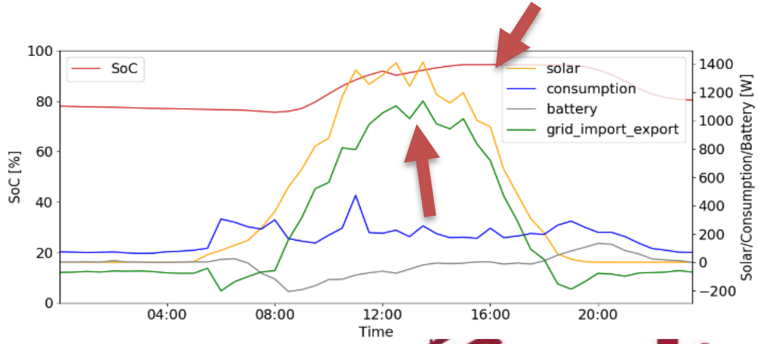
October	2018	January	2019

Threshold Charging → Maximum Impact → Demand-Led

Threshold charging (default)

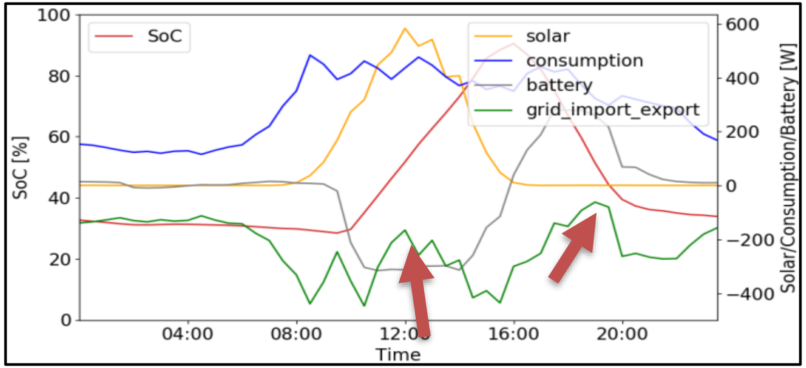
- Charges/discharges based on excess generation or demand imposing no extra cost to owner
- Significant generation being exported despite low SoC (left, winter)
- Low consumption does not discharge batteries resulting in a high SoC meaning that only a portion of the excess generation is captured (right, summer)
- *Peak reduction: Demand 28%, Generation 25%*

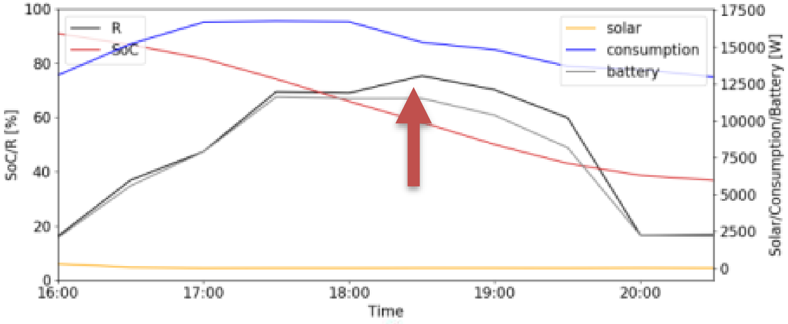




Maximum demand (winter)

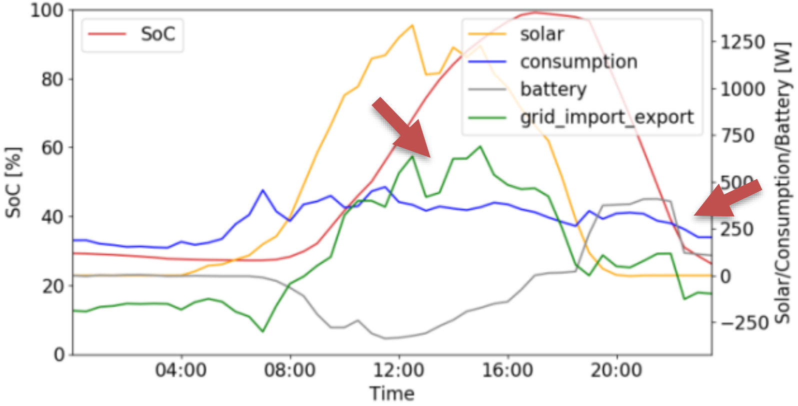
- Scheme focuses on impact batteries can have on the network without considering optimal cost performance for owner (charges: 10:00-16:00, discharges 17:00-20:00)
- The grid import/export shows that none of the generated power was exported to the grid and in the evening the electricity imported is small
- *Forcing all batteries to discharge reduces the evening peak by circa 60%*

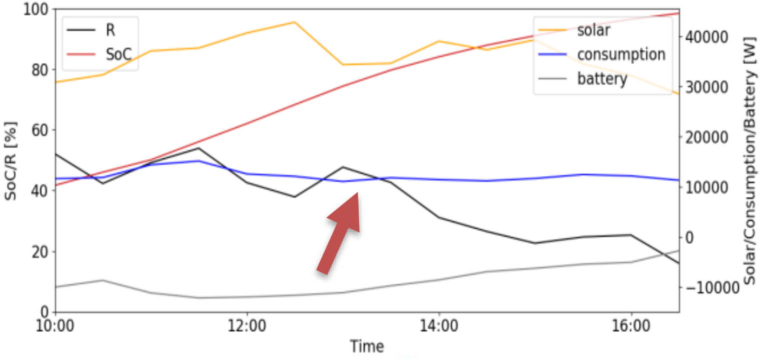




Maximum demand (summer)

- Batteries quickly reduce to a low SoC in the evening allowing them to absorb excess generation and assist the network on the next day.
- *They manage to reduce the average export by up to 50% to approximately 600W compared to the 1000W during threshold charging*





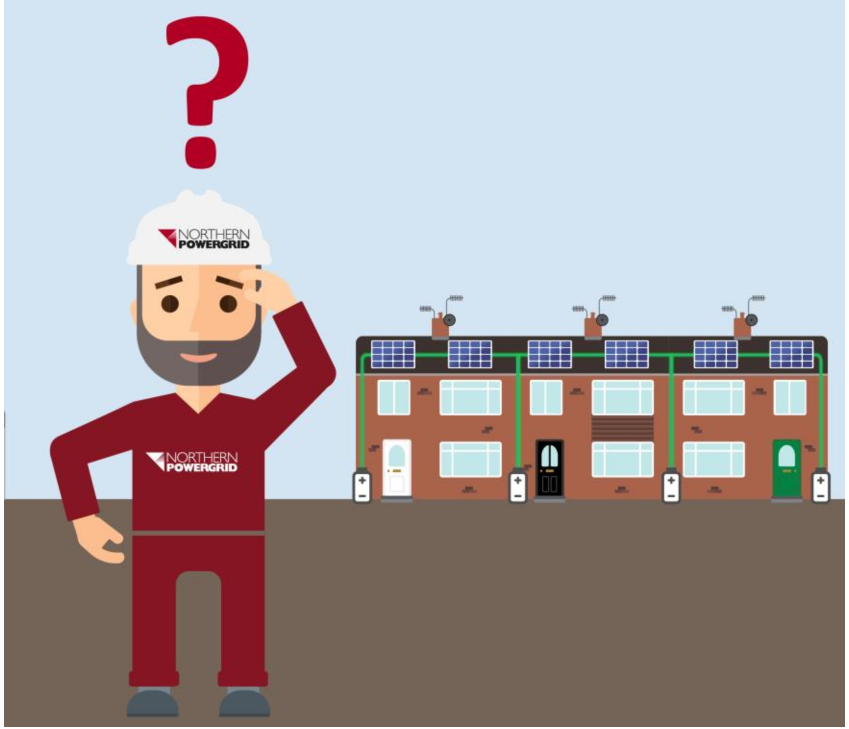
High level preliminary conclusions

- Battery inactivity during threshold charging scheme suggests that charging/discharging threshold must be set to reflect customer profiles
- Forcing the batteries to charge/discharge at their maximum rate during peak generation and demand is better than threshold
- A dynamic predictive generation scheme can be used to reflect changes in the weather and hence impact of batteries

Next steps

- Network modelling
  - Different PV and battery penetration levels
  - Different demand profiles
- Cost Benefit Analysis
  - Reinforcement Vs batteries (BtM & grid connected)
- Design policy recommendations
- Final report Q4 2019

Thank you!



- www.northernpowergrid.com/innovation
- paris.hadjiodysseos@northernpowergrid.com