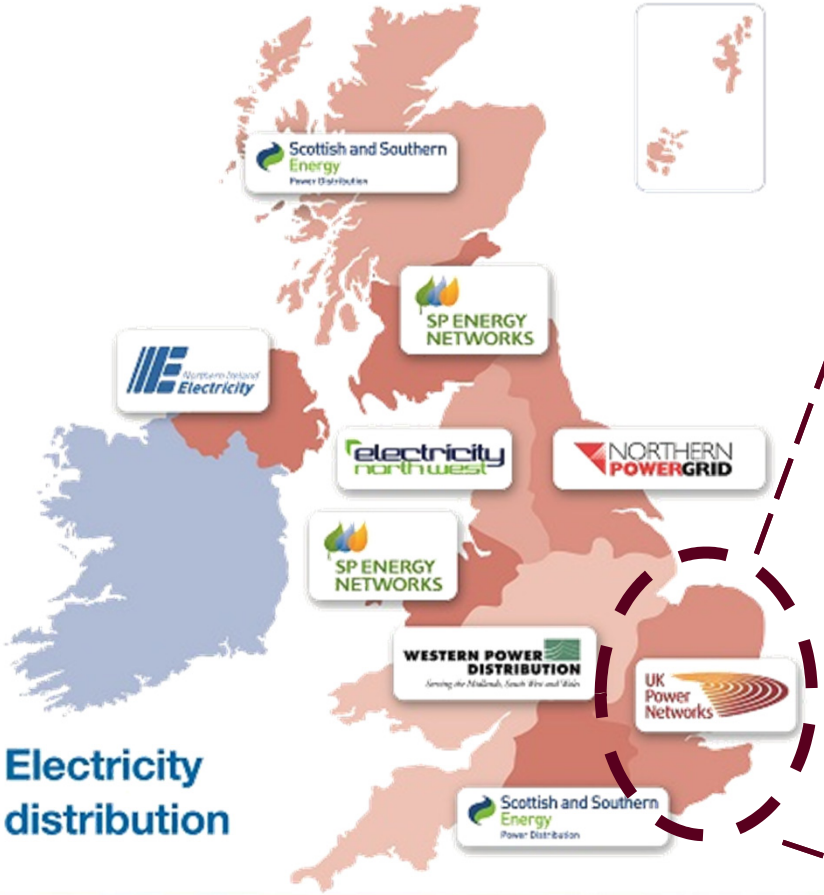
The Smarter Network Storage Project

Dr. Panos Papadopoulos, June 2nd 2015

UK Power Networks
Delivering your electricity

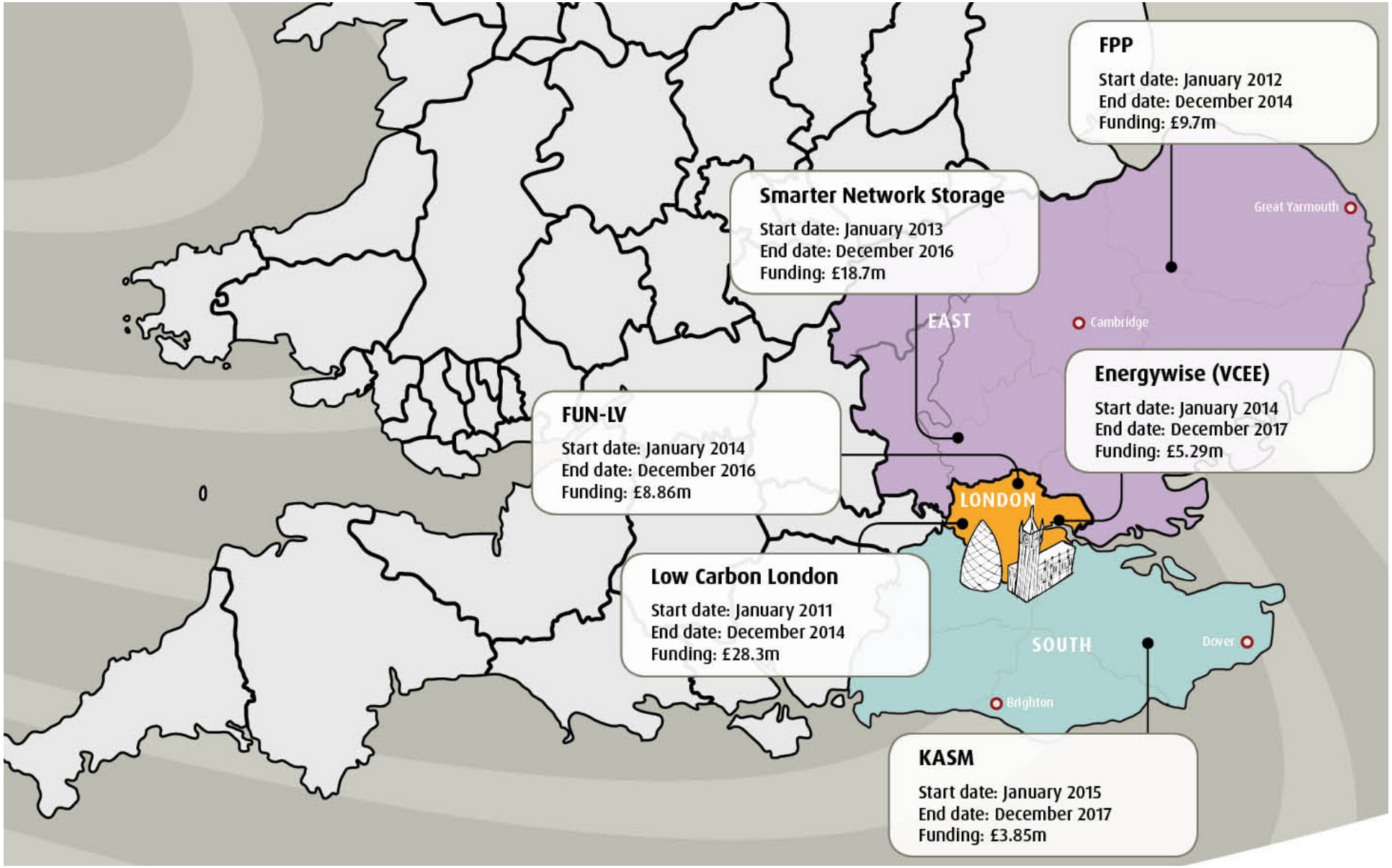
UK Power Networks – An Introduction



	Total	% of Industry
End Customers Millions	8.1	28%
Service Area km²	29,250	12%
Underground Network km	139,000	29%
Overhead Network km	46,500	15%
Energy Distributed TWh	84.8	28%
Peak Demand MW	16,229	N/A
New Connections	130,768	35%

One of the largest electricity distributors in the UK

UK Power Networks' Innovation Portfolio (large projects)



DOE Global Energy Storage Database

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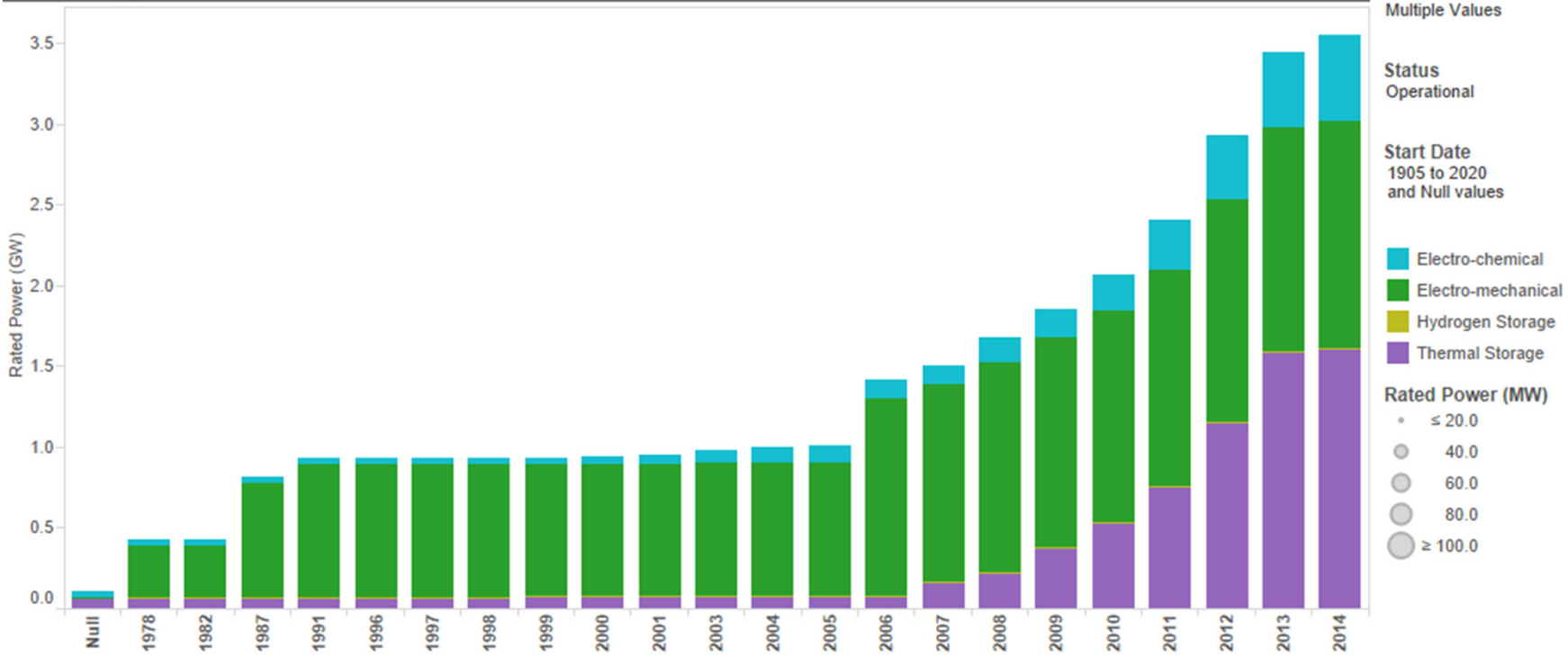
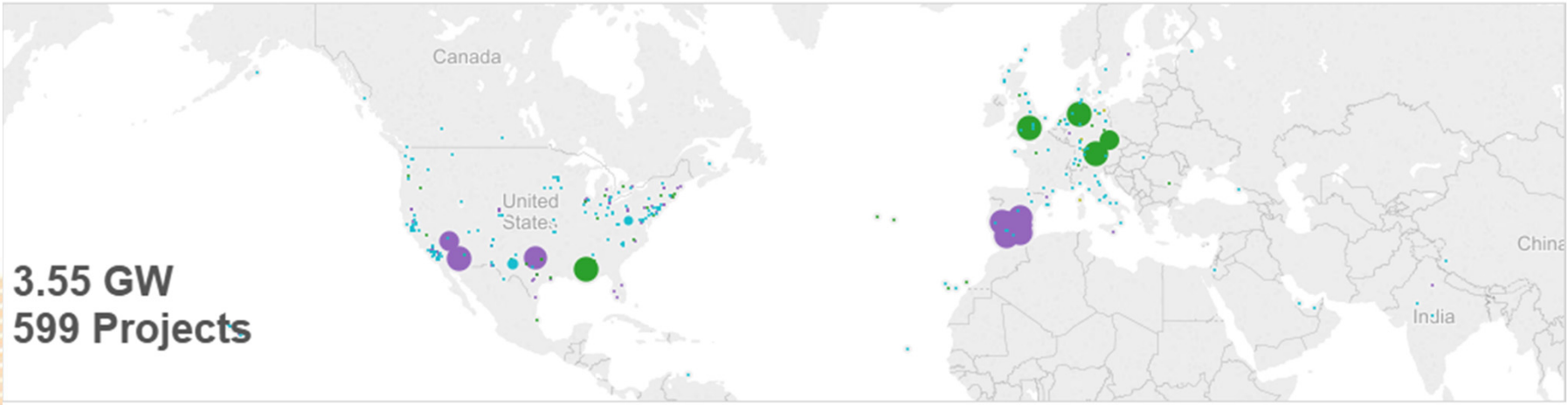
Global Project Installations Over Time



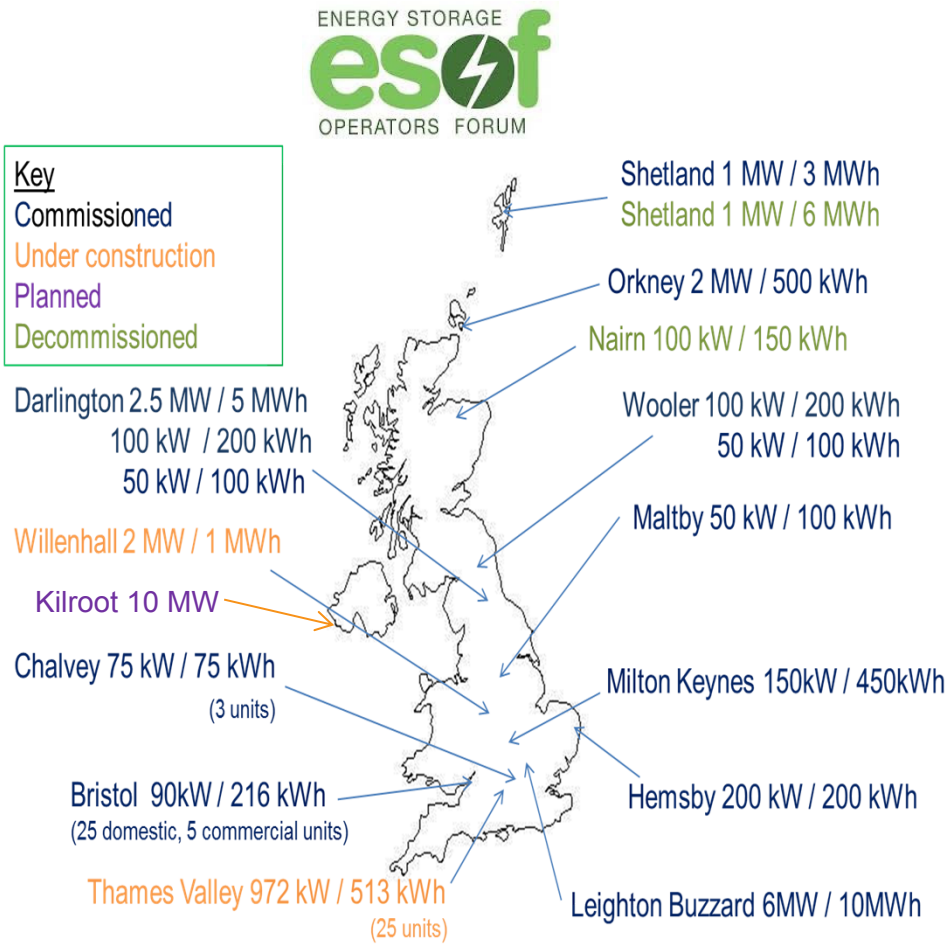


The DOE Global Energy Storage Databse (http://www.energystorageexchange.org/) is powered by Sandia Corporation (http://www.sandia.gov/) and Strategen Consulting , LLC (http://strategen.com/)

UK DNO EES Installations (December 2014)

Limited incentives for storage exist in UK and EU markets compared to other geographies…

- Californian mandate for 1.3GW of grid-connected storage by 2020
- Japanese subsidy programme for battery-based storage for residential and commercial, covering up to 2/3 of cost
- EU lags some other geographies for storage incentives, with just some isolated schemes:
  - E.g. Germany: Exemptions from grid tariffs for new storage; subsidies for residential-scale storage when paired with solar panels
  - E.g. Italy: Specific decree for TSO to install storage, resulting in targeted strategy for significant energy storage investment



STORAGE OFFERS A WIDE RANGE OF APPLICATIONS* TO SUPPORT THE CARBON PLAN…

Use-Case / Value stream of Services from Storage	TSO	DNO	Supplier	Generator
Real-time management of power quality. Active and reactive power support	■	■		
Short-term and seasonal support of intermittency challenges – Frequency Response, reserves/ancillary services markets. Smoothing renewable generation	■			
Peak shifting of daily demand-spikes Deferring or avoiding reinforcement	■	■		
Energy arbitrage and trading opportunities Reducing imbalance risk.			■	■

Value not maximised, leaving individual business cases less viable

…but simultaneous access to a number of markets is challenging under current UK market and regulatory frameworks.

- Existing UK trials have only explored technical viability and network impacts for a single industry ‘silo’
- Business models for leveraging full-system value remain un-tested

*** US DOE lists 27 Use Cases**

The Smarter Network Storage Project

Partners

AMTSybex – Enabling essential industries
Newcastle University
smartestenergy
Swanbarton – Energy Storage Consultants
KiWiPOWER – demand management
Imperial College London
PÖYRY
nationalgrid
UK Power Networks

Suppliers

S&C ELECTRIC COMPANY – Excellence Through Innovation
Younicos – Let the fossils rest in peace.
SAMSUNG SDI

Location:
Leighton Buzzard

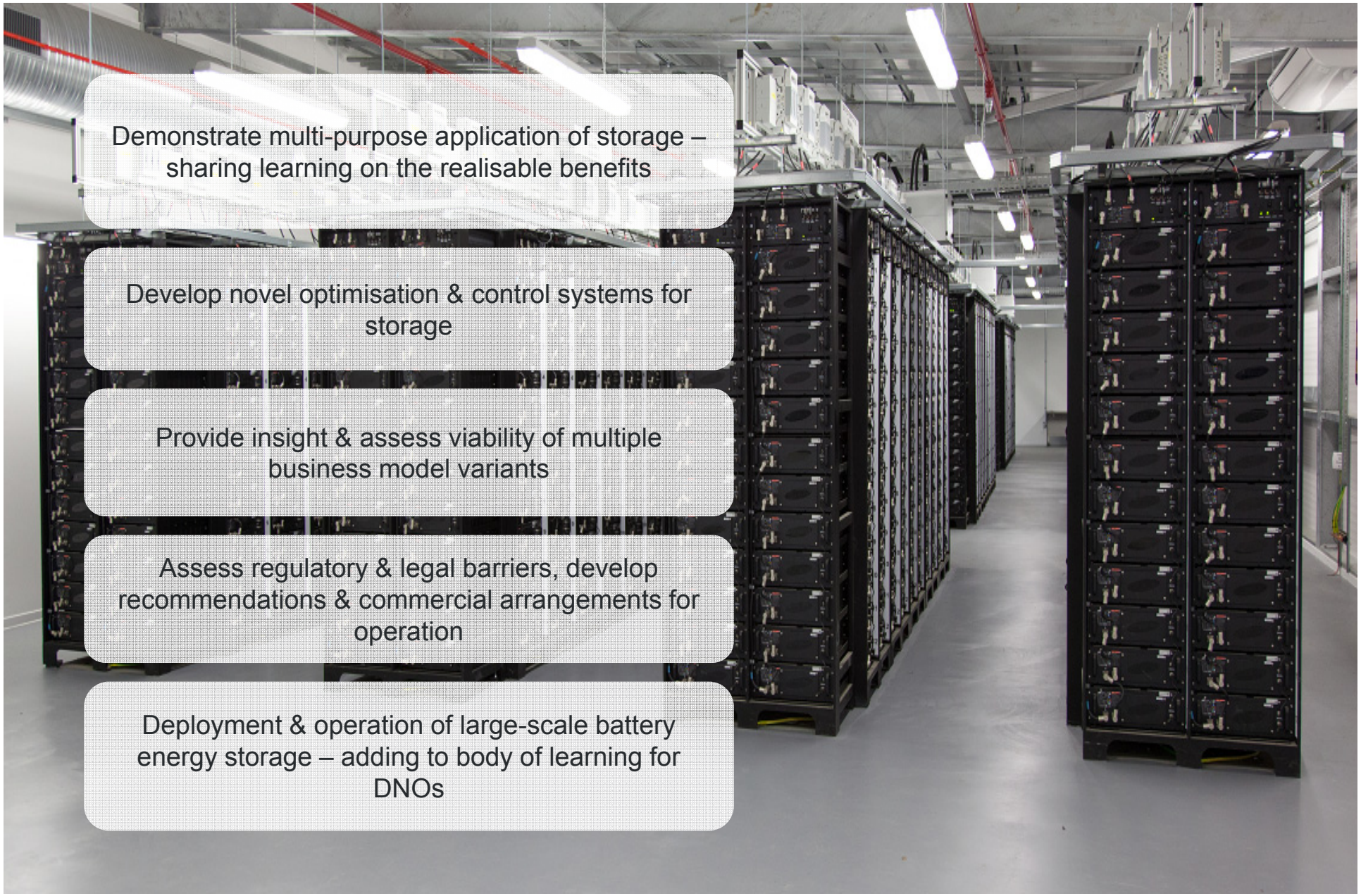
Energy capacity:
10 MWh

Real power:
6 MW

- £13.2m LCN funding awarded in Nov 2012
- £4.0m investment by UK Power Networks

LCN Fund – Low Carbon Networks

SNS Key aims & learning outcomes



Demonstrate multi-purpose application of storage – sharing learning on the realisable benefits

Develop novel optimisation & control systems for storage

Provide insight & assess viability of multiple business model variants

Assess regulatory & legal barriers, develop recommendations & commercial arrangements for operation

Deployment & operation of large-scale battery energy storage – adding to body of learning for DNOs

Functions of SNS

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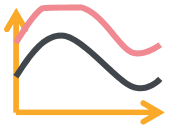
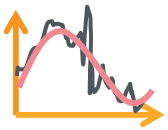


Peak Shaving

SNS uses its stored energy to meet peak demand which reduces the load on the network. This defers the need for network reinforcement to meet peak demand.

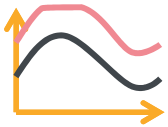


Frequency Regulation

SNS can regulate the grid frequency through power exchanges. This assists National Grid in stabilising the frequency of the wider electricity system.

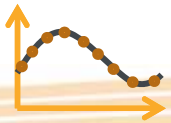
Reactive Power Support

SNS has 7.5MVAr of reactive power capability. Reactive power can help improve power factor, reduce losses and support voltage levels on the local network.



Reserve

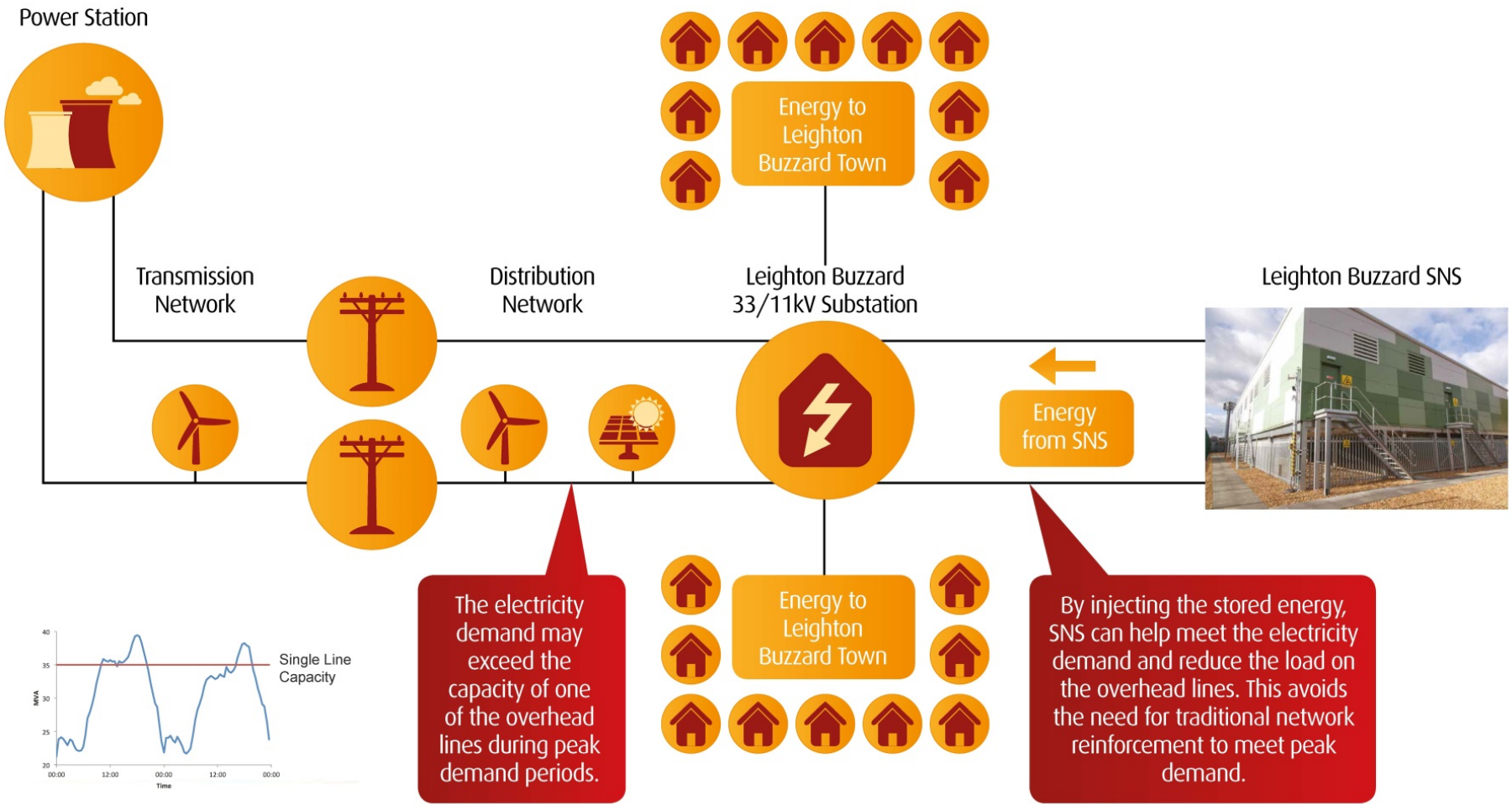
SNS provides reserve capacity and can be triggered remotely to export power. This assists National Grid in balancing electricity demand and supply.



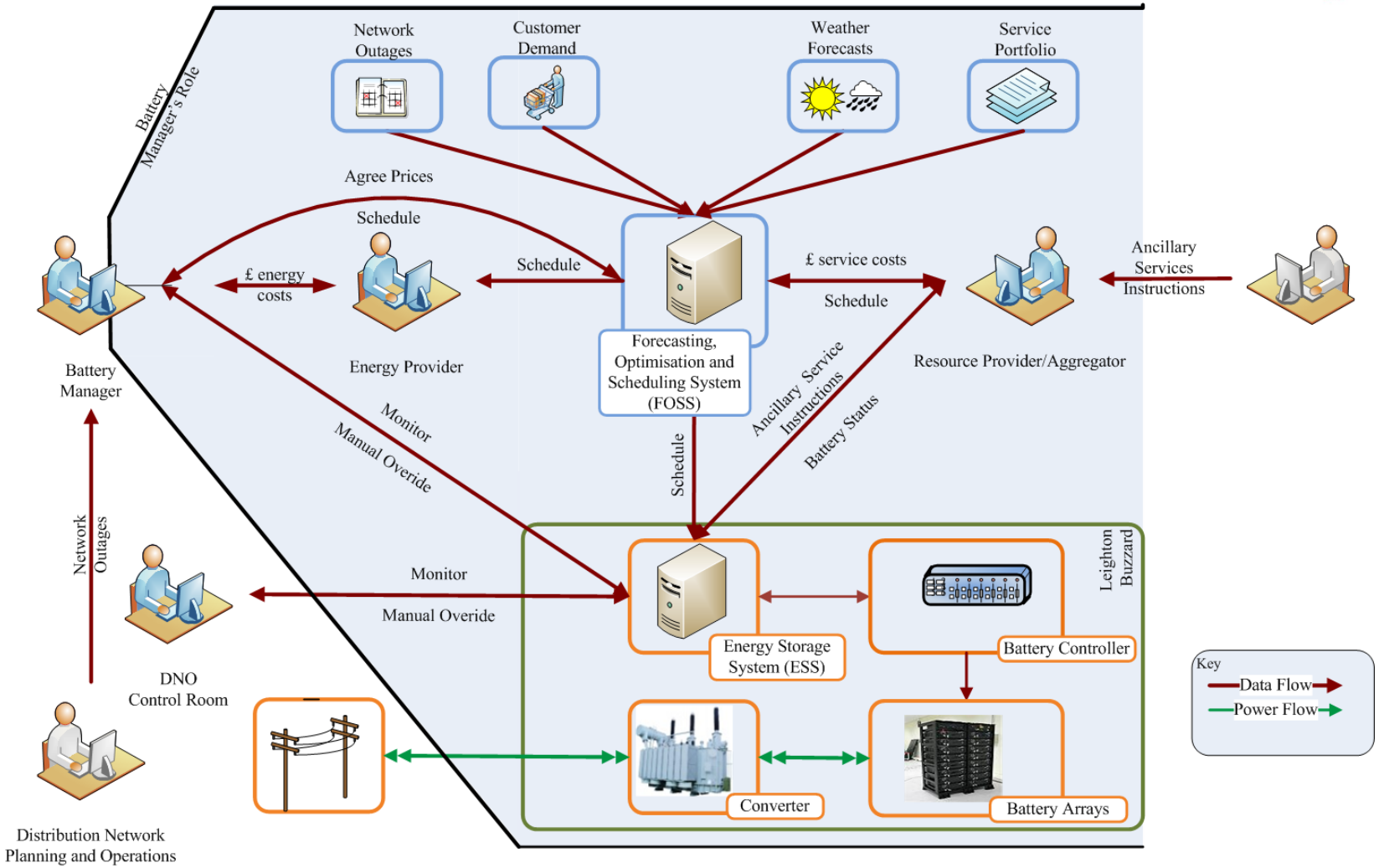
Tolling

SNS can provide energy based on a given energy delivery profile. This can be used to manage imbalance risk and assist in hedging against peak electricity prices.

How does SNS Support the Network?

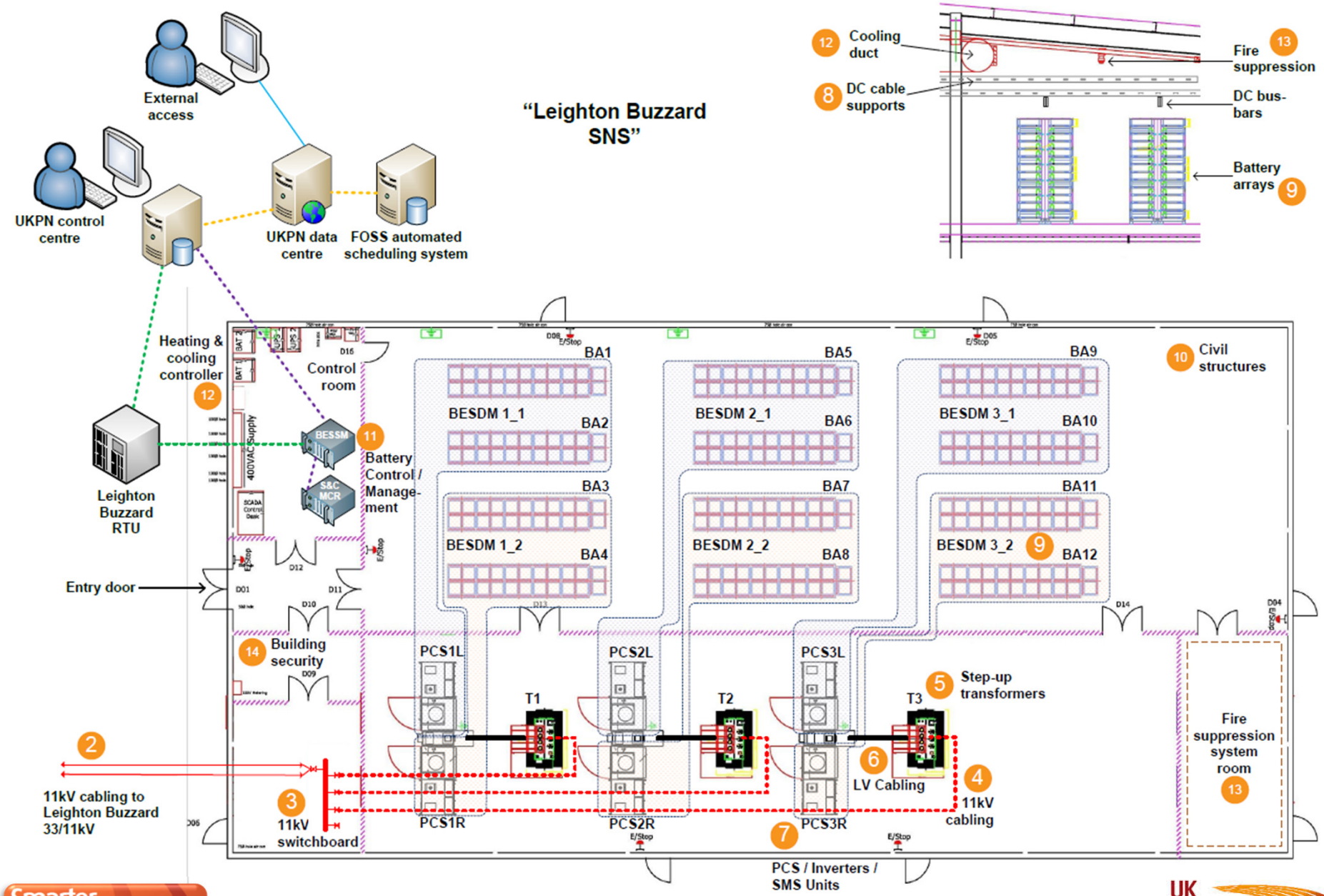


SNS Smart Optimisation and Control System



The SNS smart optimisation and control system is a novel platform that schedules the energy storage to be utilised for a range of different applications, optimising value whilst ensuring network security is maintained.

"Leighton Buzzard SNS"



Smarter Network Storage

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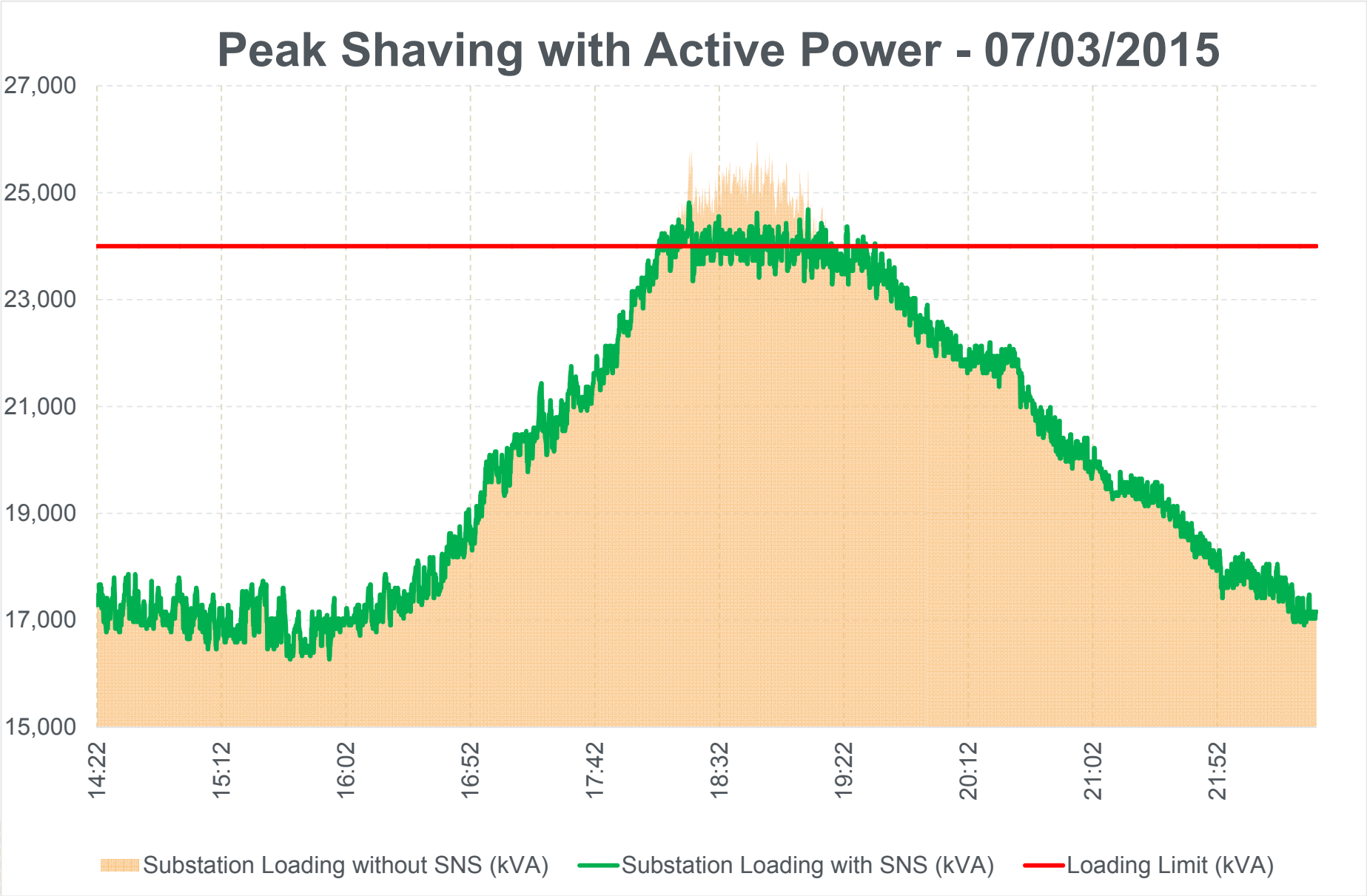

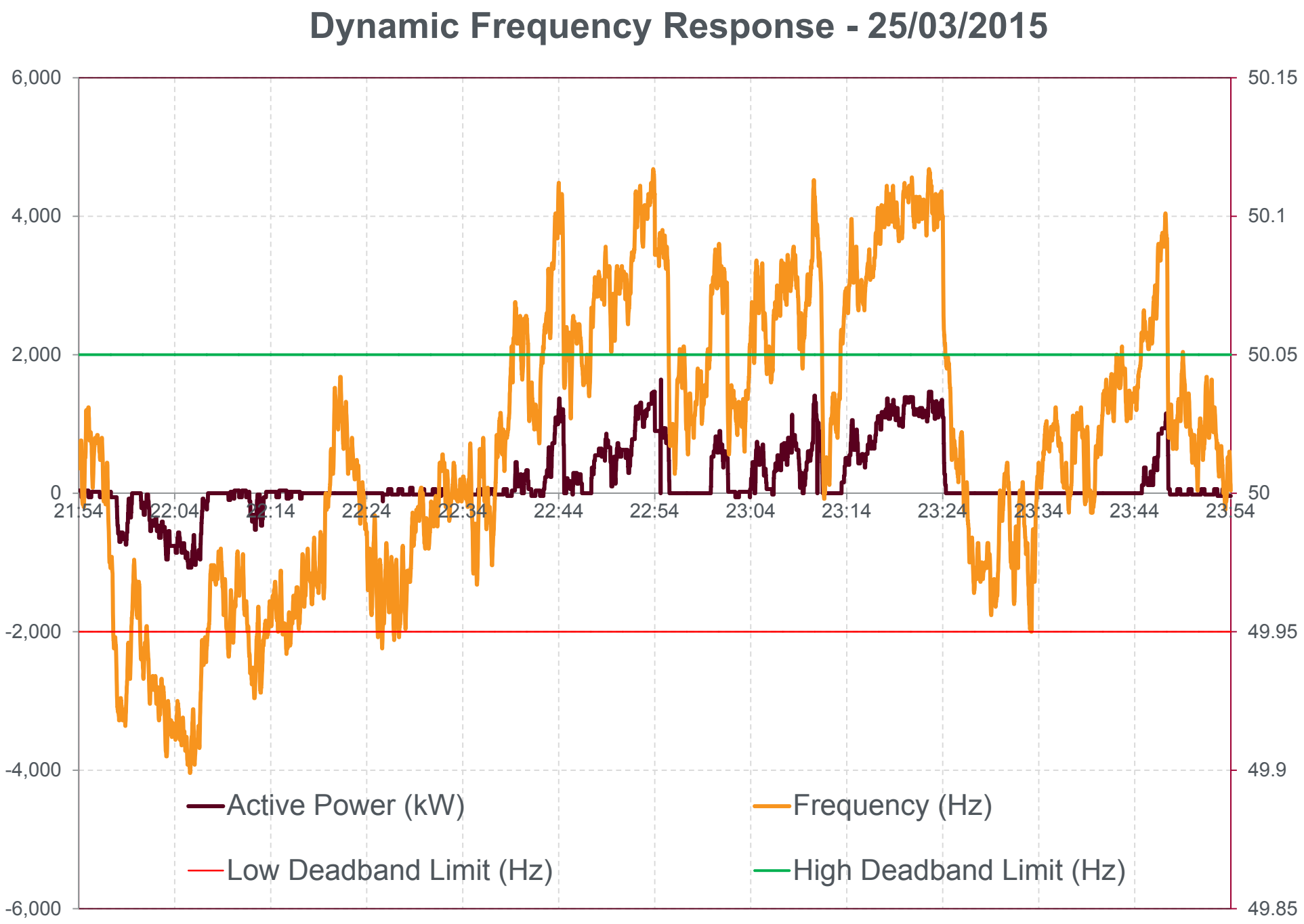
Dynamic Frequency Response - 25/03/2015
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
50.15
50.1
50.05
50
49.95
49.9
49.85
21:54
22:04
22:14
22:24
22:34
22:44
22:54
23:04
23:14
23:24
23:34
23:44
23:54
Active Power (kW)
Frequency (Hz)
Low Deadband Limit (Hz)
High Deadband Limit (Hz)

First Quarter Performance

Application / Service	Availability / Requirements	Results
Peak Shaving	24 days (72HH) with deviations over firm capacity experienced; Peak Power 3.2MVA; Peak Energy 5.41MVAh	Support provided. No N-1 outages requiring despatch.
TRIAD	TRIAD periods announced: 1) 4th Dec 14, 17:30 2) 19th Jan 15, 17:30 3) 2nd Feb 15, 18:00	1/3 TRIADS covered: 1) Idle for investigations 2) Idle for investigations 3) Peak export of 1600kWh
STOR	April Committed Season 1 for 2015: Weekday: 7:00 – 13.30; 19:00 – 22:00 Weekend: 10:00 – 13:30; 19:30 – 22:00	~100% 3MW Availability for 222.5 hours. 0 despatch calls

Other Learning Outputs

Consultation on possible future business models for grid-scale energy storage
July 2013

Design & planning considerations for grid-scale storage
October 2013

Design & Architecture of Optimisation & Forecasting platform
December 2013

GB Regulatory and Legal barriers for energy storage
June 2014

Commercial Arrangements for the shared use of storage flexibility
October 2014

Energy Storage as an Asset – Asset management, training and commissioning
May 2015

Recommendations for regulatory & legal amendments for storage
September 2015

Energy storage contribution to Security of Supply, and effect on standards
January 2016

Evaluation of value streams, business model viability
March 2016

More Information available at:
http://innovation.ukpowernetworks.co.uk/innovation

ED1 Challenges

Final Determination

DNO	DPCR5 totex**	Fast-track submitted totex	Slow-track final submitted totex+	Slow-track dd allowance*	Ofgem's view slow-track fd	Slow-track fd allowance*	Difference between st submitted and fd allowance*	Difference between dd and fd allowances*
	£m	£m	£m	£m	£m	£m	%	%
ENWL	1,949	1,900	1,876	1,794	1,808	1,8[illegible]5	-2.7%	1.[illegible]7%
NPgN	1,307	1,365	1,368	1,243	1,230	1,2[illegible]5	-7.6%	1.[illegible]%
NPgY	1,771	1,859	1,805	1,685	1,657	1,6[illegible]4	-6.1%	0.[illegible]%
LPN	1,762	1,968	1,970	1,749	1,704	1,7[illegible]1	-10.1%	1.[illegible]%
SPN	1,827	1,897	1,872	1,710	1,673	1,7[illegible]2	-8.0%	0.[illegible]%
EPN	2,753	2,861	2,775	2,537	2,457	2,5[illegible]6	-8.6%	0.[illegible]%
SPD	1,581	1,740	1,563	1,519	1,505	1,51[illegible]	-2.8%	0.[illegible]0%
SPMW	1,908	2,220	1,924	1,687	1,581	1,66[illegible]	-13.4%	[illegible].2%
SSEH	998	1,230	1,210	1,097	1,092	1,121	-7.4%	2.2%
SSES	2,264	2,490	2,425	2,301	2,304	2,334	-3.7%	1.4%
Total	**18,120**	**19,531**	**18,788**	**17,321**	**17,011**	**17,455**	**-7.1%**	**0.8%**

Important cuts!

Our final business plans include spending until 2023:

South-Eastern Power Networks, £1.71 billion

Eastern Power Networks £2.54 billion

London Power Networks £1.75 billion

Improved Efficiency

Increased Network Reliability

Identify Areas of Cost Reduction

Network Innovation Allowance funding

Strategy Themes that aim to deliver tangible benefits fast

UKPN Innovation Strategy

https://library.ukpowernetworks.co.uk/library/en/RIIO/Main_Business_Plan_Documents_and_Annexes/UKPN_Innovation_Strategy.pdf

Challenges - Energy Storage from a DNO Perspective

- Energy pricing: visibility and forecasting
- Huge amounts of data from over 50,000 cells (higher number than our substations!), is data analytics/pattern recognition/predictive maintenance a way forward?

Challenges - General

- Probabilistic/Risk based planning with evolving P2/6 – Composition of load/generation profiles based on location (i. contribution to security of supply, ii. maximisation of capacity)
- Real-time forecasting, online state estimation/load flow
- Mechanisms for/Coordinated Voltage Control in LV/HV from DER with power electronics converters (“avoiding hunting” and interacting with existing systems-e.g. AVC)
- Optimisation of normally open points
- Smart metering data

Thank you

- For your attention

- to Nick Heyward, Ian Cooper, Jordi Ros, John Hayling, Paresh Mehta, Jose Barros and Sotiris Georgiopoulos for some of the material, the SNS project partners, and all the people that dedicated over 46,000 man-hours to build the ESS

http://www.ukpowernetworks.co.uk/innovation

Smarter Network Storage
Maximising the whole system value of grid-scale storage

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