Long-run resilience in the energy & water sectors

NEW PIN Workshop
22 June 2016

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Introducing Electricity North West

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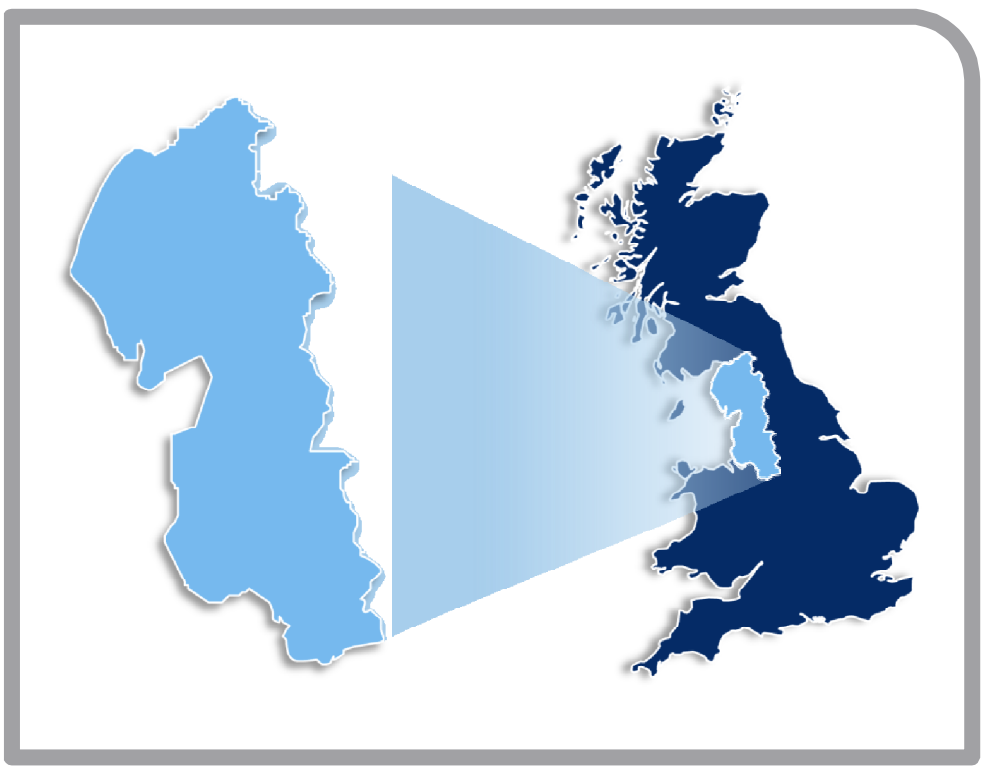
4.9 million

2.4 million

23 Terawatt hours



£12 billion of network assets

56 000 km of network ● 96 bulk supply substations
363 primary substations ● 33 000 transformers

A model of resilience

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Minimising exposure

Maximising tolerance

Resilience Risk

- Removal
- Resistance
- Redundancy
- Response

Mitigating impact

Expediting recovery

A model of resilience

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- Removal – asset never sees event
- Resistance – asset sees event but resists or withstands it
- Redundancy – asset sees event, is impacted by it but effect is minimised
- Response – asset sees event, is impacted & affected but recovers quickly

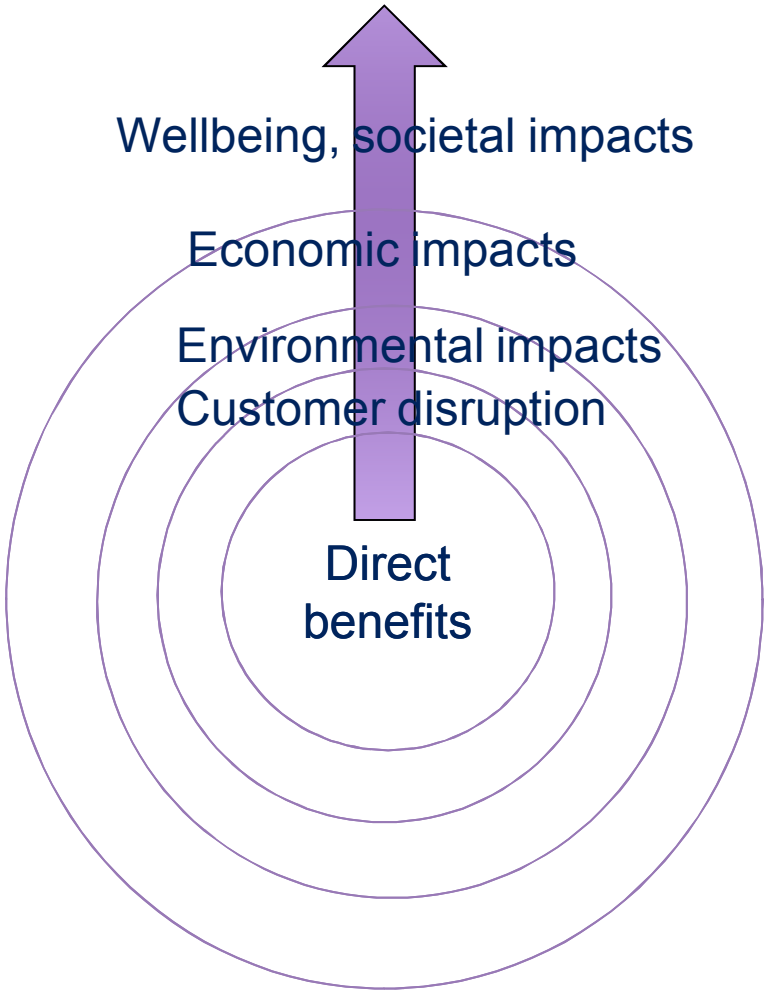
Key discussion points

- What is the appropriate balance between the different dimensions of resilience?
- Proactive measures come at a cost
- Total risk removal is rarely possible
- What level of preparedness is appropriate or economic?
- Should we have deterministic or risk-based standards?
- Should there be an overall measure (or Index) for resilience?

- Resilience of what? Against what? For whom?

Benefits or consequence framework

- How wide should the basket of benefits be in assessing appropriate proactive measures?
- Historic focus on direct benefits, eg avoided repair costs
- More recently, this has expanded to include a measure of customer disruption
- Ofgem now require consideration of Cost of Carbon in investment appraisal, although DNOs are not exposed to this
- Consideration of Critical risks has considered impact on economic activity, eg GVA
- Should measures for wider social impacts and wellbeing be included?
- Key link is valuation of the lost amenity from the service loss



Appendix - Storm Desmond

4/5 December 2015

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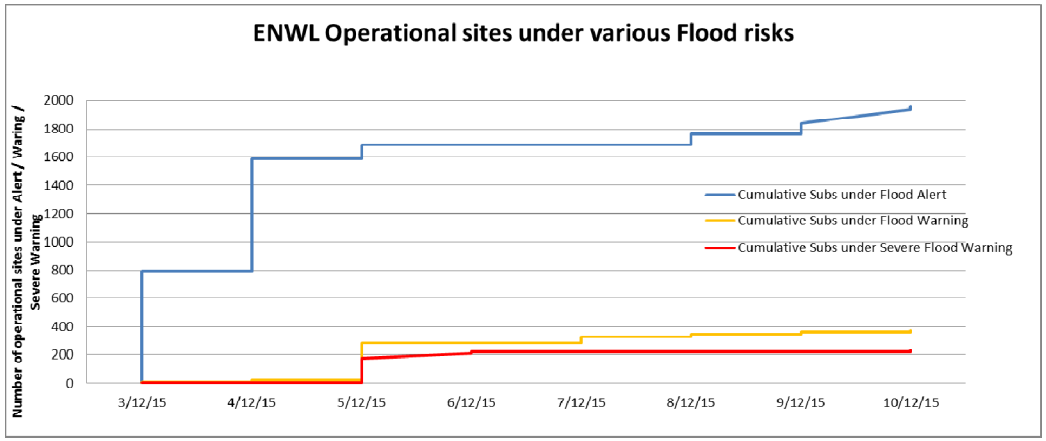
Storm Desmond Flooding

Met Office

48 Hour UK Rainfall Total 0900 4th December – 0900 6th December

Site Name	Area	Rainfall Total mm
Shap	Cumbria	262.6
Keswick	Cumbria	178.4
Blencathra	Cumbria	174.8
Capel Curig	Gwynedd	170.6
Tyndrum	Perthshire	141
Eskdalemuir	Dumfriesshire	139.2

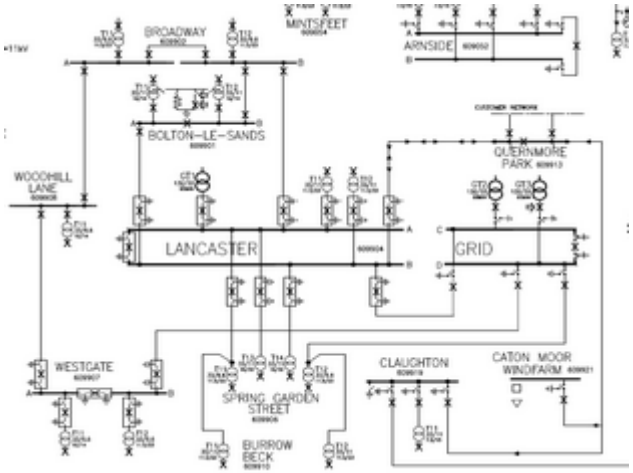


- Rainfall exceeded previous 24 and 48 hour records.
- Exceeded 300mm locally.
- Rain fell on saturated hills causing rivers to ‘flash’
- River levels spiked beyond EA models
- EA Alerts, Warnings and Severe Warnings covered some 2,500 ENW operational sites
- Severe Warnings (danger to life) covered over 200 sites.

Lancaster Grid 1

- Severe flooding of River Lune adjacent to Lancaster Grid
- High volume pumping and installation of additional defences unsuccessful
- Defences overtopped - Supplies lost to 60,987 customers by 22:39 on 5/12
- Flooded assets - both 33kV switchboards, A and B section busbars, protection systems, batteries, SCADA and auxiliary wiring and control systems
- 75 >500KVA generators connected restoring 22,000 customers
- Access to site noon 6/12
- GT1 restored 04:28 on 7/12 with most customers restored shortly after, generators left in situ. Final restorations 15:30 on 7/12

Lancaster 2



- 15:56 on 7/12 fault on section A busbar in the GT1 busbar connector interrupting 45,525 customers
- Catastrophic failure of GT1 section A link chamber due to water ingress into the resin oil – confirmed by EATL
- Section A un-repairable - all work now focused on GT2 and sections C and D
- Extensive emergency jointing, including associated control systems
- Supplies restored successively. Final restorations at 19:18 on 8/12

Willowholme Primary substation, Carlisle

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- Site immediately adjacent to the Environment Agency's River Eden defences and relies on those defences in line with ETR138
- Willowholme Primary substation site was flooded to a depth of more than 1m exceeding 1:100 and 1:1000 (2010 forecast) depths
- 11kV switchboard submerged to a depth of 1.5m
- Additional temporary defences including door seals, sand bags and pumps did not prevent loss of site. Supplies lost 08:37 on 6/12
- Access to the site only possible by boat and access to the switch house only possible through roof apertures
- Majority of customer supplies were restored from adjacent network feeders
- Small number of customers – mainly industrial/ commercial – remained off (many flooded)
- Site restored 09:46 on 15/12

Melling Primary Substation

- 1.29m Flood defences overtopped
- Protected to 1:1000
- RC used to supply majority of 1,096 customers via HV interconnection from Keswick
- Remaining customers off until repairs completed 07/12/15 (2 days later)