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Bringing energy to your door

# Building in resilience to cope with future challenges

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# Agenda

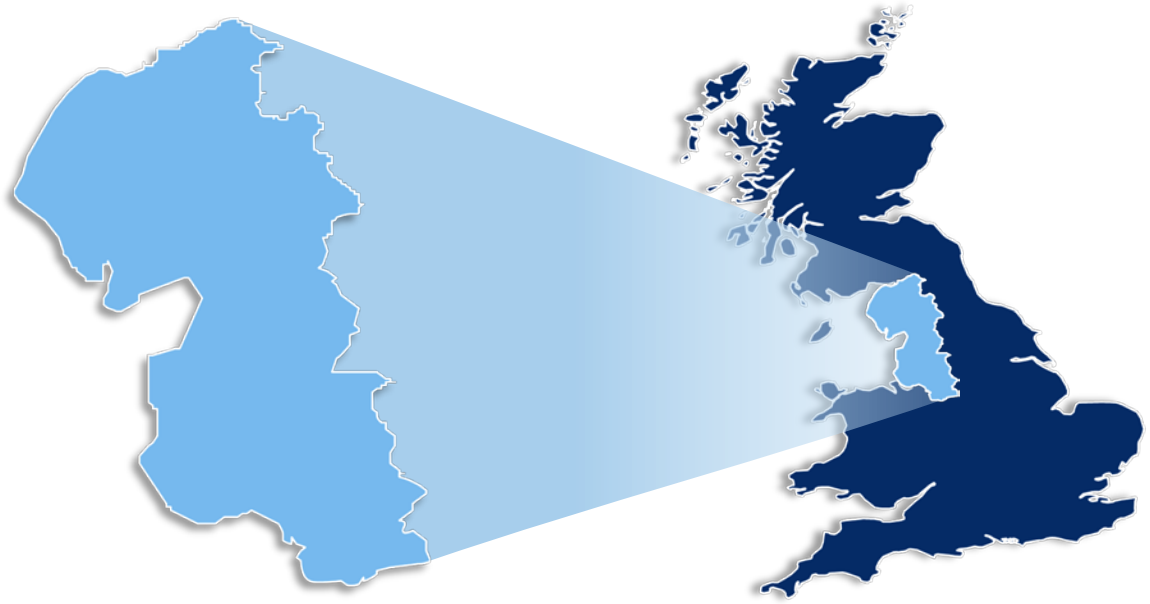
- The impacts of climate change on future networks resilience
- Planning for ‘what if’ scenarios
- Lessons from Lancaster
- Preparing for the unforeseen

# Introducing Electricity North West

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

# We have one job

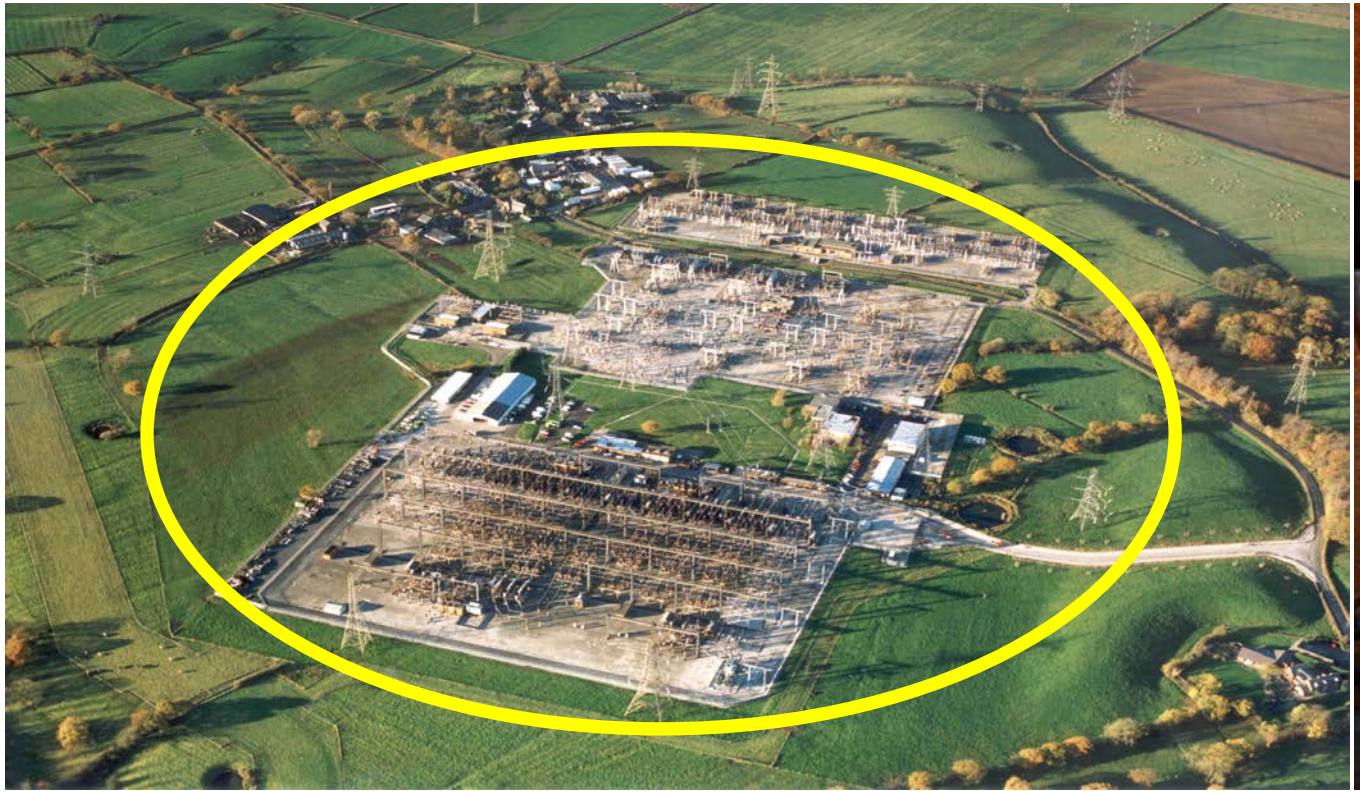
- Our role is to deliver electricity to customers in the North West of England from both national and local generators
- We have a reliability of 99.99%

- If we meet our current regulatory targets  our customers will have an interruption to their power supply once every 27 months
- That interruption will last 85 minutes on average
- For most customers performance is a lot better than this

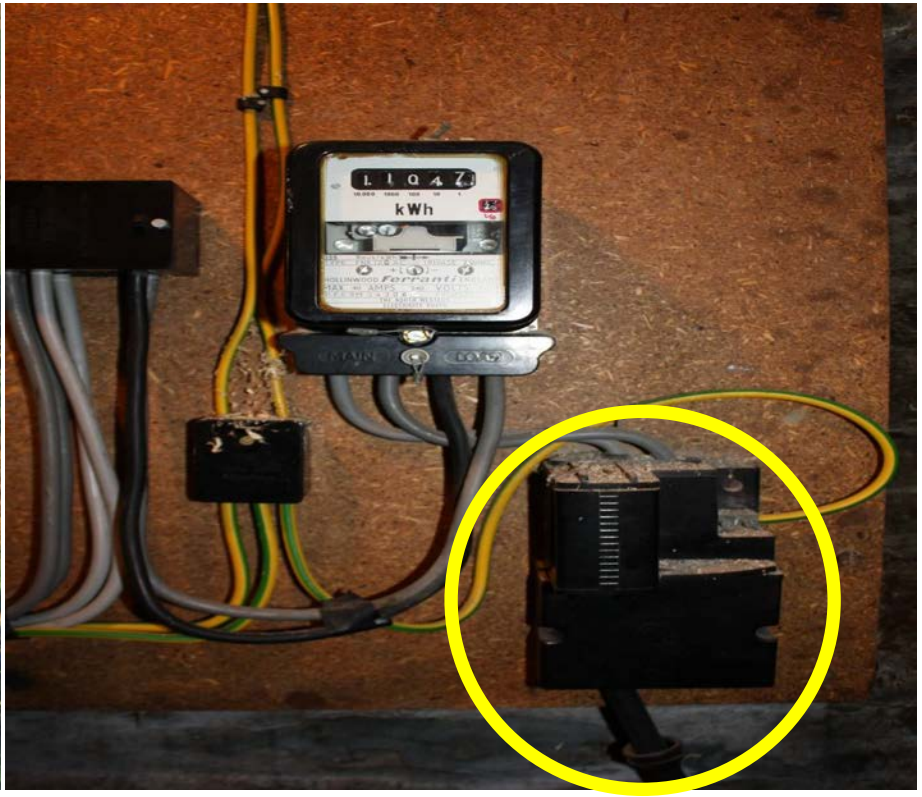
- Previously we described our role as ‘keeping the lights on’
- Now we talk about ‘powering your day’

# The assets we manage

From 15 of these



To around 2.4 million of these



# The impacts of climate change on future networks resilience

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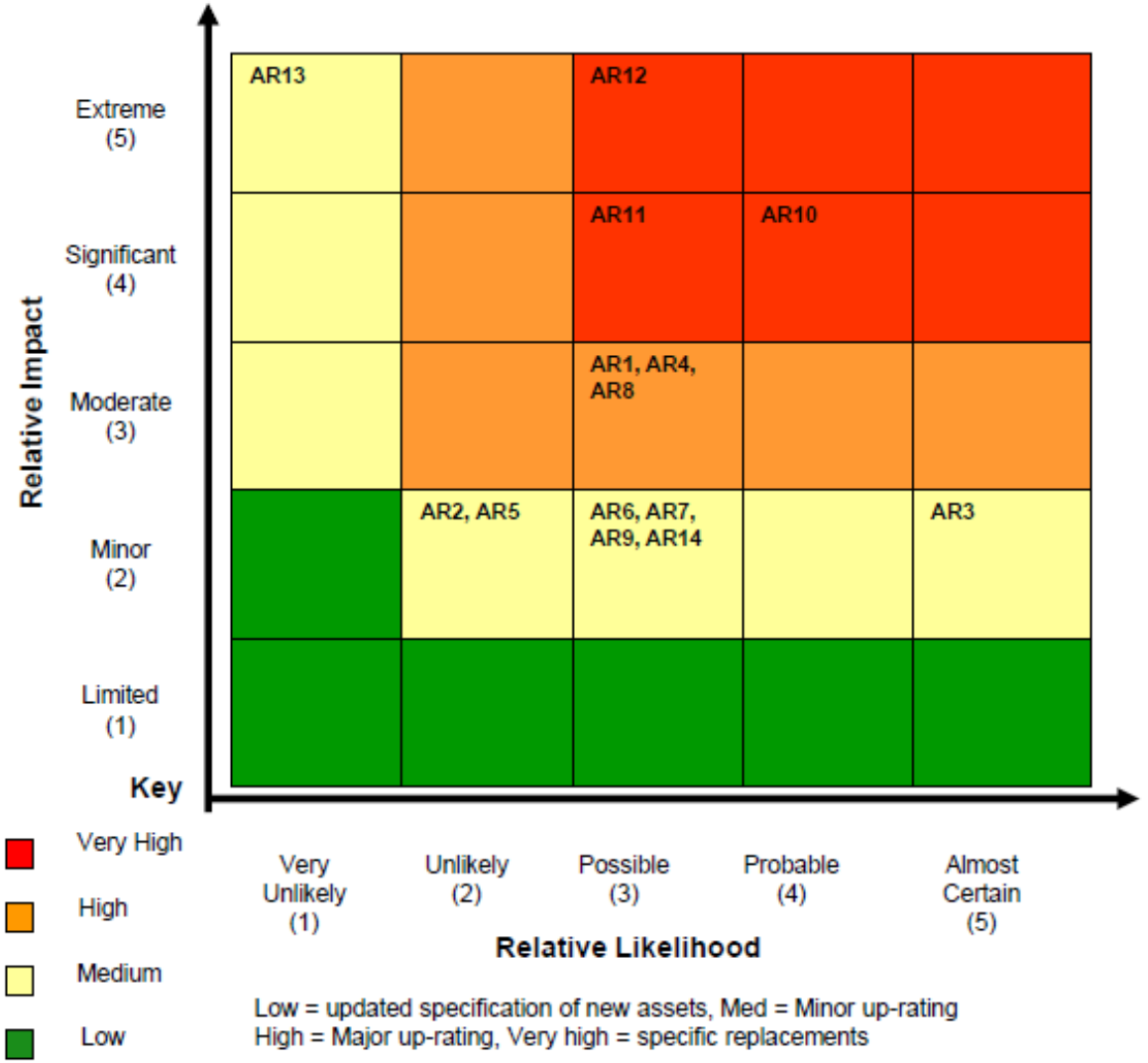
# Climate Change Adaptation Reporting

- Electricity North West are a Reporting Authority under the Climate Change Act of 2008
- In 2011 and 2015 we submitted our company reports to Defra accompanied by an industry document for electricity distribution and transmission developed through an ENA working group
- Defra are currently consulting on plans for the third round of reporting, which is expected to take place in 2021

# Industry view of Climate Change Risks

- Top three risks are:
  - AR10 - river flooding
  - AR11 – pluvial flooding
  - AR12 – sea flooding

**Risk Matrix Showing Overall Impact (Refers to UKCP09 projections for the end of the century assuming a High Emissions Scenario and 90% probability level and no adaptation measures taken)**




Low = updated specification of new assets, Med = Minor up-rating
High = Major up-rating, Very high = specific replacements

AR1 Overhead line conductors affected by temperature rise, reducing rating and ground clearance.
AR2 Overhead line structures affected by summer drought and consequent ground movement.
AR3 Overhead lines affected by interference from vegetation due to prolonged growing season.
AR4 Underground cable systems affected by increase in ground temperature, reducing ratings.
AR5 Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage.
AR6 Substation and network earthing systems adversely affected by summer drought conditions, reducing the effectiveness of the earthing systems.
AR7 Transformers affected by temperature rise, reducing rating.
AR8 Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months.
AR9 Switchgear affected by temperature rise, reducing rating.
AR10 Substations affected by river flooding due to increased winter rainfall.
AR11 Substations affected by pluvial (flash) flooding due to increased rain storms in summer and winter.
AR12 Substations affected by sea flooding due to increased sea levels and/or tidal surges.
AR13 Substations affected by water flood wave from dam burst.
AR 14 Overhead lines and transformers affected by increasing lightning activity.

# What will be the major impacts?

- In both our reports we noted the following potential impacts:
  - Flooding
  - Increase in temperature
  - Increased vegetation growth
  - Resilience to extreme events
- With the exception of flooding we expect that the impacts on our business from climate change will be gradual, largely indistinguishable from other factors, and that we will be able to deal with them with a long term approach.
- We will continue to work with our colleagues in the industry and other expert bodies to regularly assess our vulnerability to climate change, and we will adapt our policies and procedures accordingly when required.

# Planning for what-if scenarios

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# Quick quiz

- What do the following substation photos have in common?

# Carrington

# Stalybridge

# Kearsley

# Sale

# Rochdale Grid Supply Point

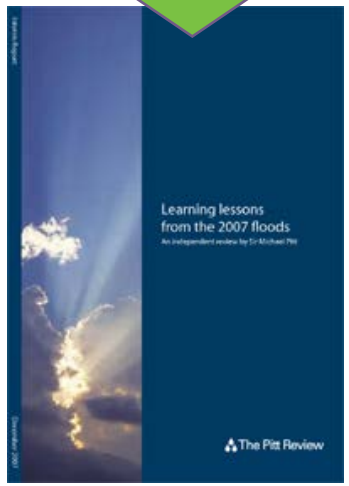
# Ribble

# Flooding is not a new phenomenon

- 2005 - Carlisle
- 2007 - national flooding event
- 2008 - Rochdale
- 2009 – West Cumbria
- 2015 – Lancaster, Cumbria, Rochdale

# Development of flood risk management

Led to

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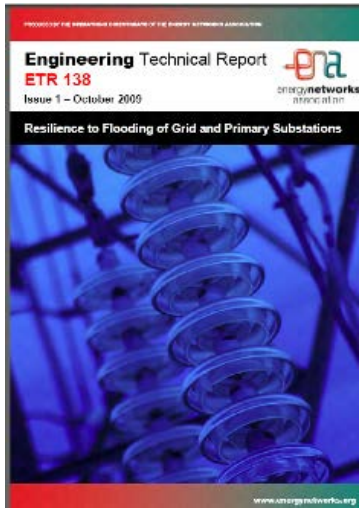


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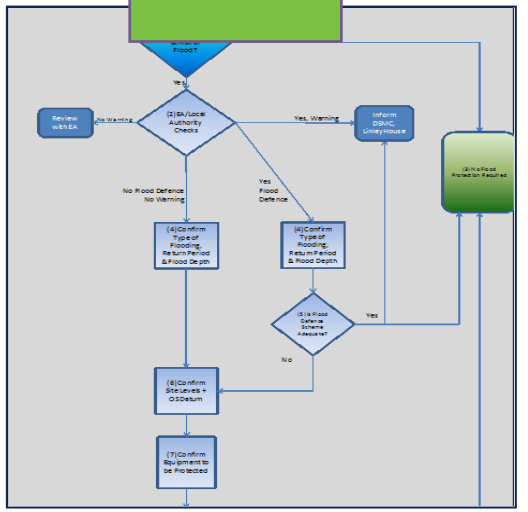
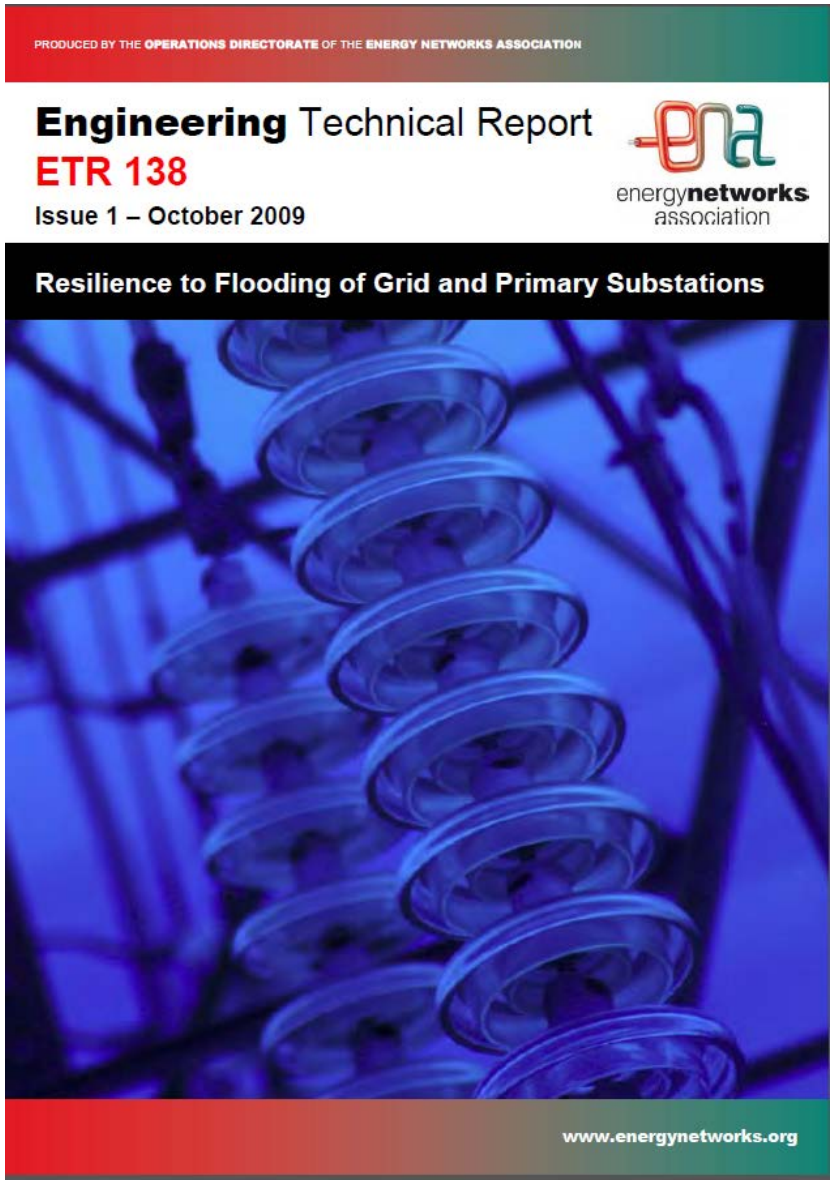


# ETR138

- ETR138 developed by a working group co-ordinated by the Energy Networks Association (ENA)
- Largely deterministic approach to flood risk management
- Identifies three different levels of acceptable flood risk
  - Level 1: most important grid substations (typically supplying 50,000 to 500,000 customers) - likelihood of flooding should be no more than 1 in 1000 annual probability
  - Level 2: other primary substations (typically supplying 5,000 to 30,000 customers) - likelihood of fluvial flooding no more than 1 in 100 annual probability and 1 in 200 annual probability for sea flooding.
  - Level 3: for sites where level 1 or 2 cannot be justified – other flood resilience measures.

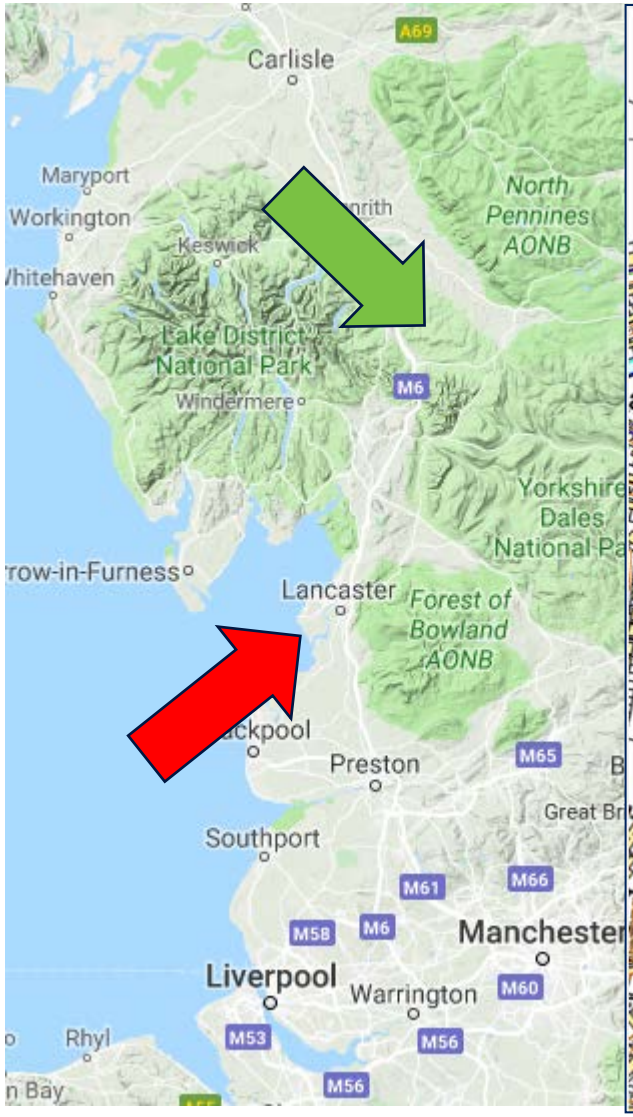


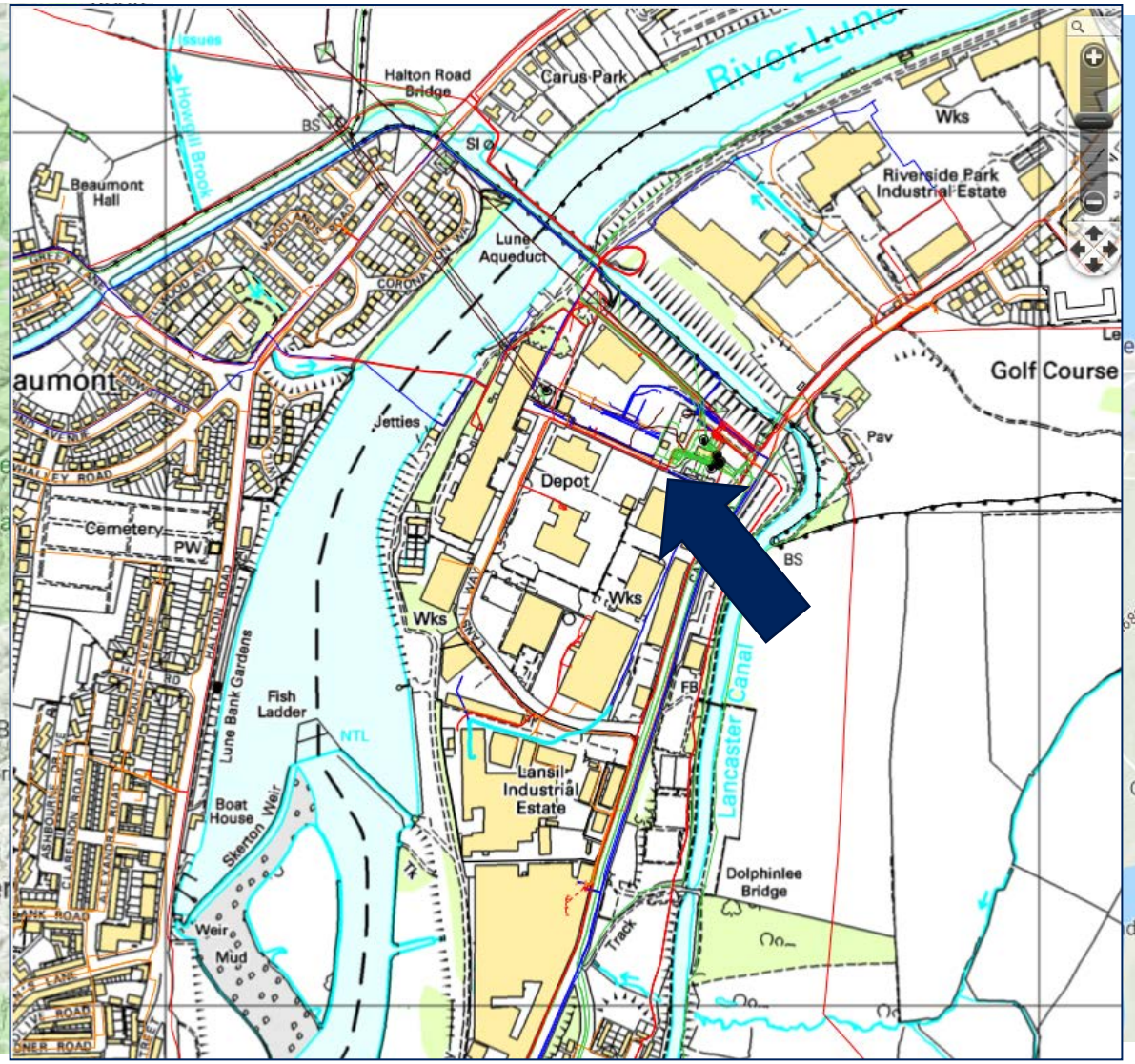
# Application of ETR138

- Levels of flooding risk defined by Environment Agency flooding maps
- Only applies to larger substations – it has always been assumed that if a distribution substation is flooded then the properties it supplies will also be flooded. We can usually restore a substation to service before a property is dried out
- Typically led to pouring concrete – hard defences
- We spend about £100m each year on network investment
- Over the last seven years about £1.6m per year has been on flood protection

# Lessons from Lancaster

# Where is Lancaster?

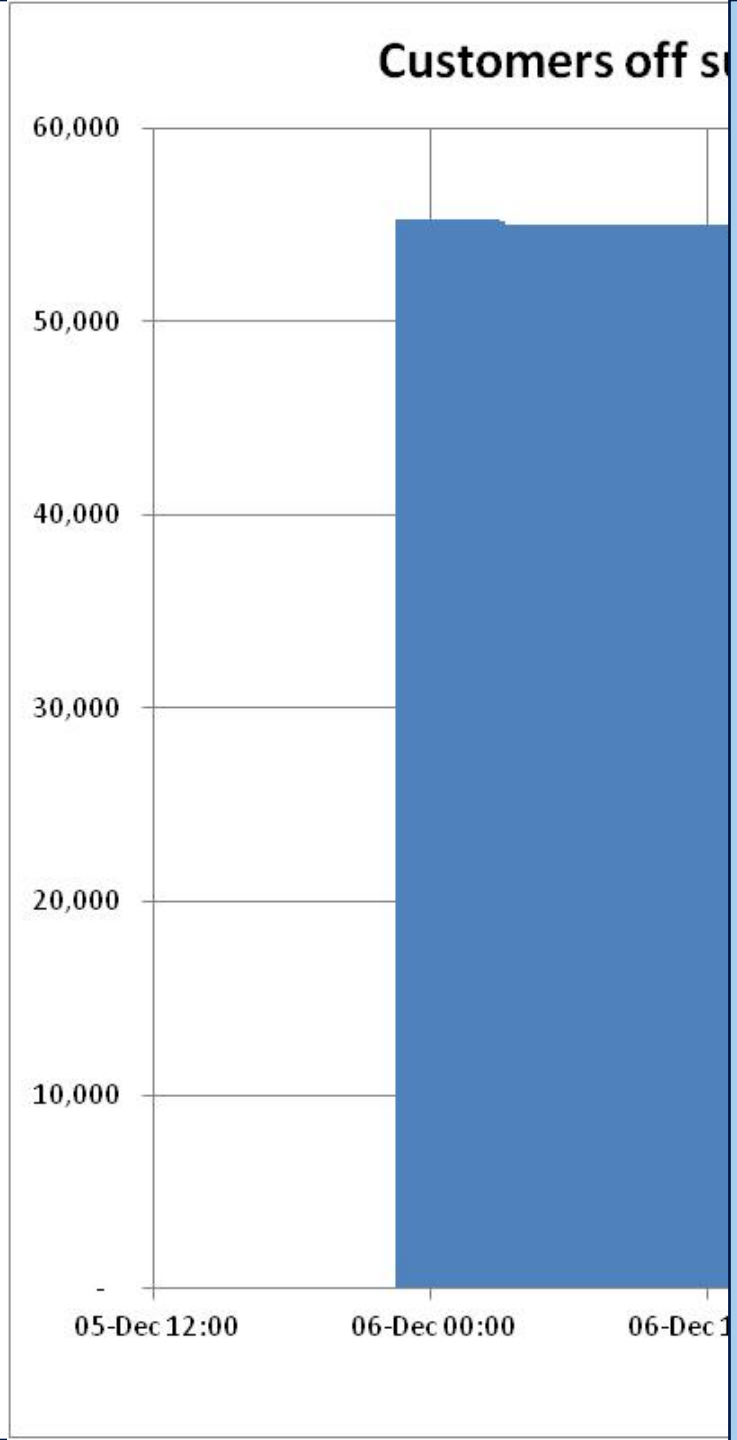


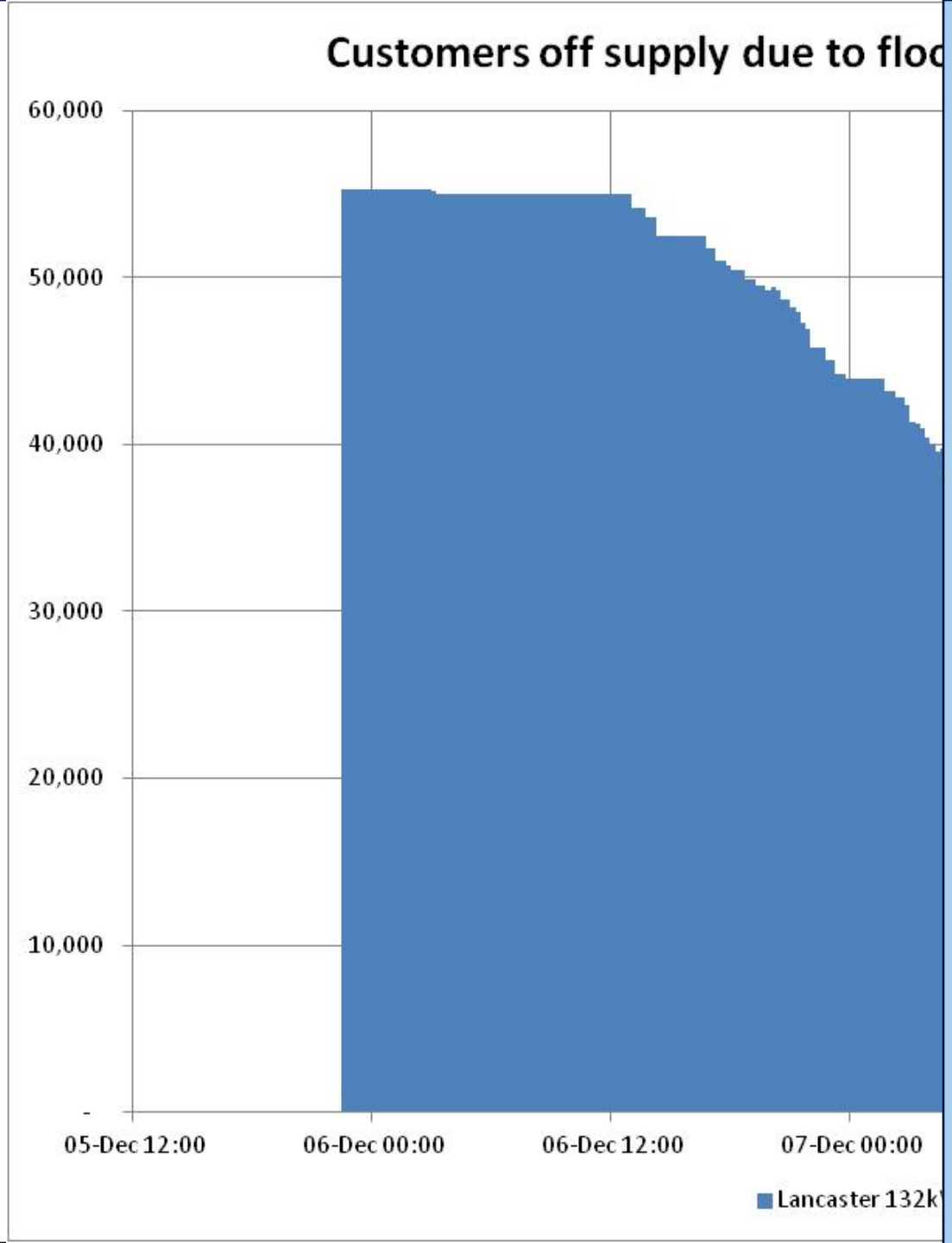

# Storm Desmond

- Storm Desmond brought unprecedented levels of rainfall to the North West of England in the first week of December 2015
- Rain fell on hills that were already saturated due to a prolonged period of heavy rain in the wettest November on record
- River levels spiked above the levels in the Environment Agency (EA) models
- 2,500 of our operational sites were subject to alerts, warnings and severe warnings
- Severe warnings, which indicate a danger to life, covered over 200 of our sites
- Our defences at Lancaster, completed in 2009, were 1.02m high meeting the one-in-hundred criteria in ETR 138
- River levels rose about 6m above normal at their peak putting the substation at risk
- At 22:39 on Saturday 5 December 2015 the decision was made that the Lancaster Grid substation would be switched off to avoid catastrophic damage.

You had one job!

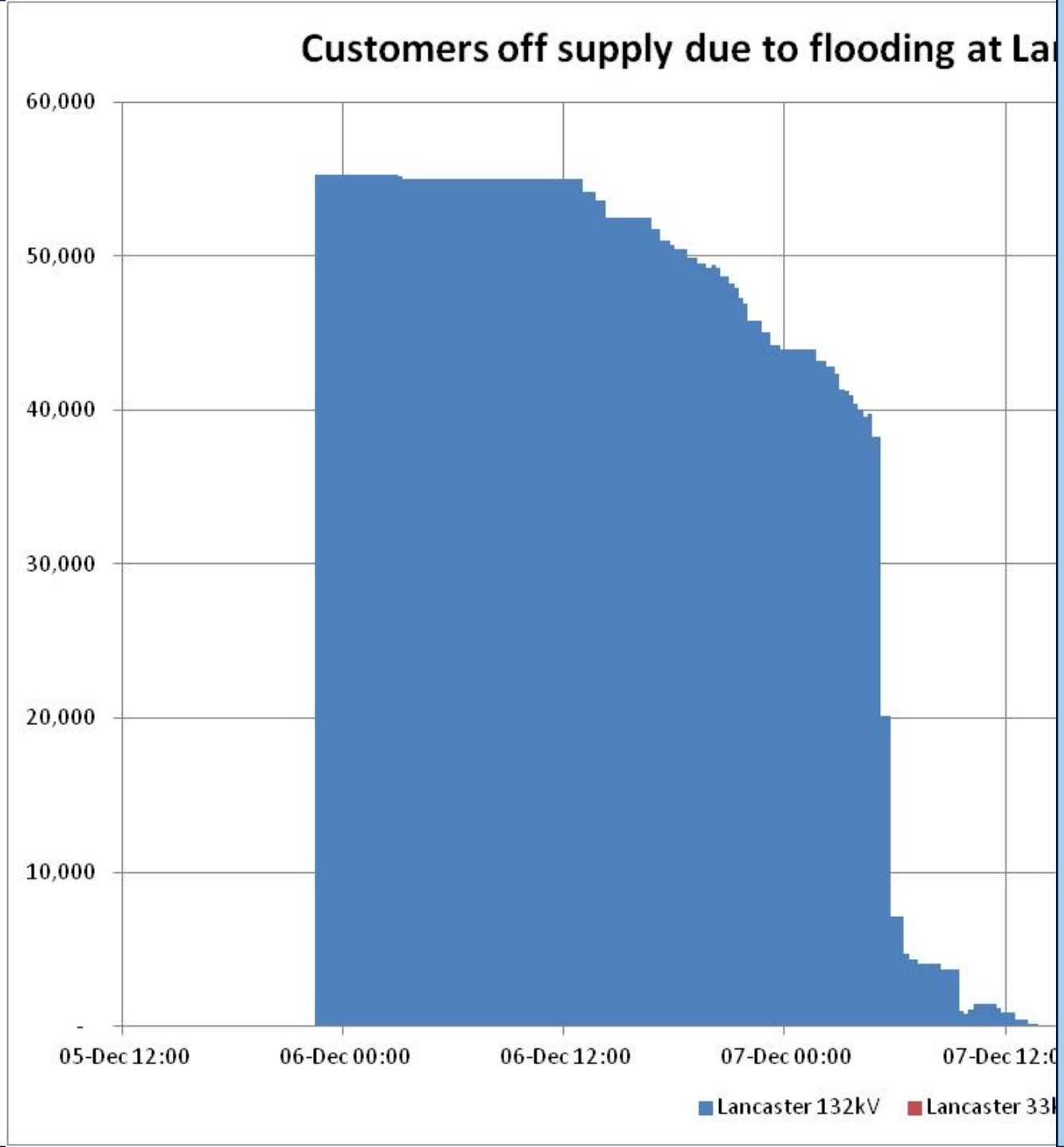



- At 22:39 on Saturday evening supply was lost to 55,249 customers
- Approximately 300 were restored by 12:30 on Sunday

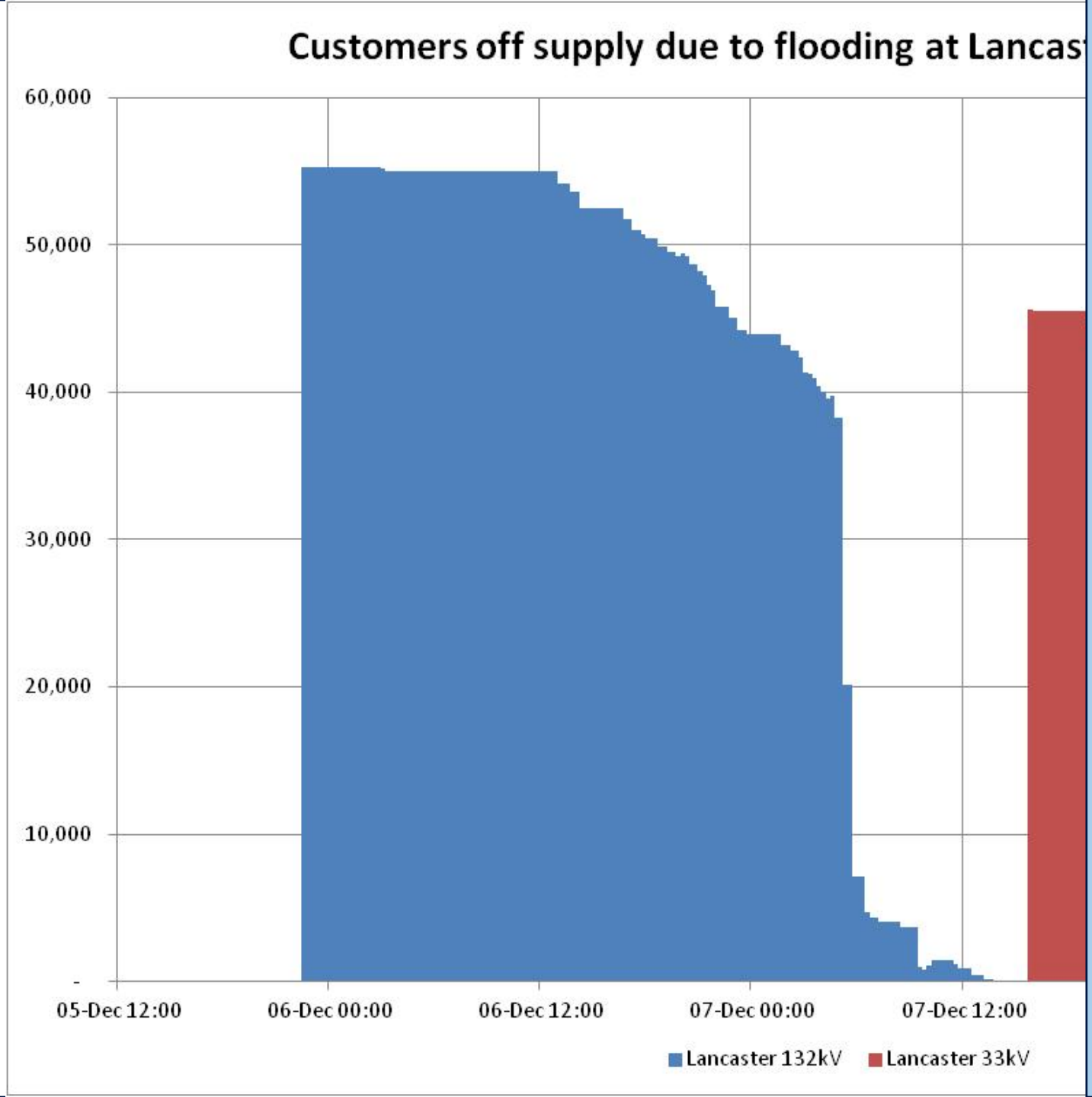



- By 05:00 on the Monday morning a further 17,000 had been restored using 75 mobile generators

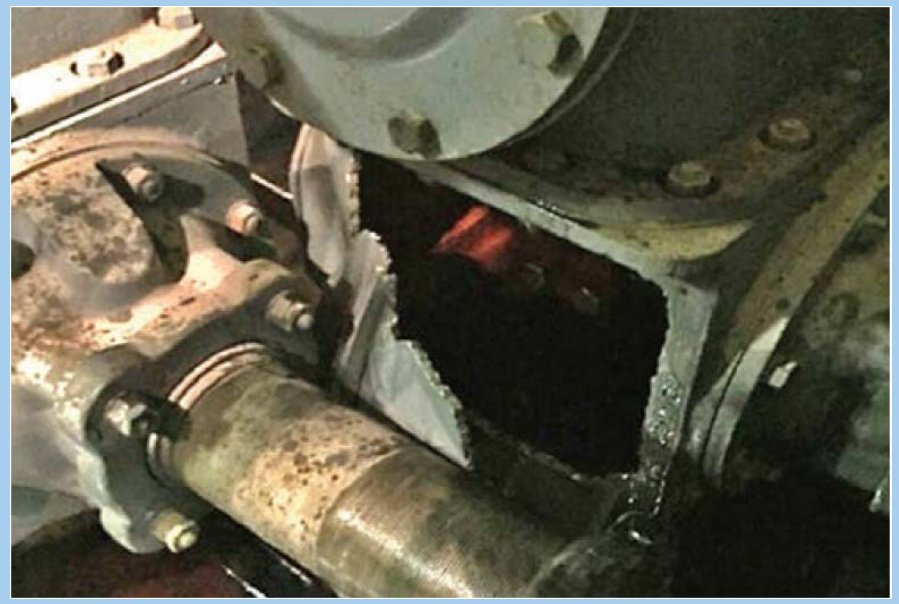

- There were still 38,236 customers who had been off supply for 32 hours at this stage

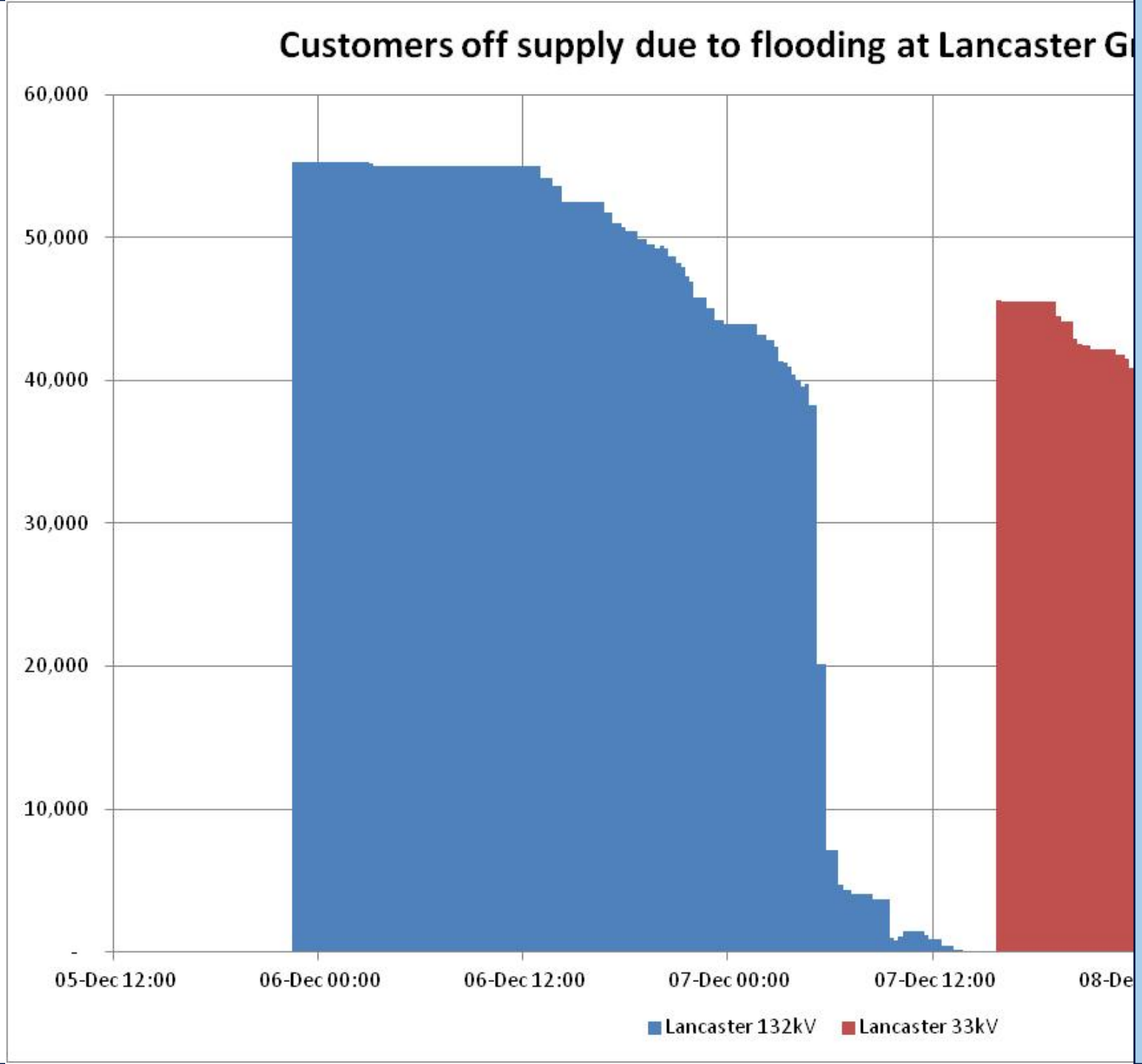



- The substation was made safe at 04:28 and customers were gradually restored to the grid in a phased process
- By 15:30 on Monday all customers had their power restored
- This incident had lasted 41 hours

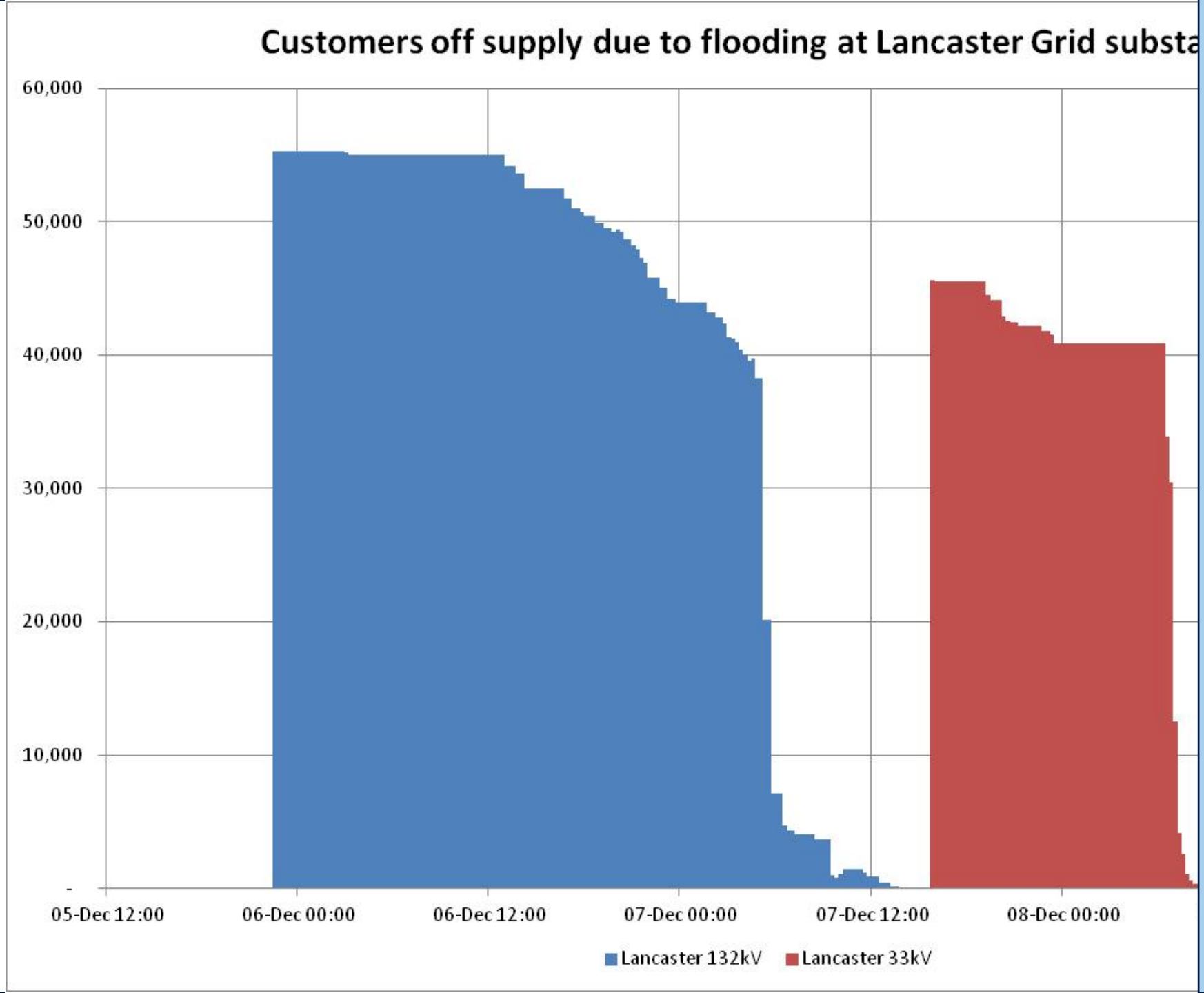



- Unfortunately water had entered a 33kV busbar
- At 15:56 on Monday that busbar failed and supplies were lost to 45,628 customers

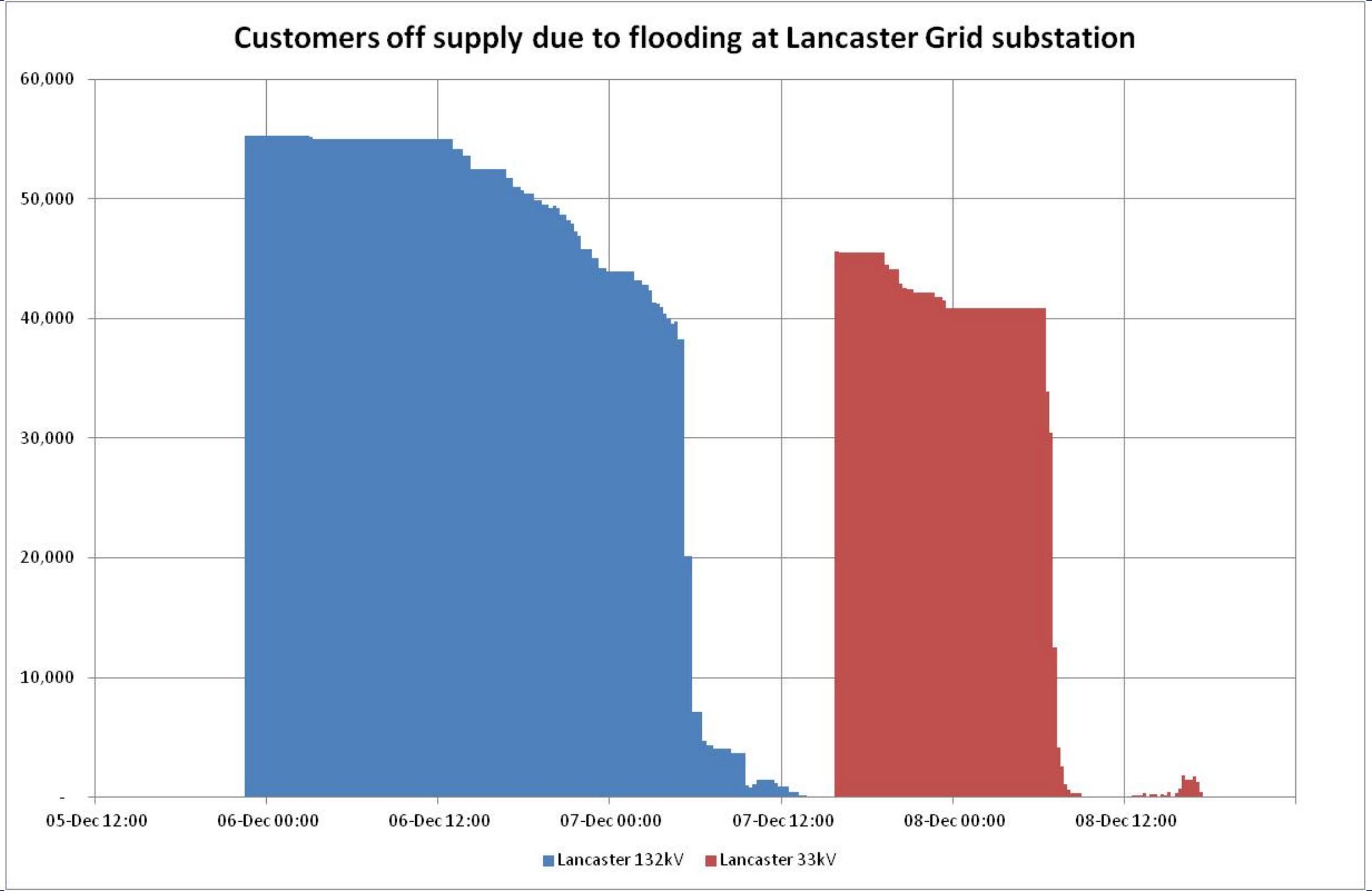





- Again generators were used to restore around 4,000 customers by 23:00 on Monday

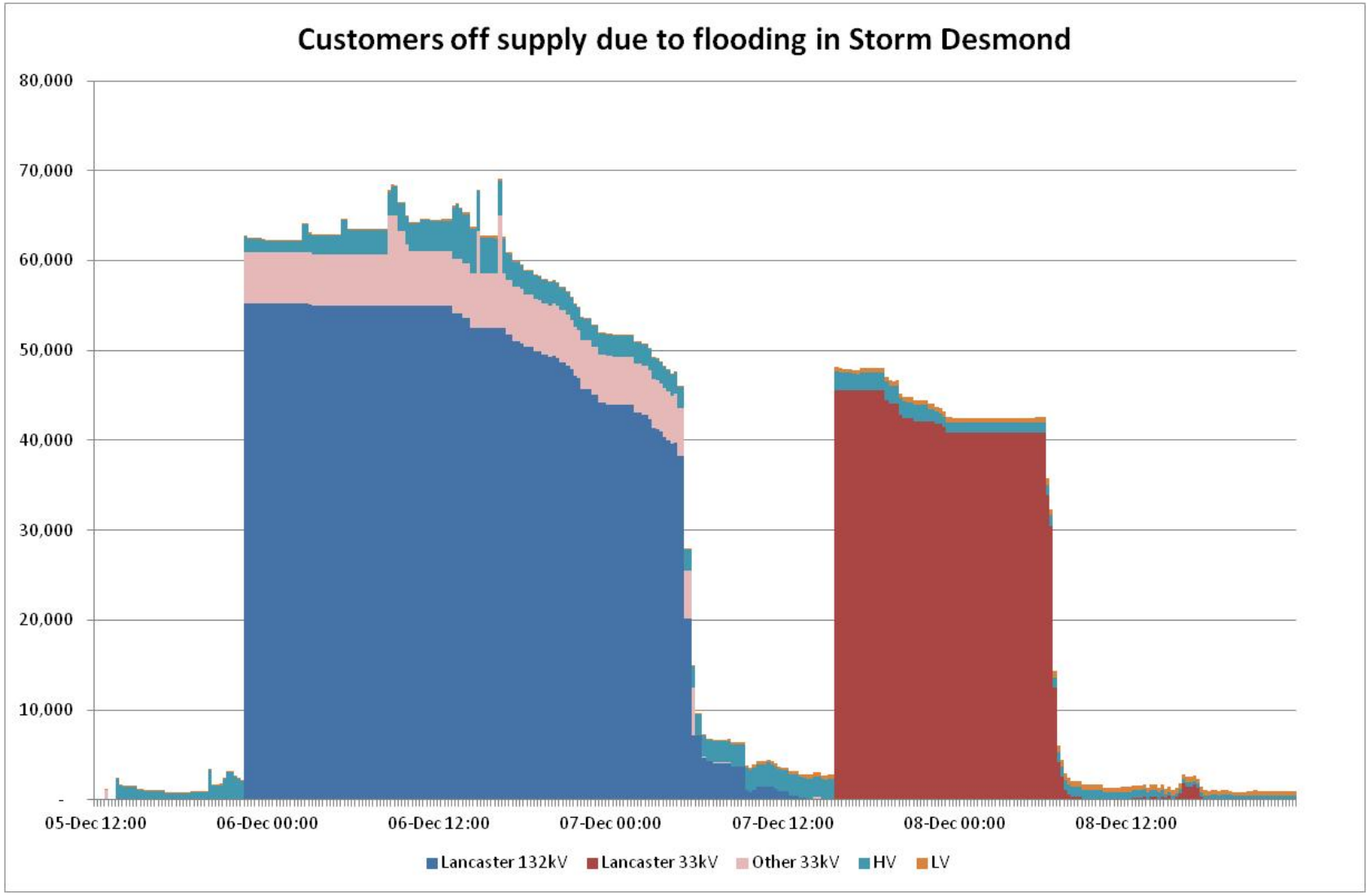



- The fault was repaired by 06:00 on Tuesday morning and most customers were back on supply by 08:00
- 40,849 customers were off supply for a further 14 hours in the second incident
- All customers restored at 19:18 on Tuesday evening

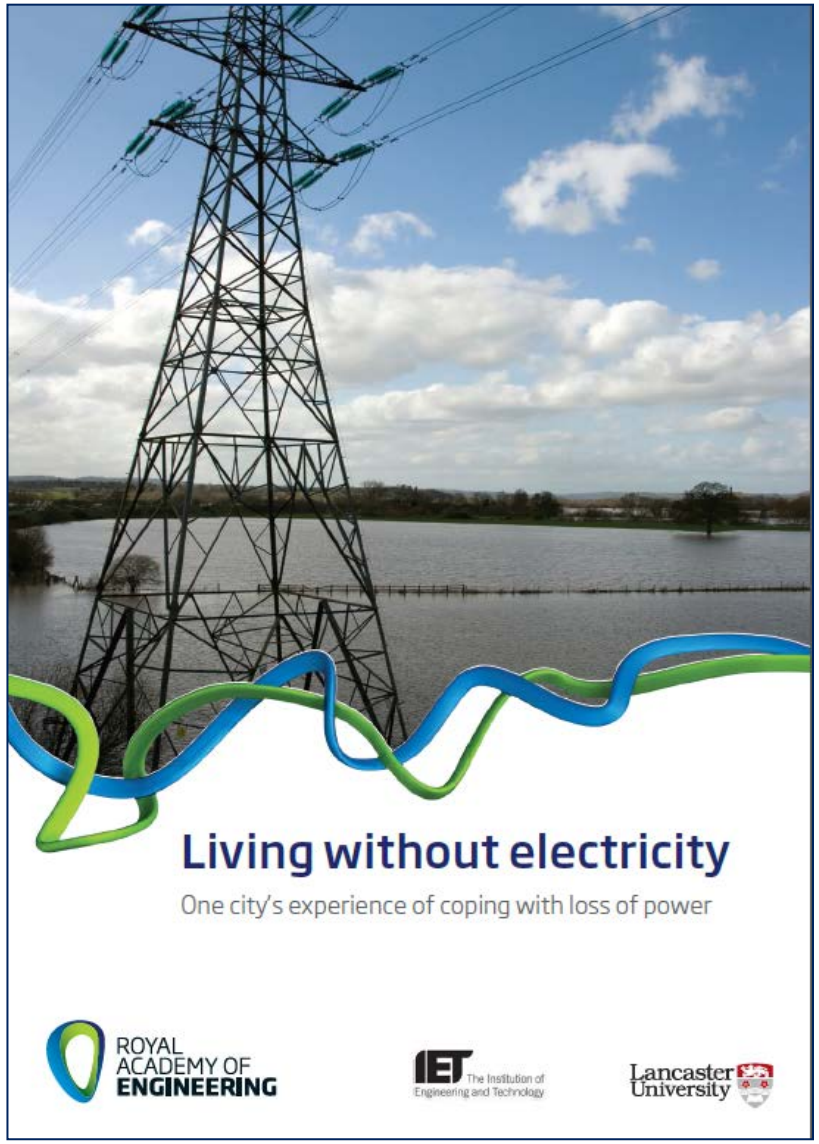

Customers off supply due to flooding at Lancaster Grid substation
60,000
50,000
40,000
30,000
20,000
10,000
-
05-Dec 12:00
06-Dec 00:00
06-Dec 12:00
07-Dec 00:00
07-Dec 12:00
08-Dec 00:00
08-Dec 12:00
Lancaster 132kV
Lancaster 33kV

# Floods across the area

- We also had major flooding across Cumbria and in Carlisle
- At 16:15 on Sunday afternoon almost 3% of Electricity North West customers were without electricity



# Impact on our customers




- In a period of 55 hours over 40,000 of our customers were off supply for nearly 44 hours
- We live in a society that assumes that electricity will almost always be available and our lives are built around this assumption
- When we lose supply for such a length of time it has a major impact
- In May 2016 the Royal Academy of Engineering, the IET and Lancaster University produced a report summarising these impacts and how they interacted
  - *Although these dependencies were not difficult to see, few had thought through the implications of losing so many aspects of modern life at once.*

# Selected impacts – please read the whole report

- Most mobile phone coverage was lost within an hour; although most landline phone services were available, but only with traditional ‘plugged-in’ hand sets
- In shops lights, freezers and electronic payment systems wouldn’t work
- Even where customers had gas heating it would not work without the electric control systems and pumps
- The railway line through Lancaster had its own supply, but with no lighting the station had to be closed
- Very limited capability to communicate what was happening

*Each individual action – for example, doctors replacing paper files by computer systems, a government department ceasing production of hard-copy leaflets and moving to online information systems or the banks phasing out cheque books and introducing contactless cards – sounds like a good idea at the time. However, each such action moves society inexorably towards a greater dependency on the continual availability of the internet.*

https://www.raeng.org.uk/publications/reports/living-without-electricity

# Preparing for the unforeseen

# What happened next?

- Storm Desmond was followed by Storm Eva which brought further flooding and supply interruptions over the Christmas holiday period
- The government also launched the National Flood Resilience Review
- The feedback on electricity network preparedness was generally positive
- The report suggested that all substation sites serving more than 10,000 customers be protected to a 1/1000 flood return interval.

# A risk based model of resilience

## Minimise exposure

## Maximise tolerance

**Resilience**

**Risk**

- Removal
- Resistance
- Redundancy
- Response

## Mitigate impact


## Expedite recovery

# Response at Lancaster

- Removal of the risk
- About £5m has been spent to raise the substation by 3.6m
- At its peak the flooding was at about 8m aod
- The equipment is now at 11.05m aod.

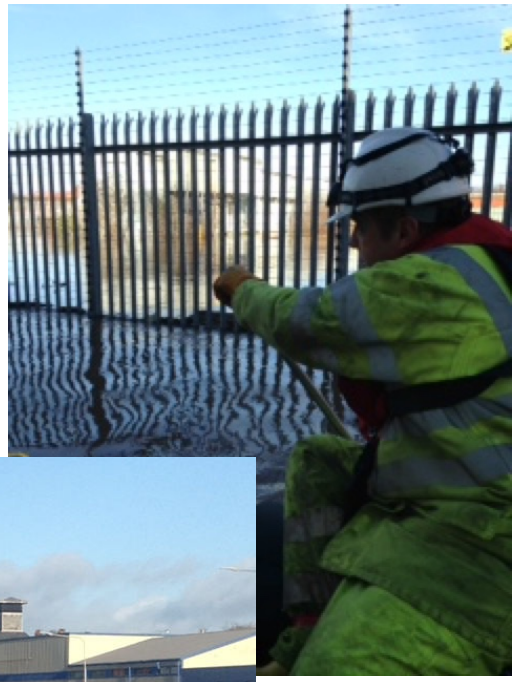

(AOD = above ordnance datum equivalent to above sea level)

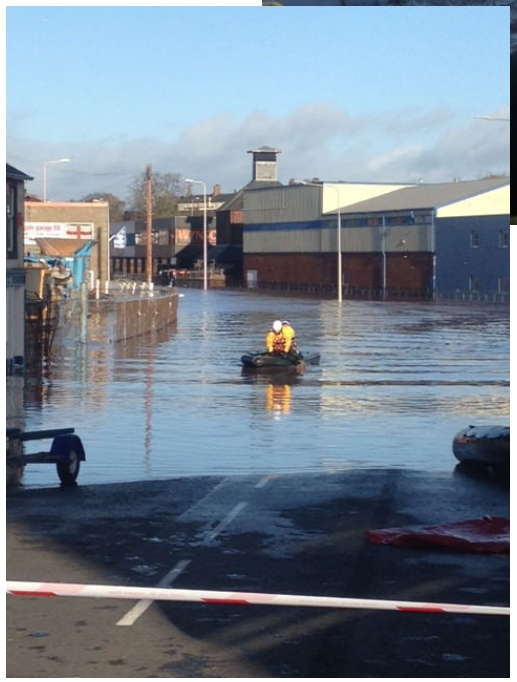
# Melling Primary Substation

- Melling was protected to the 1:1000 level
- Despite this the 1.29m flood defences were overtopped
- The majority of customers were restored from other substations
- We do not plan to improve the defences here, but will rely on interconnection
- This is not a viable option at Lancaster

# Willowholme Primary substation, Carlisle

- Willowholme Primary substation is immediately adjacent to the Environment Agency's River Eden defences and relies on those defences in line with ETR138
- The site was flooded to a depth of more than 1m exceeding 1:100 and 1:1000 forecast depths
- Access to the site was only possible by boat and access to the switch house only possible through roof apertures
- In the future we may not be able to rely on other organisations defences



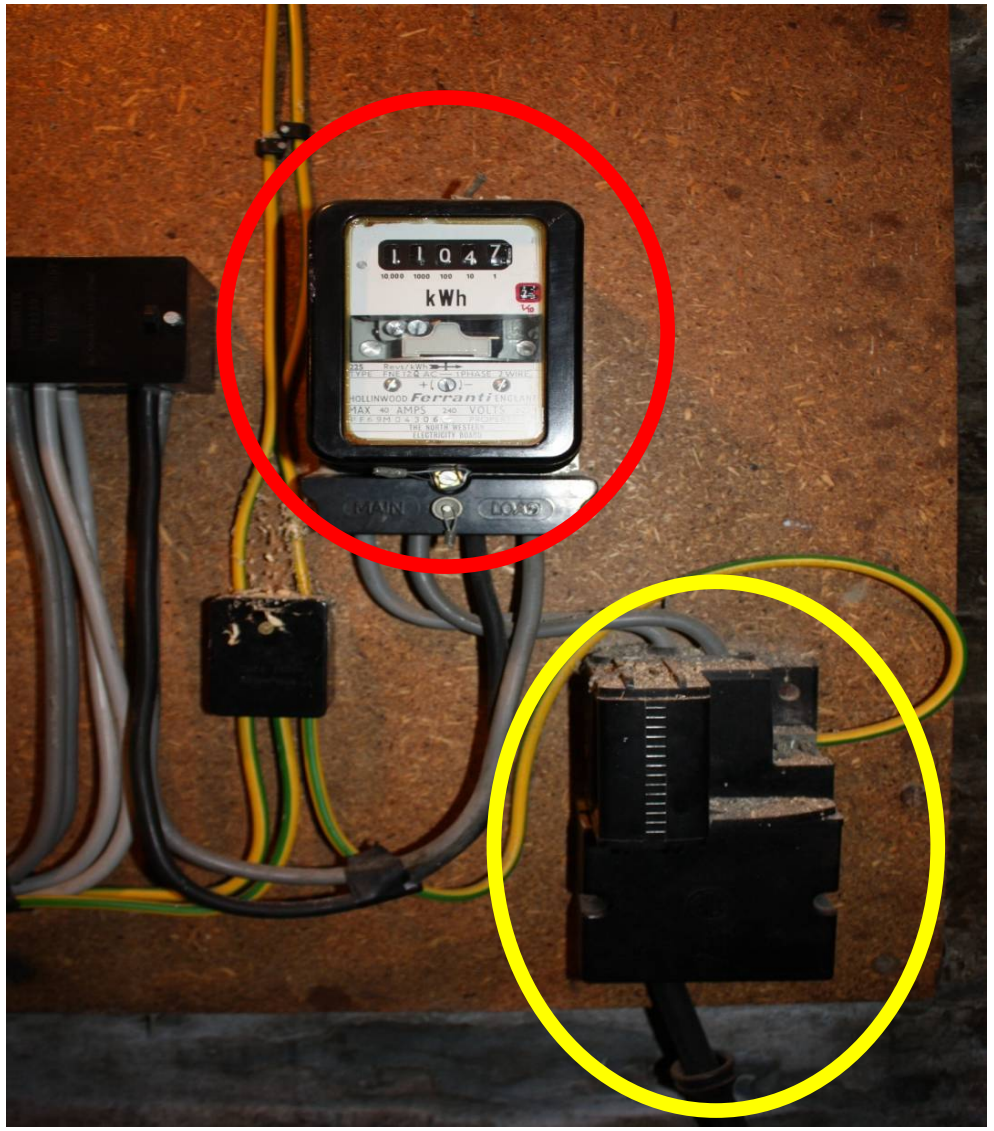


# Storm Eva - Tower VA25

- The route of River Irwell changed as a result of flooding in Storm Eva
- The tower foundations had been on land prior to the storm
- After the storm tower VA25 was located in the new course of river
- If the tower had failed, supplies to Bury Grid (64,339 customers) would have been lost
- ETR 138 only looks at the risk to substations
- We now review  the risk to other network assets

# Customer interface with our network

- Around 9,000 customers were flooded in the two storms
- If customers have been flooded we need to check that our equipment is safe before re-energising
- The supplier also needs to check that the meter is safe and working correctly
- We have to work with all the different suppliers to make sure that our work is co-ordinated



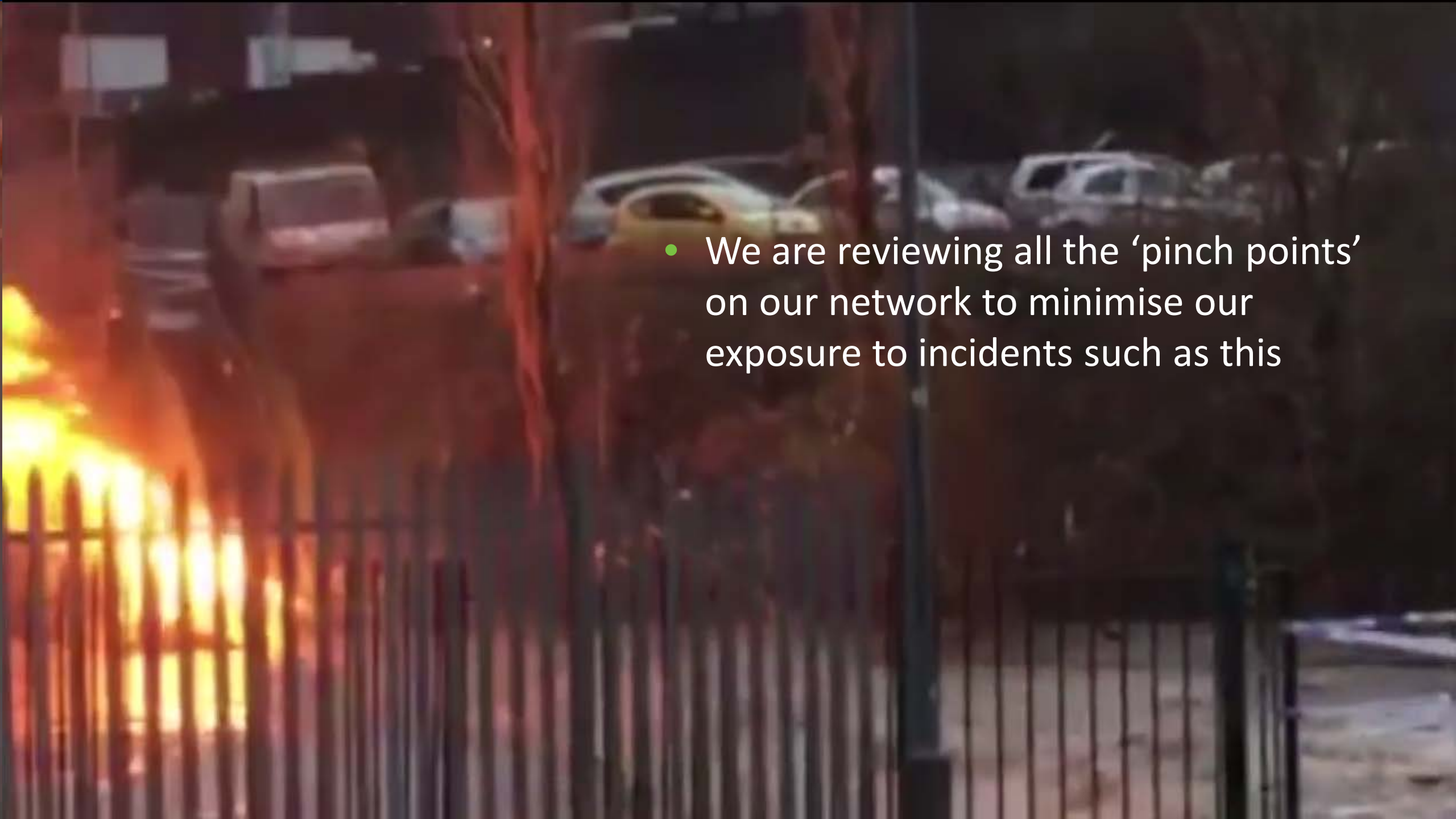
# Make sure everybody gets fed


In Storm Desmond we served 22,000 hot meals and a further 12,000 in Eva

# Safety - do you know what you are walking on and in?


# Cable bridges

- This is a pedestrian footbridge over the River Irwell in Radcliffe (picture from Google Street View)
- It also carried a gas main, a sewage pipe and two of our 6.6kV cables
- Following stills are taken from a YouTube video
- (https://www.youtube.com/watch?v=Mb4HPYSSv8U)



- We are reviewing all the ‘pinch points’ on our network to minimise our exposure to incidents such as this

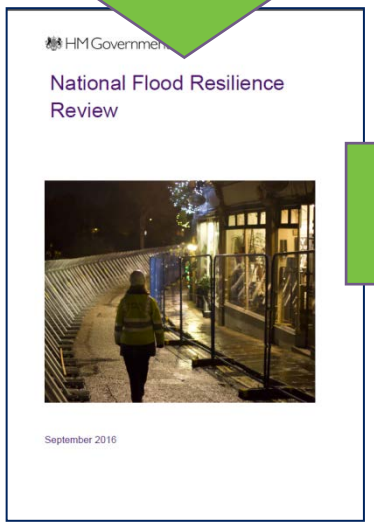
# Generators




- These are three of the 75 generators used in Lancaster
- They were brought from all over the UK and Ireland
- We don’t think there were many more available

# Development of flood risk management - take two

Led to

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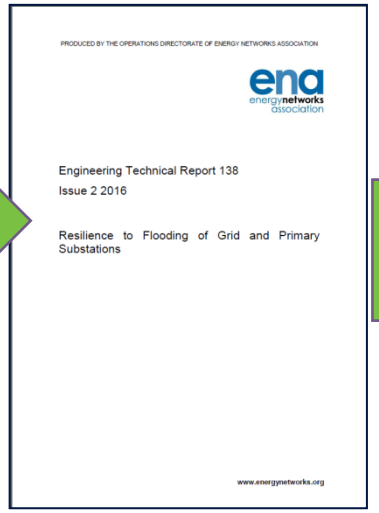


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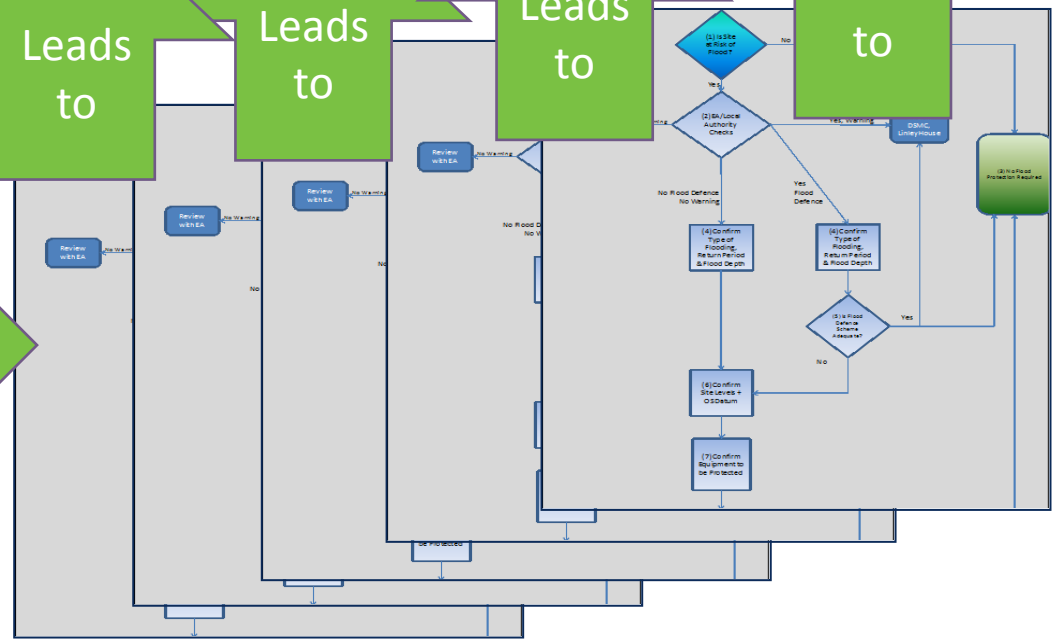

# Summary

- Flooding presents our biggest Climate Change challenge
- We expect the frequency of flooding events to increase
- We have a range of options for investment in flood prevention
- We will choose the ones to adopt using a risked based approach
- We will never prevent all interruptions due to flooding
- We will be better prepared to restore customers when they do lose supply
- We will be better prepared to support customers while they are off supply

- We will continue to perform our ‘one job’ as effectively as possible

# Thank you for listening

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