RESNET
Resilient Electricity Networks for Great Britain

ARCC scenarios workshop
Manchester
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Resnet: aims & objectives

- Demonstrate a comprehensive approach
- Analysis at national scale
- Climate-related changes in reliability of grid
- Develop tools for quantifying the value of adaptations that would enhance its resilience

Challenges to resilience

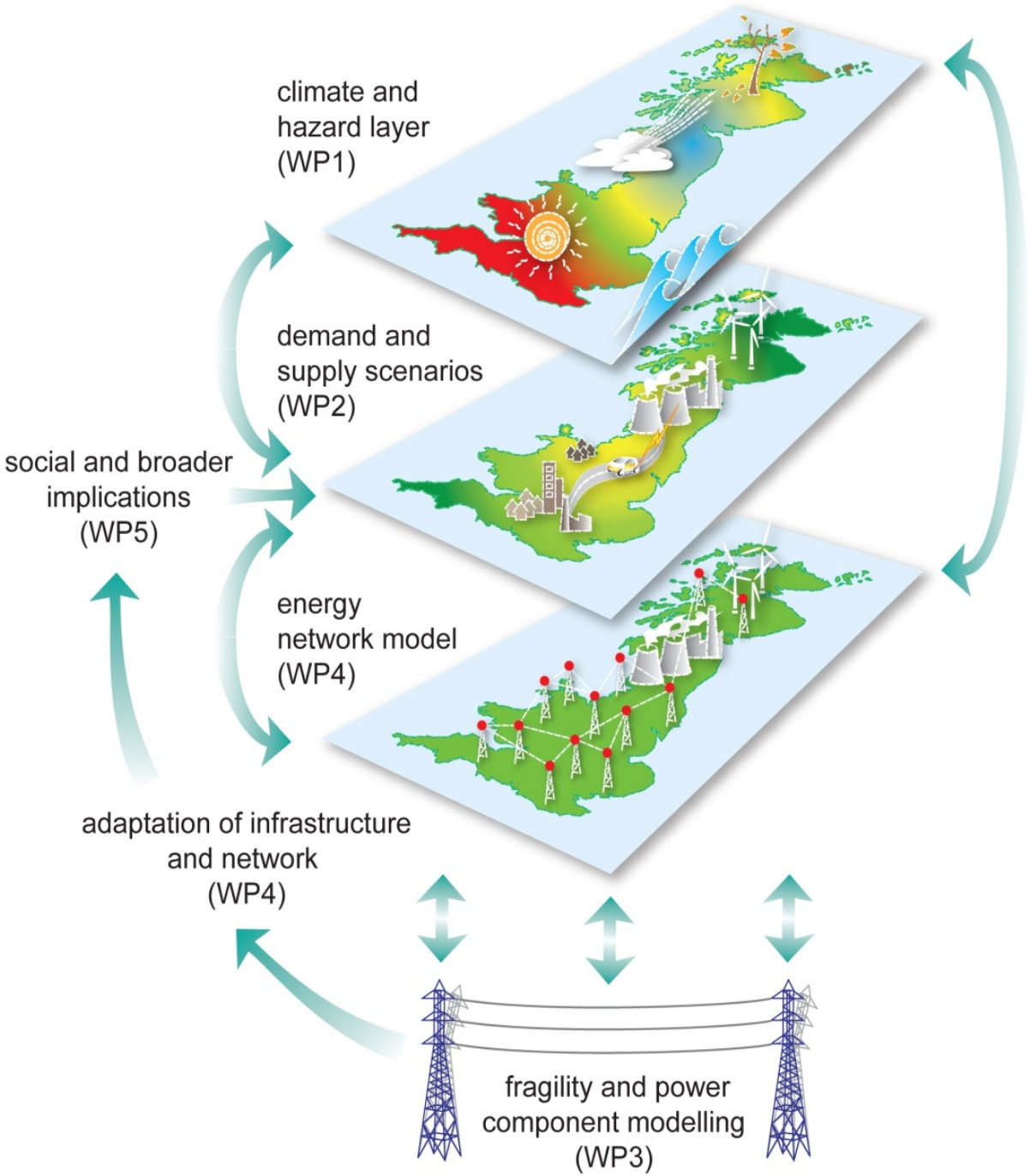
In period to 2080…

(i) Decarbonisation of supply mix

(ii) Shifting non-electric energy demand onto grid

(iii) Climate impacts on

- levels of demand
- performance of electricity infrastructure



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Resnet project USPs

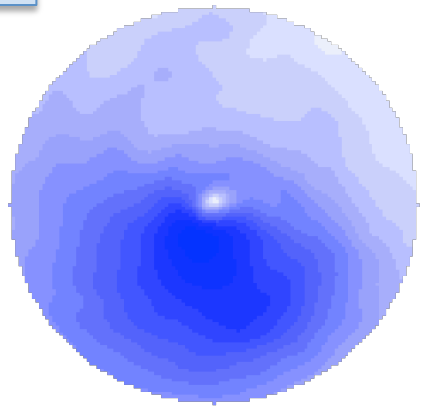
- Contextual analysis, framed by climate science
- *Interdisciplinary* approach and methods
  - Electrical engineers
  - Energy modellers
  - Social scientists
  - Network modellers
  - Civil engineers
  - Private sector stakeholder
- Enables *whole system* view of electricity network

Spatial scenarios of future climate (WP1)

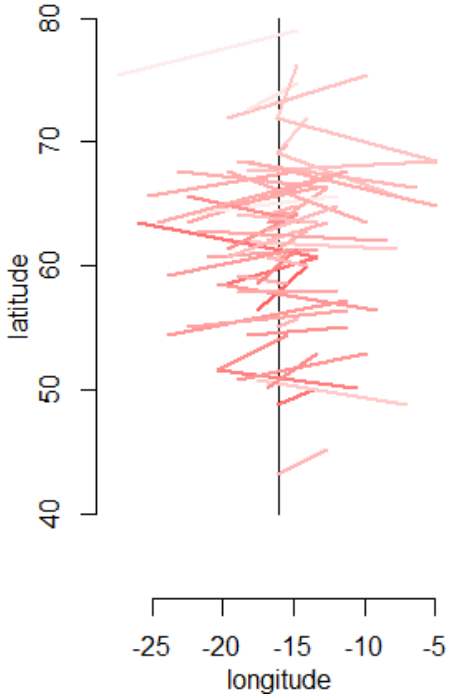
- Weather generator model (Great Britain):
  - simultaneous extreme wind gusts (6 hourly, 12km grid)
  - hourly mean winds, for operational analyses

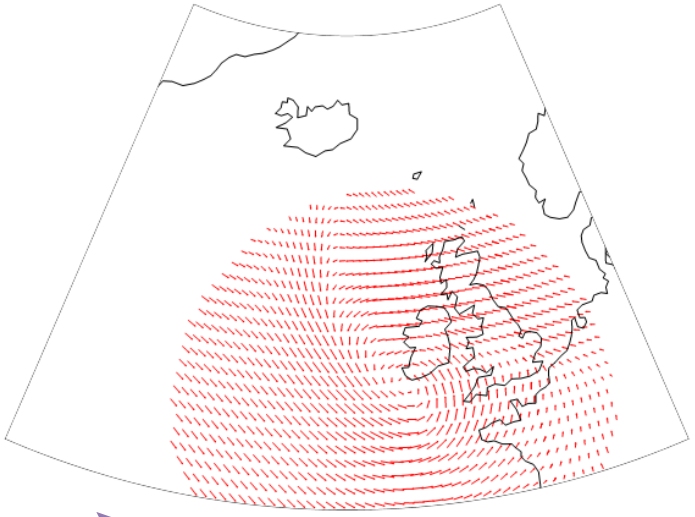
- Used alongside the UKCP09 weather generator, will provide information to industry about the nationwide threat of storms to infrastructure.

Wind – high-level extremes: model principles



Storm travel direction





Storm direction

Demand & supply model (WP2)

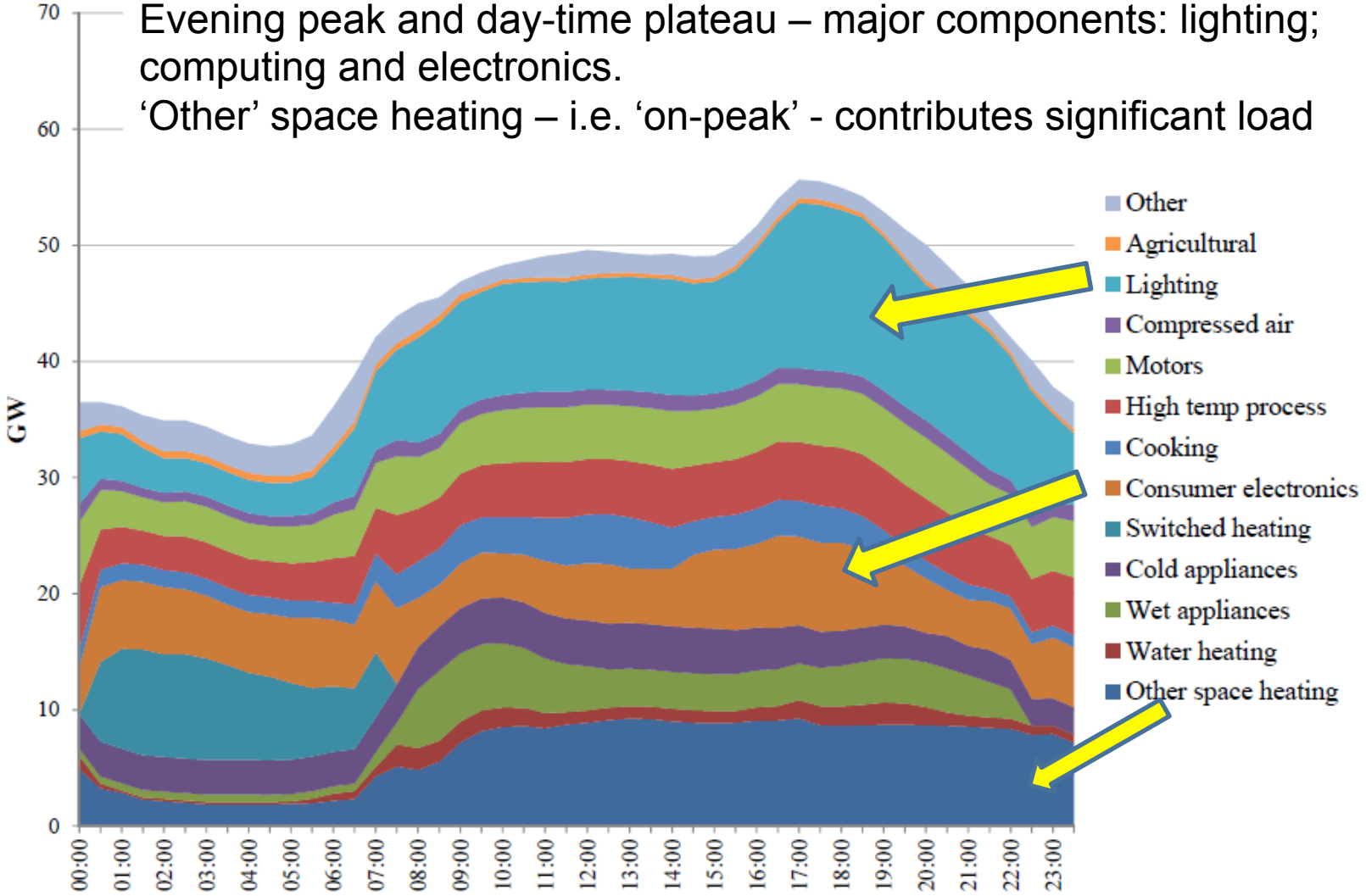
- Quantitative scenarios of demand for each sector
  - Highly disaggregated (~150 individual demand parameters)
  - Spatially resolved into 17 zones (grouped into 3 ‘weather zones’)

- Changes in diurnal demand (load profile)
  - in response to policy
  - uptake of new energy consuming technologies
  - changing behavioural practices

2010 baseline load profile

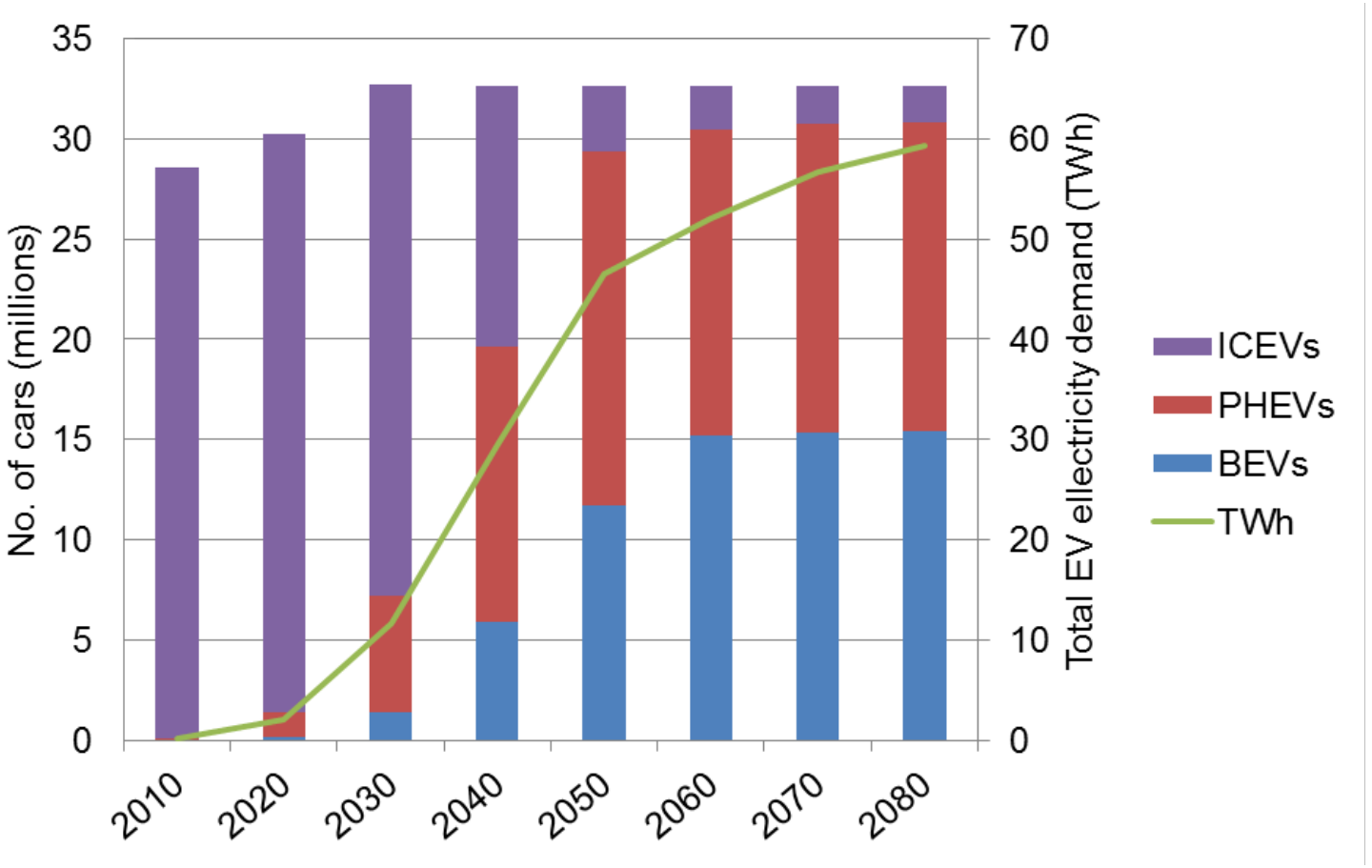
Evening peak and day-time plateau – major components: lighting; computing and electronics.

'Other' space heating – i.e. 'on-peak' - contributes significant load

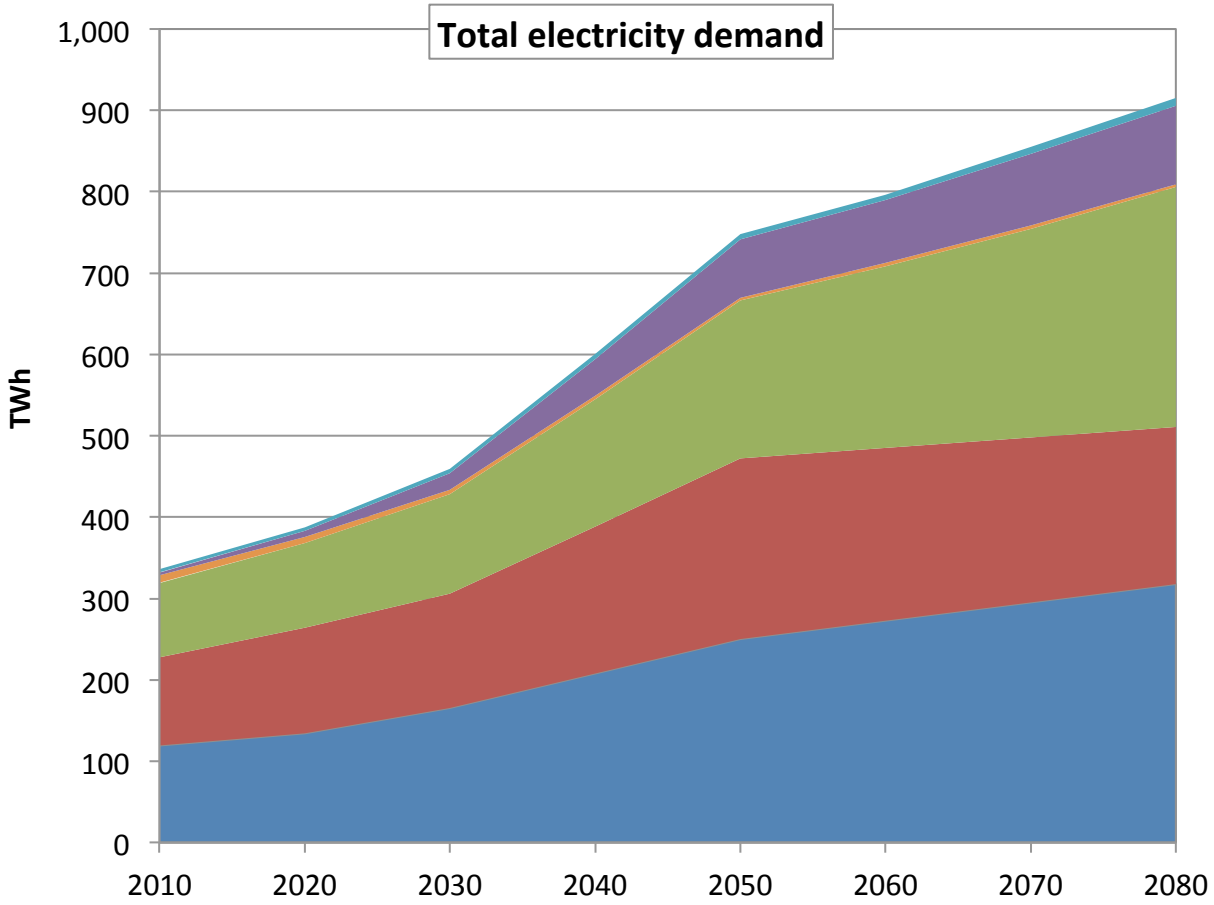


Source: sustainability first, 2012

Electric vehicles: fleet penetration & annual electricity demand

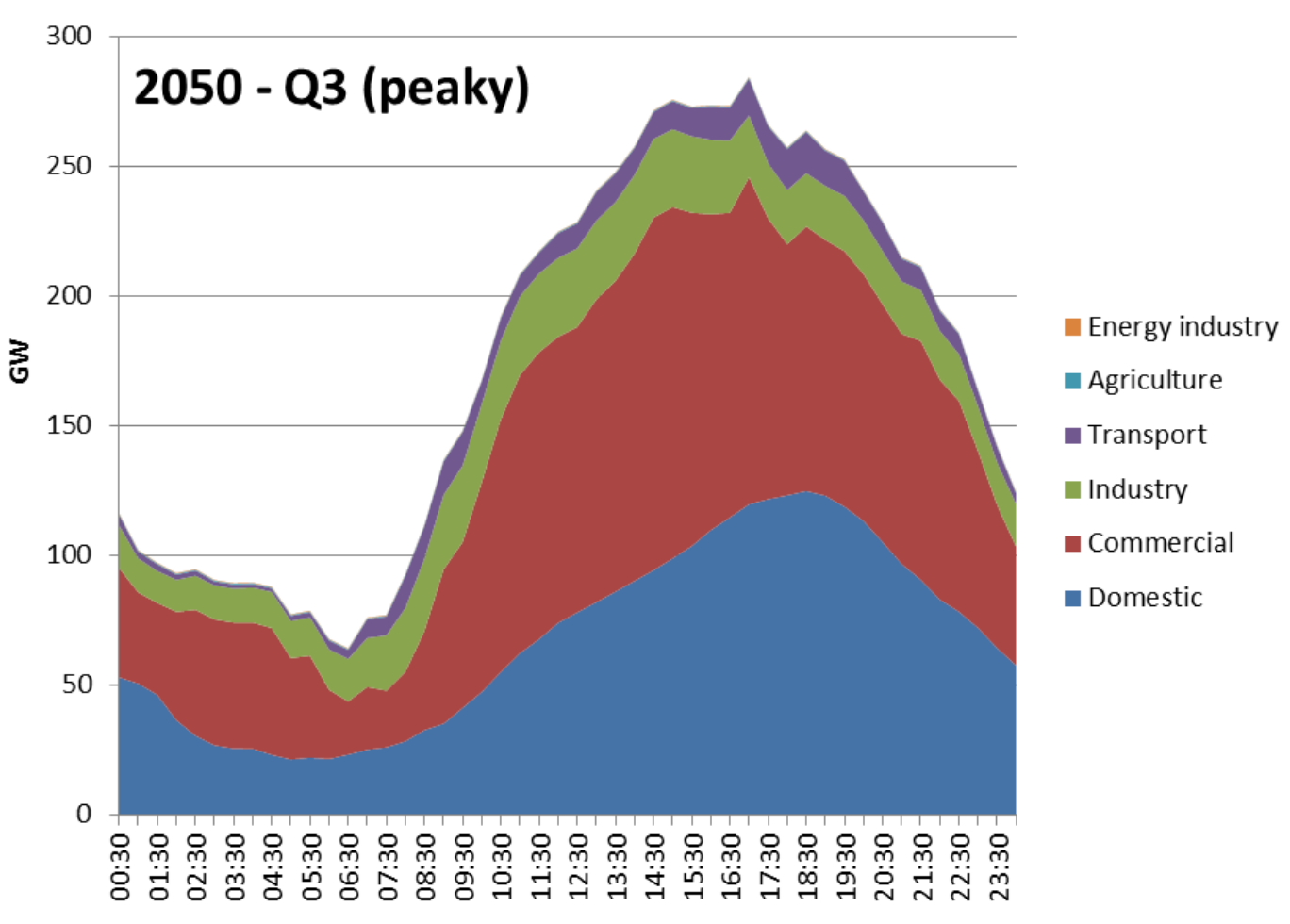


‘National Grid–based’ scenario



	Growth 2010–80
Domestic	166%
Commercial	79%
Industry	221%
Transport	2268%
Agriculture	132%
Energy Industry	-61%
totals	172%

Load profiles – NG-based scenario



Spatial disaggregation

17 NG transmission system study zones from 7YS

Regional proxies of demand:

- Domestic: households by census SOA
- Commercial: m^2 floorspace by VOA admin area
- Road: vehicle kilometres by local authority
- Rail: track km by NG-region
- Industry: local authority data (minus commercial)
- Agriculture: holdings by local authority
- Energy industry: no. of plant by NG-region

Weather link

‘Regions’ 1–7: Edinburgh weather zones

‘Regions’ 8–11: Manchester weather zones

‘Regions’ 12–17: Slough weather zones

Weather-dependent variables

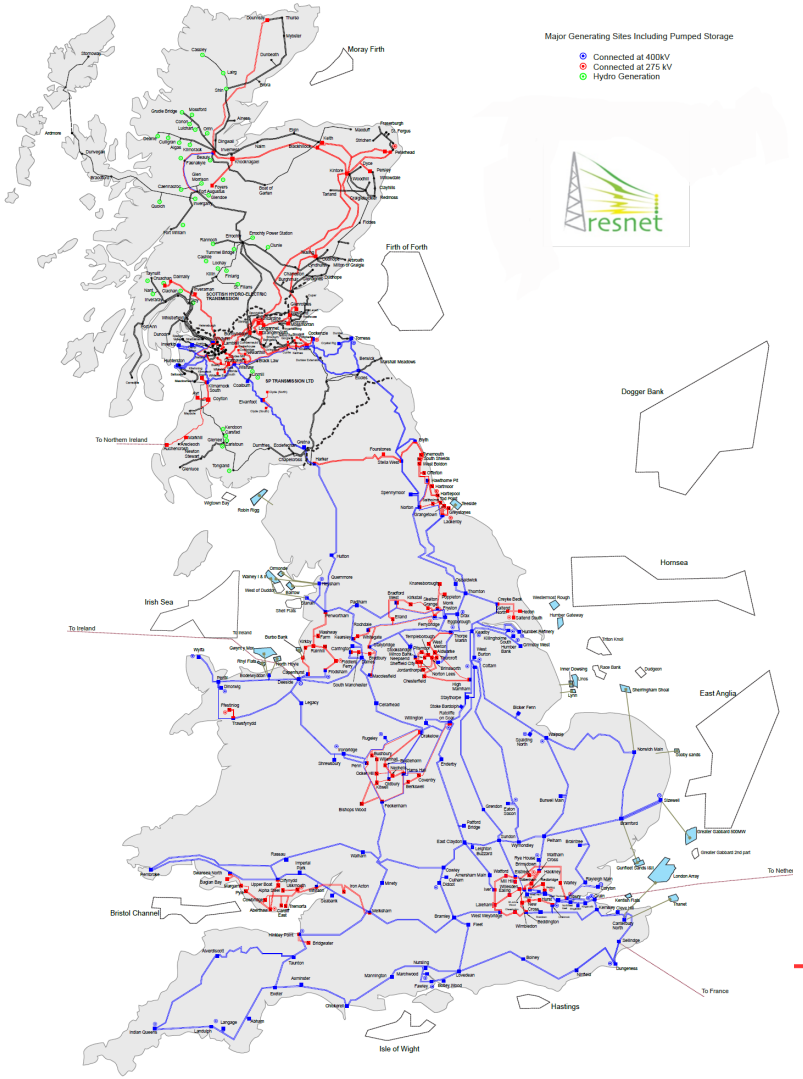
- Peak day – 95th percentile values:
  - HDDs: slight decline over next 7 decades
  - Domestic CDDs up from ~2 in 2020 (Slough) to ~16 in 2080s
- Heating and cooling
  - ‘Domestic’ baselines: 16°C / 22°C
  - ‘Commercial’ baselines: 18°C / 18°C
- Option to change:
  - heating and cooling baselines
  - relationship between heating / cooling demand and degree days

Supply scenario

Practical resource estimates

	Tidal stream	Tidal barrage	Tidal lagoon
England	11 GW	27 GW	8 GW
Wales	9.5 GW	8 GW	3.5 GW
Scotland	11 GW	10 GW	2.5 GW

Wave nearshore		Wave offshore	
Scotland	1900 MW	west	13500 MW
England	50 MW	north	6750 MW
Wales	50 MW	south west	6750 MW



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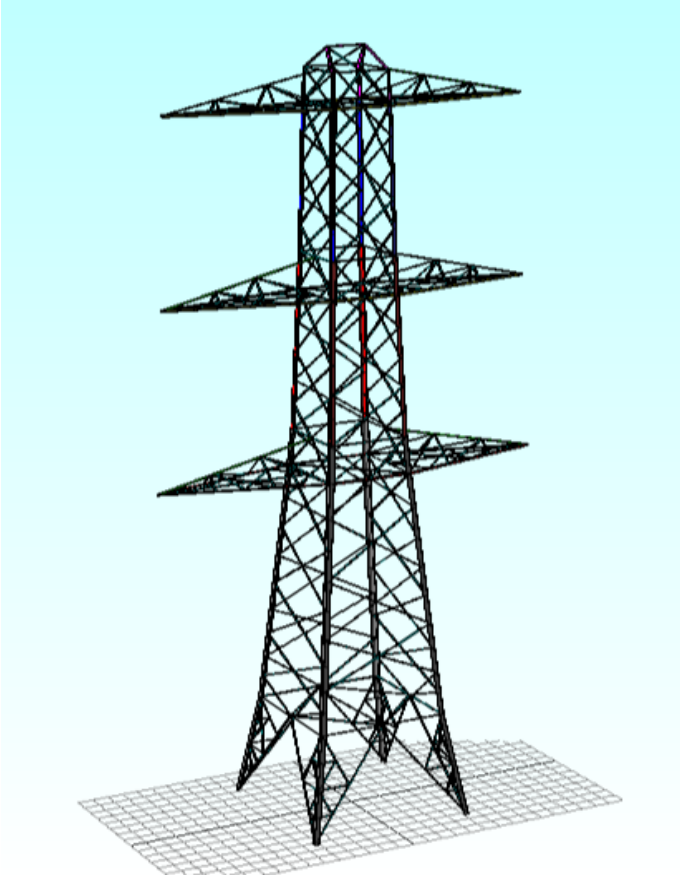
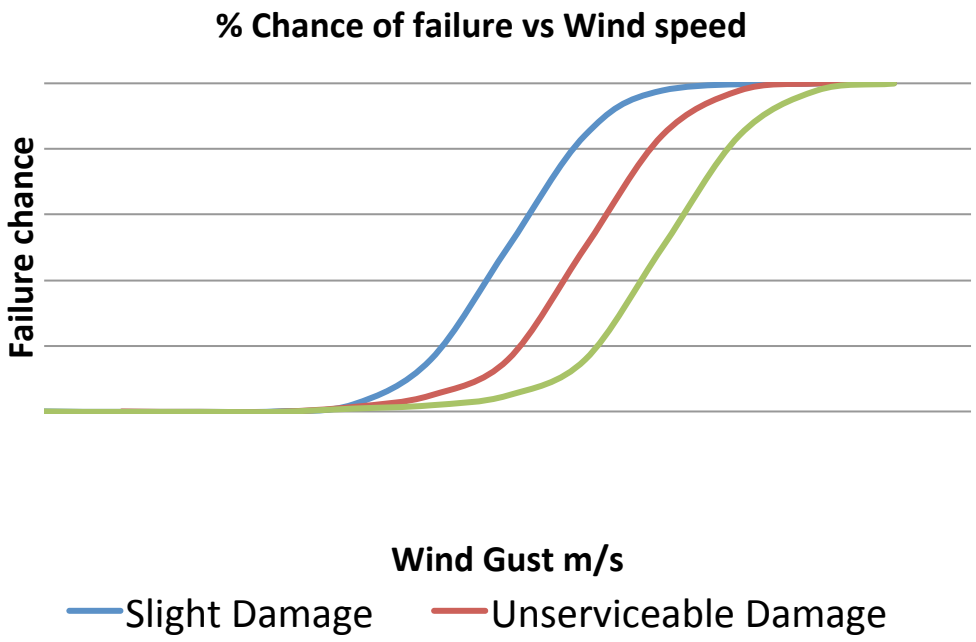
Component & structural models (WPs 3&4)

- Methodology for assessing the resilience of infrastructure systems through probabilistic modelling of components

- Developed a new statistical approach for analysis of both static ratings and dynamic ratings that will enable operators to use lines more efficiently

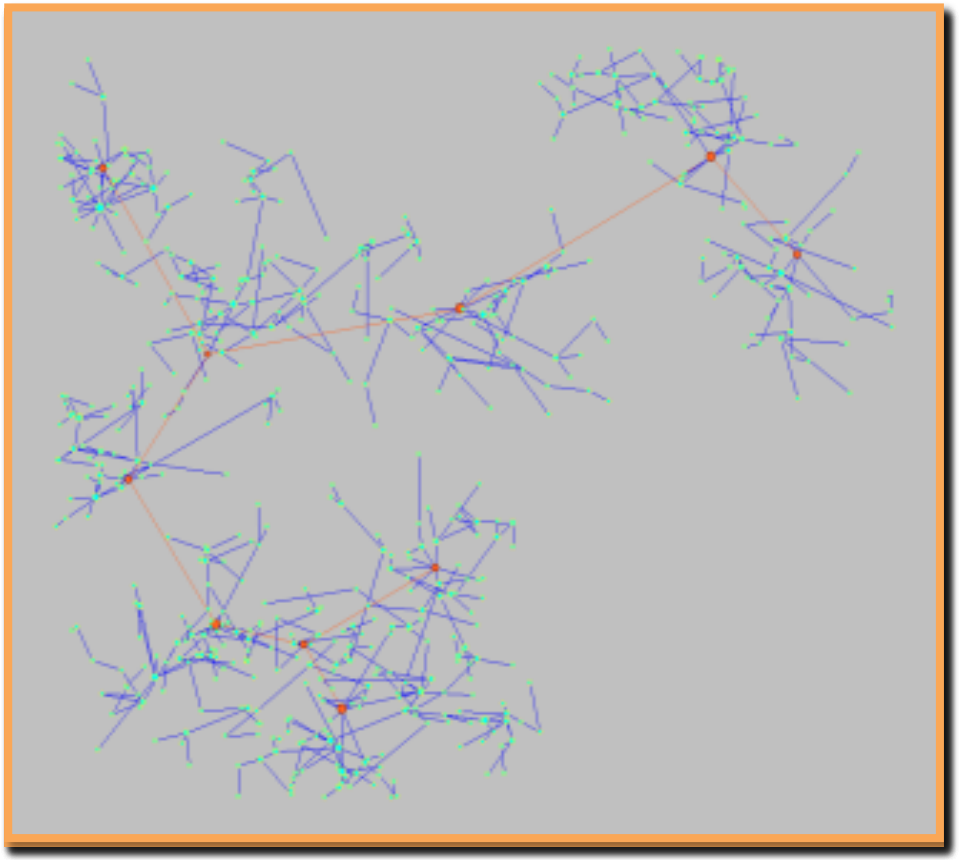
WP 4 Electricity Infrastructure Resilience





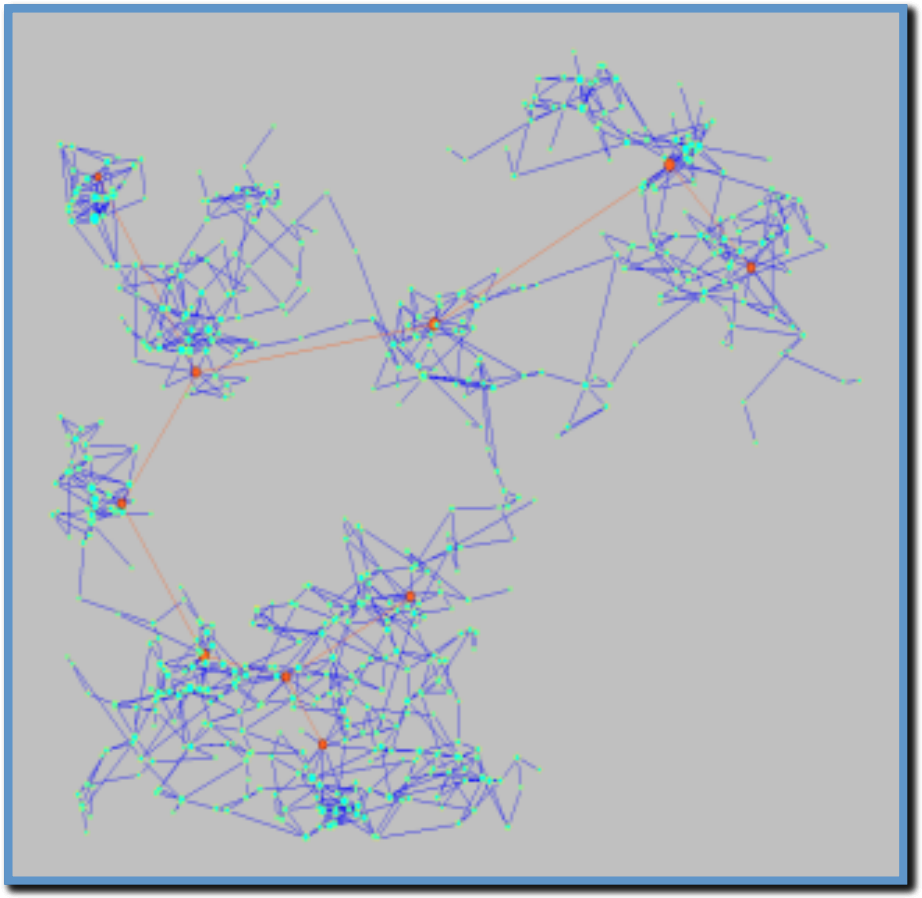
Network Growth and Adaptation (WP3&4)

Scenario 1: Demand for power grows. To meet this, network *size* is increased but all other network properties remain unchanged.



Network Growth and Adaptation

Scenario 2: demand for power grows and expectation for system reliability is higher. To meet the target, we increase both network *size* and link *redundancy*.



Social responses to adaptation measures (WP5)

- Qualitative scenario workshops and interviews
- Interview public with experience of blackouts
- Rich understanding of public & stakeholder responses
- Test a range of future energy scenarios emerging from the demand & supply model and the component and structural models.

Next steps for Resnet WP2

- Account for previous work by other ARCC projects
- Utilise ITRC high level strategy drivers
- Develop additional demand scenarios that test:
  - Robustness (physical resilience) of the grid
  - Reliability (operational resilience) of the grid
- Develop supply scenarios
  - Effective capacity at each of 17 National Grid study zones

With thanks to

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Thanks for listening

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