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Energy & Environment

Energy at Birmingham

July 8th 2011

The Environment; a cross-cutting energy theme

- All energy is extracted from the environment
- All energy sources and technologies create environmental impacts
- Global dynamics in energy systems; complex patterns of impacts over space & time
- Science, technology, economics, governance, health, behaviour..

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Environmental impacts in a nutshell

- Humans; mine ‘raw’ stuff, process it into stuff we (think we) want, then dump left-over stuff.
- Where do we mine or dump/‘store’? underground, under water, in the air, in living organisms & on the surface
- These environments are transformed; often bad news
- So what can we do? prevention, mitigation, remediation
- Types of research; fundamental env. science, monitoring and mapping, prediction of future trends, designing interventions, evaluating existing policies
- Research directions include: lifecycle & whole systems; inclusive & participative, ecosystem services; no waste.

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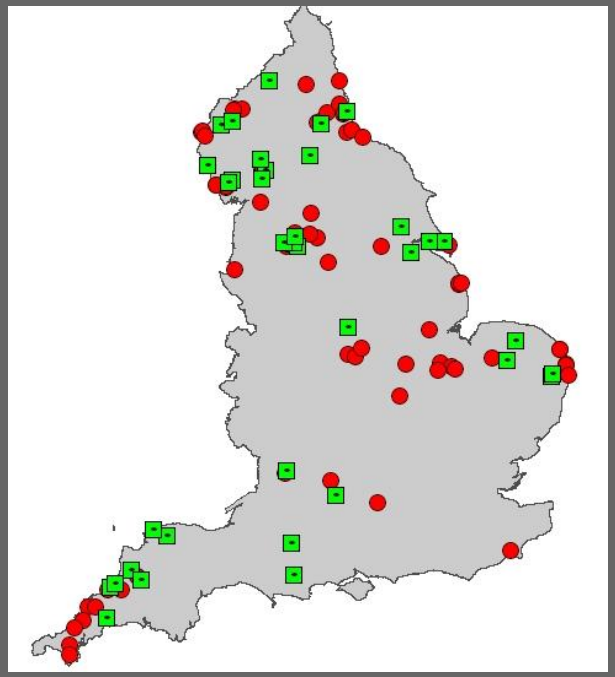
Sub-theme Spatial Planning

- New energy infrastructure needs lots of space
- Space is a scarce resource
- Multiple users & uses of space
- Vested interests, sunk costs, dated rules, procedures & knowledge
- Synergies, conflicts?
- How & what to plan?
- How to negotiate?
- Sharing best practice



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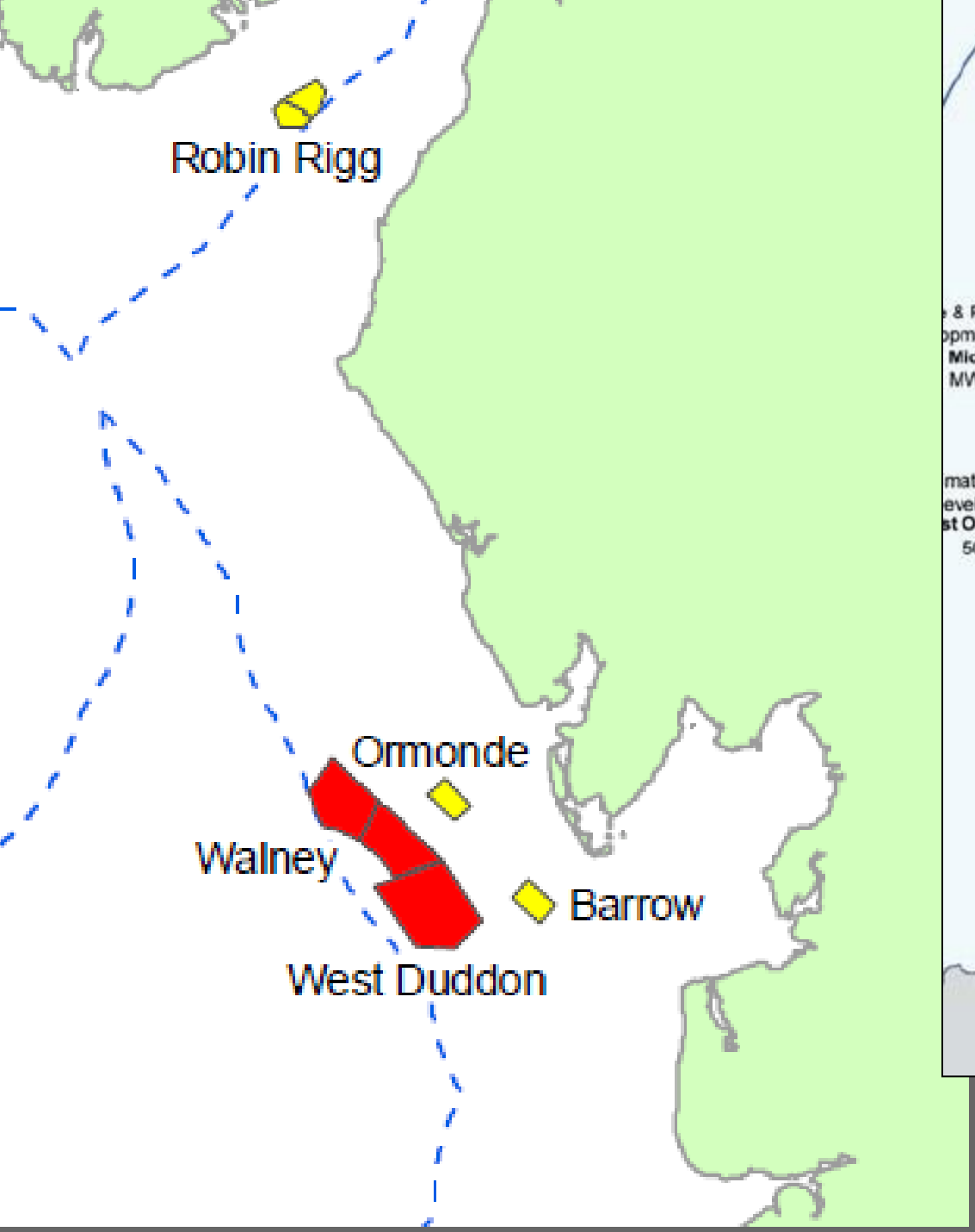

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What about:

- Gravel
- Cables
- Birds
- Sea lanes
- Defence
- Oil rigs
- Wrecks
- Recreation
- Views

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Sub-theme Restoration Ecology

- Indicator species & ecology of polluted land/water.
- Constructed wetlands to trap pollutants
- Phytoextraction & phytoremediation
- Restoration of brown-field sites
- Urban ecology & constructed green spaces
- Green infrastructure to enable migration and adaptation.

Example: use of soil bacteria to capture radioactive contaminants at nuclear sites

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Sub-theme Built Environment

- Energy footprint of infrastructure
- Lock-in of energy practices (e.g. car dependency)
- Environmental justice & externalities by spatial separation of supply and demand
- Urban heat island effect
- Impacts on human health

Examples; (1) air pollution, (2) heat island effects on energy infrastructure

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Cooking & Environment: Characterisation of Exposure from Cooking emissions

Doctoral Researcher - LK Abdullahi

Supervisors – Prof R Harrison & Dr JM Delgado-Saborit

- Cooking generates emissions of pollutants:
  - respirable particles (PM10, PM2.5, Ultrafine)
  - irritant and greenhouse gases (CO, CO2, NO2)
  - organic compounds ... some of them known or suspected carcinogenics (eg BaP)
- Emissions depend on:
  - the source of energy (gas or electricity)
  - the ingredients being cooked (oil, meat, etc)
- There is the need to:
  - Assess the exposure of people to cooking emissions
  - Characterise the profile of cooking emissions from different energy sources, and their contribution to outdoor air.

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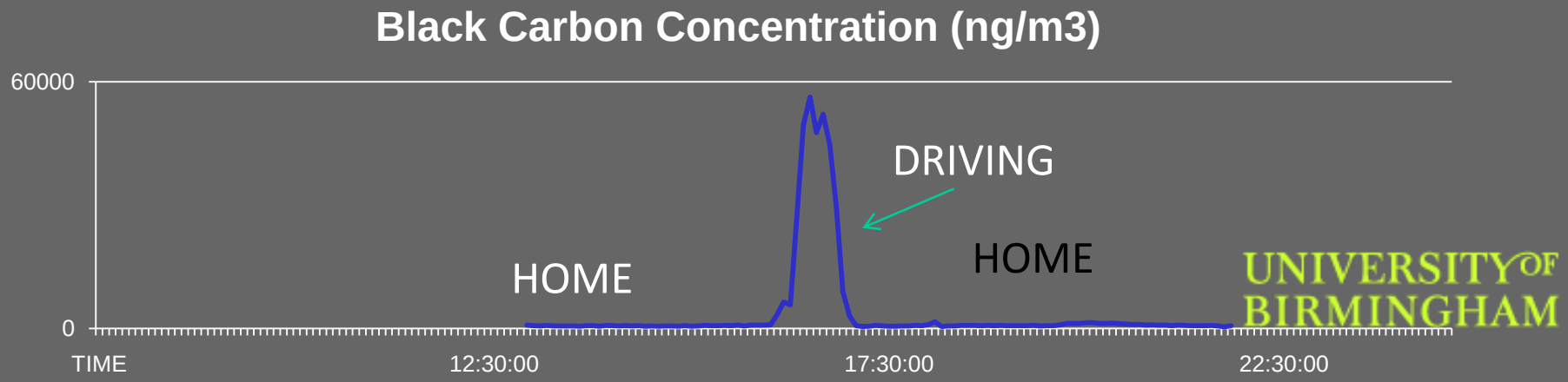
Transport/Cooking & Environment: New Fingerprints of exposure to Air Toxics

Doctoral Researcher – B Macias

Supervisors – Prof R Harrison & Dr JM Delgado-Saborit

- People are exposed to different air toxics emitted from outdoor (e.g. motorised traffic) and indoor combustion (e.g. cooking) sources.
- Some of the higher pollutant exposures are linked with peaks related to energy consumption sources (e.g. transport & cooking).
- There is the need to characterise the contribution to personal exposure from activities related to energy consumption.



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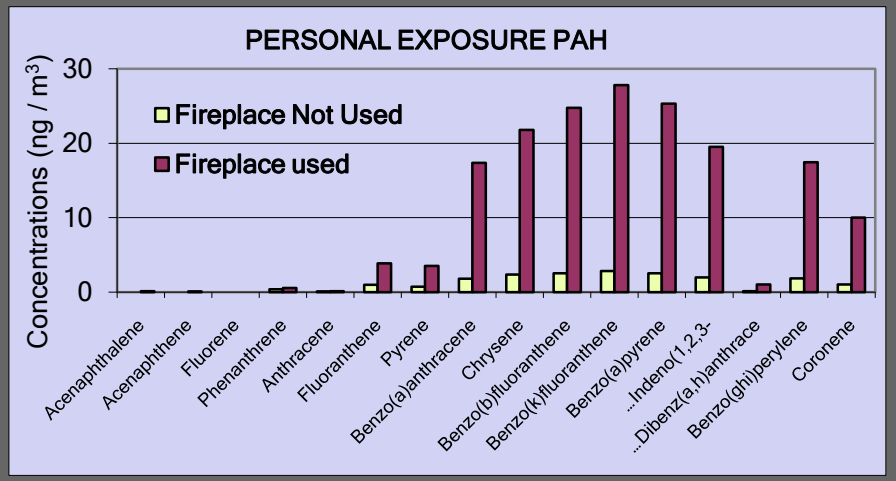
Heating & Environment: Measurement & Modelling of Exposure to Air Toxics



- Burning wood in fireplaces for space heating found to be a major indoor source of polycyclic aromatic hydrocarbons.
- The existence of additional heating sources at home also found to increase exposures to volatile organic compounds.

- Cooking and heating with solid fuels in unvented appliances, is likely to be the largest source of indoor air pollution globally due to the high usage of these fuels in developing countries.

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Impact of Urban Heat on Transformers

- Ambient temperatures and loading influence transformer temperature.
- A transformer operating at too high a temperature is not working efficiently and has a shorter life expectancy
- Life expectancy halves for every 6°C increase in transformer temperature above 98°C = rapid decline!
- Climate and technological change are combining to create a perfect storm: Higher temperatures, more refrigeration / air conditioning, electrification of transport...

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Impact of Urban Heat on Transformers

- 2 year Knowledge Transfer Partnership co-funded by E-ON, NERC and TSB.
- Focus on distribution transformers:
  - Age of assets (over 40y old)
  - Limited routine monitoring
- The IEC international standard document states:

"Wind, sunshine and rain may affect the loading capacity of distribution transformers, but their unpredictable nature makes it impracticable to take these factors into account."

- The project aims to change this view...
- Setting up a monitoring infrastructure, calculating current life expectancy of assets so asset replacement programmes can be planned

e·on UK

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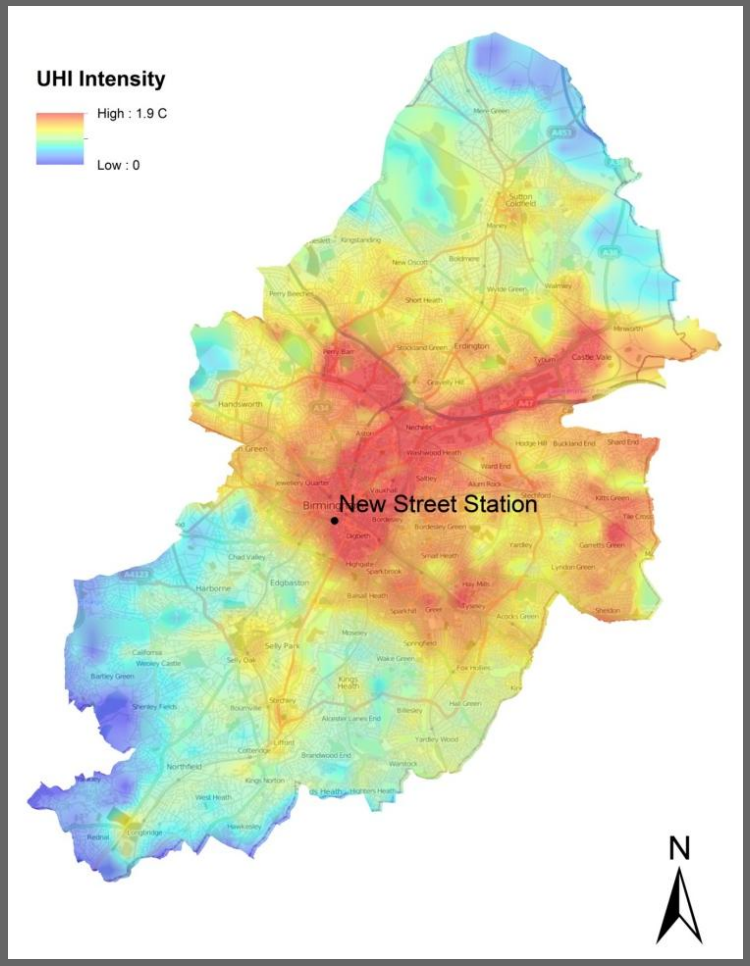
Preliminary Results

- A central core of elevated temperatures exists in Birmingham
- Early results indicate that some distribution transformers in the city centre are operating at levels above 98°C for some of the time.
- These assets will need replacing as a priority.
- It is £5k cheaper to replace an asset before failure. There are 1500 transformers in Birmingham meaning a potential saving of £7.5m



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Birmingham Urban Climate Laboratory

- Higher electric stresses potentially place primary substations at greatest risk.
- Unplanned maintenance of a 132/33KV could cost up to £500k more than a planned replacement
- The Birmingham Urban Climate Laboratory is a nested network of sensors focussed on measuring urban heat including:
  - 33 Full Weather Stations located in primary substations
  - 231 Wi-Fi sensors located in schools and across the CBD
- This Lab will be used with urban heat models, climate change data as well as scenarios for future loading to assess the long-term resilience of the electricity network.

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