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UK Energy Networks – Transition Challenges

BEIS Talk
Tuesday 7th February 2017
Liam Lidstone

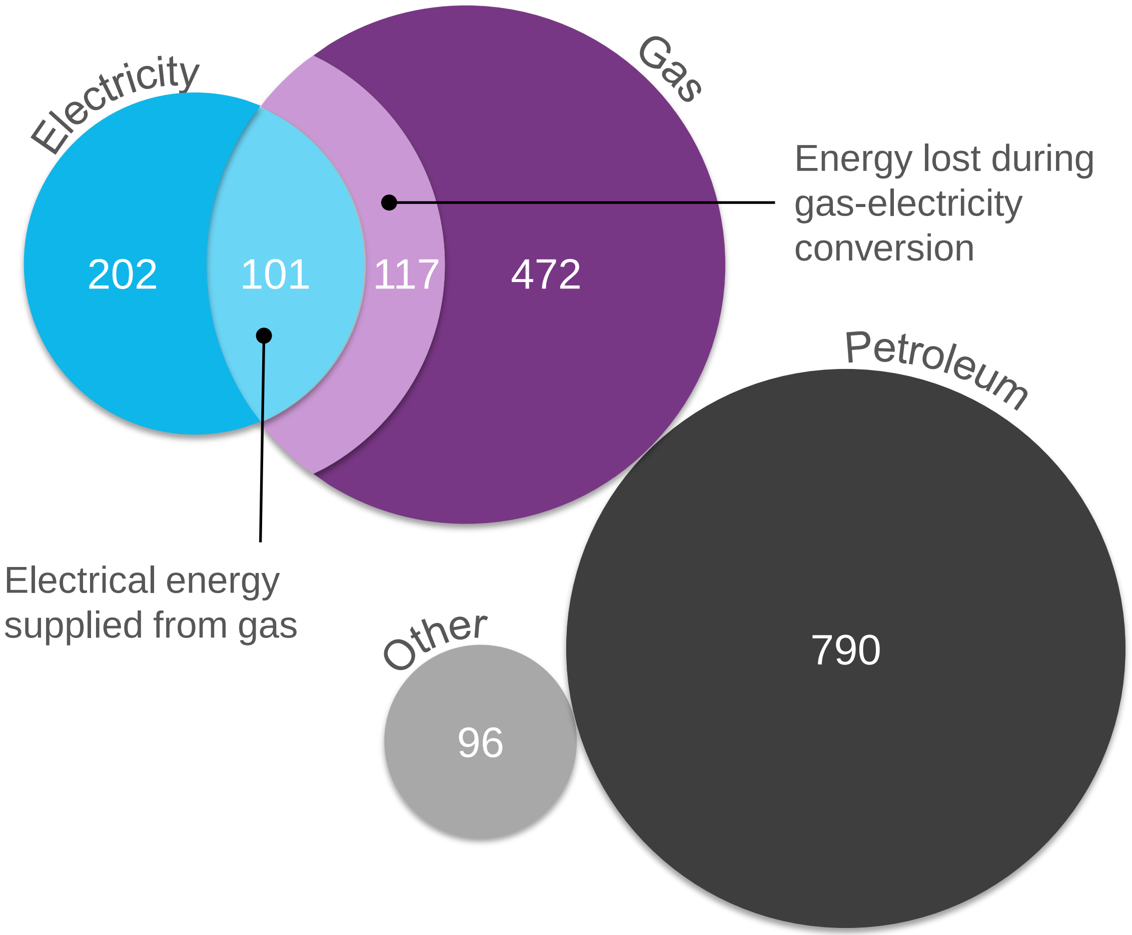
ETI10 TEN YEARS OF INNOVATION 2007 – 2017

Energy networks as a part of the energy system

- Energy networks are a core part of a functioning energy system – enabling the right amount and type of energy to be delivered to where and when it is needed

- Long term changes are expected for:
  - energy generation type and geographic location
  - demand patterns and energy use requirements

- The UK's energy network infrastructure will need to evolve to manage these fundamental long term changes



Energy carried by networks in the UK (TWh/yr)

Estimated from data published by DECC (2014)

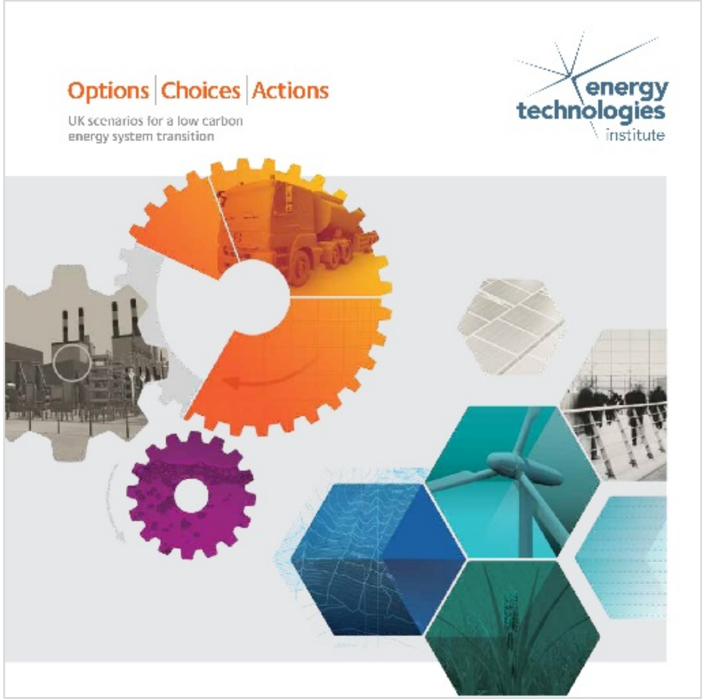
Energy system scenarios

Clockwork *– national level, coordinated planning for the energy system*

- Large scale investments in centralised thermal power generation (nuclear and CCS) alongside deployment of renewable generation
- Increased electrification of heat and transport
- Deployment of large scale heat networks
- A phased shut-down of the local gas distribution network
- Hydrogen used as a fuel for generating electricity at peak times
- Gas used for industrial process heating in conjunction with CCS

Patchwork *– locally led development and implementation of energy strategies with strong societal engagement*

- A prominent role for renewable generation (large scale and distributed) with a continued role for large thermal power generation
- Increased electrification of heat and transport.
- In different areas, the gas distribution network is either:
    - decommissioned
    - retained as backup to heat pumps
    - utilises significantly decarbonised gas supply
- Small and medium scale heat networks are deployed in some towns and cities
- Hydrogen is used for industry, in the transport sector and to support peaking generation



Options | Choices | Actions

UK scenarios for a low carbon energy system transition

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Available at:
http://www.eti.co.uk/insights/options-choices-actions-uk-scenarios-for-a-low-carbon-energy-system/

Or search for: ***ETI scenarios***

Network transition challenges

Adapting and enhancing existing networks

Creating efficient and effective new networks

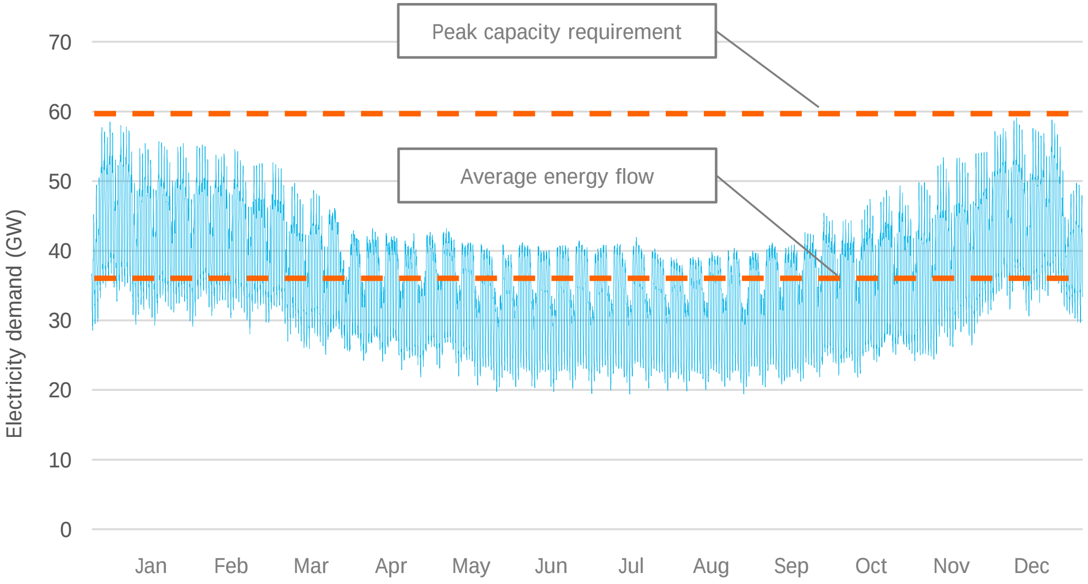
Integrating networks to optimise performance across energy vectors

Electricity	Handling increased capacity
	Delivering new connections
	Balancing supply and demand
Gas	Decommissioning (especially within the distribution network)
	Operating at much lower utilisation
	Integrating low carbon fuels at significant levels
Heat	Cost reduction and technology advancement
	Supply-chain scale-up
	Adoption
Hydrogen	Meeting the needs of different sectors
	Scale-up

Transitioning electricity networks

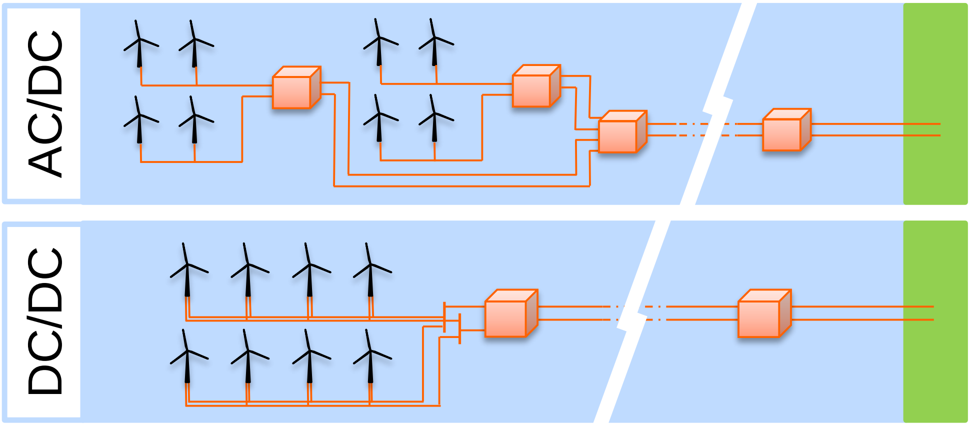
Increased capacity

- There is a major challenge in knowing, where, when, in which way and to what extent to enhance the network
- This will be particularly acute for the distribution network, where information on the existing state of the network is not as widely available
- Factors include: variation in capacity growth requirements; available physical space; and land value
- Options include: smart grid solutions; fault current limiters; energy storage; and conventional reinforcement



New connections

- It will be necessary to connect new and a greater number of sites
- Network architecture choices for integrating, e.g., new types of generation, new locations, higher capacity connections
- Trade-offs in network and generation choices, e.g., resource availability vs network length and generation technology vs network technology



Transitioning gas networks

For greenhouse gas emissions targets to be met there will need to be significant decarbonisation of heat supply
This has implications for the ***gas distribution network***

Decommissioning

- Establishing the costs and practicalities of decommissioning
- Managing the logistics of switching over to the replacement heating system
- Resource requirements

Operating at much lower utilisation

- Provide back-up to electrified heating
- Efficiency, safety and reliability impacts for use of the gas distribution network at low levels of utilisation need to be properly examined
- Sustainable operation will require the costs of infrastructure operation and maintenance to be recouped somehow
- Integration with the electricity network

Integrating low carbon fuels at significant levels

- The need for sustainable and cost effective sources and the value of use elsewhere

Hydrogen

- Energy content
- Leakage, embrittlement (for some steel grades), compatibility with boilers, etc.

Bio-SNG

- Assessment of the overall lifecycle emissions

The gas grid as a whole also serves the power and industry sectors

- Gas consumption in non-heat sectors could grow in the 2020s and 2030s (depending on the availability of CCS)
- How to maintain investment in the gas network as a whole when there is declining overall usage

Transitioning heat networks

Heat networks possess several features that make them a compelling proposition for helping to decarbonise heat:

- Able to deliver **large amounts of heat** cheaply
- **Long asset life**
- **Flexible** to a multitude of heat sources – *can adopt new heat sources as they become available / cost effective*
- Most cost effective when serving large numbers of buildings in **close proximity**

A major opportunity for heat networks lies in connecting **existing (less efficient) properties** – *a shift from the current focus on new developments* – in **denser areas**

To achieve this key challenges need to be addressed…

Advances made in these areas will need to be compatible with the beneficial qualities of heat networks

Cost reduction and technology advancement

- Installation advances
- New technology and processes
- Minimise disruption

Supply-chain scale-up

- Increase deployment to reach as much as 20x current levels
- In a shorter time than current levels were reached
- To a new market category

Adoption

- Put in place the mechanisms, processes, technologies and supply chain
- Showcase successful implementations to create industry and consumer demand

Transitioning hydrogen networks

Scale-up

- Significant quantities from the 2030s – *back-to-base fleets for the transport sector prior to this*
- Decisions need to be made and initial steps taken to demonstrate and prove these options by the mid-2020s
- Infrastructure options include: road tanker transportation, new pipelines, repurposed natural gas pipelines, hydrogen storage and electrolysis
- Practical and economic factors influence the suitability of each
- A sufficient scale-up of an industry supply chain would be needed to deliver the required roll-out

Meeting the demands of different sectors

- Large scale salt cavern storage (and limited pipeline infrastructure) will be needed
- The NW and NE of England provide a good opportunity for hydrogen storage and CCS connected production

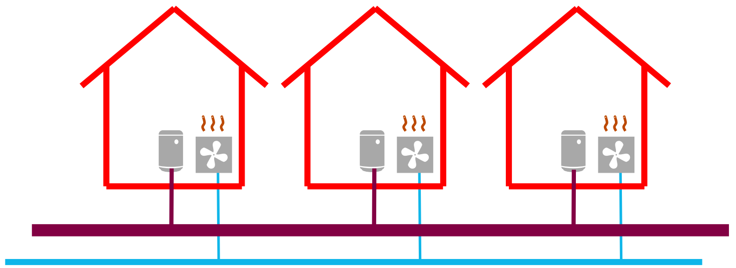
- Repurposed natural gas pipelines may be an option
- The long term certainty of industry demand will affect the investibility of new network infrastructure

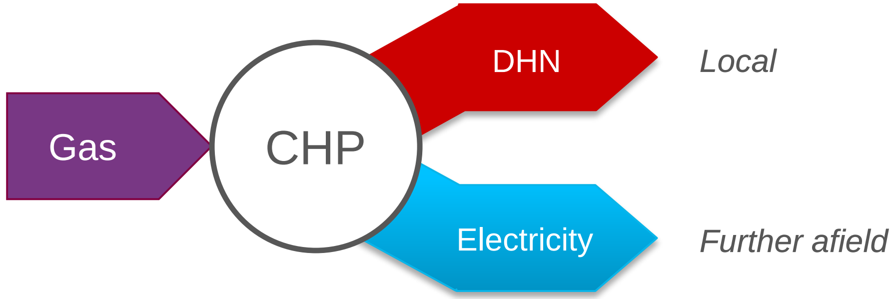
- Nationwide refuelling infrastructure will be necessary for mainstream use
- Very high purity hydrogen will be required
- Integration of a mixture of hydrogen sources and modes of delivery – both in any transition to mainstream hydrogen vehicles and to provide nationwide coverage

- Making use of existing gas distribution network infrastructure
- Managing leakage and network component compatibility
- Regional conversions – managing possible appliance replacement and ensuring hydrogen resource availability

Integrating networks to optimise across energy vectors

- There are multiple instances where, in future, increased integration between networks could yield benefits
- Interdependencies could arise in terms of:
  - How networks develop
  - How networks are operated
- Further examples include:
  - Encouraging PHEVs to be run on liquid fuels at times of high electricity demand
  - Using surplus wind to generate hydrogen
  - Feeding surplus wind into a nearby heat network
  - Feeding surplus wind in remote areas into local heating systems or locally based EVs
- Understanding the value of these approaches will come from:
  - Quantifying the scale of the benefits they can offer
  - Understanding the wider technical and operational implications for each network
  - Identifying the barriers to integration and, if need be, where potential innovative solutions might be necessary





Gas

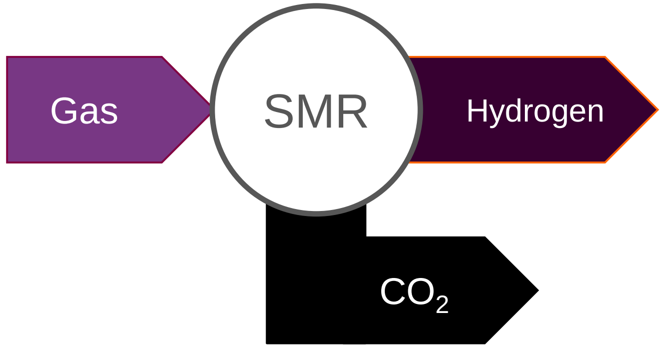
CHP

DHN

Local

Electricity

Further afield



Gas

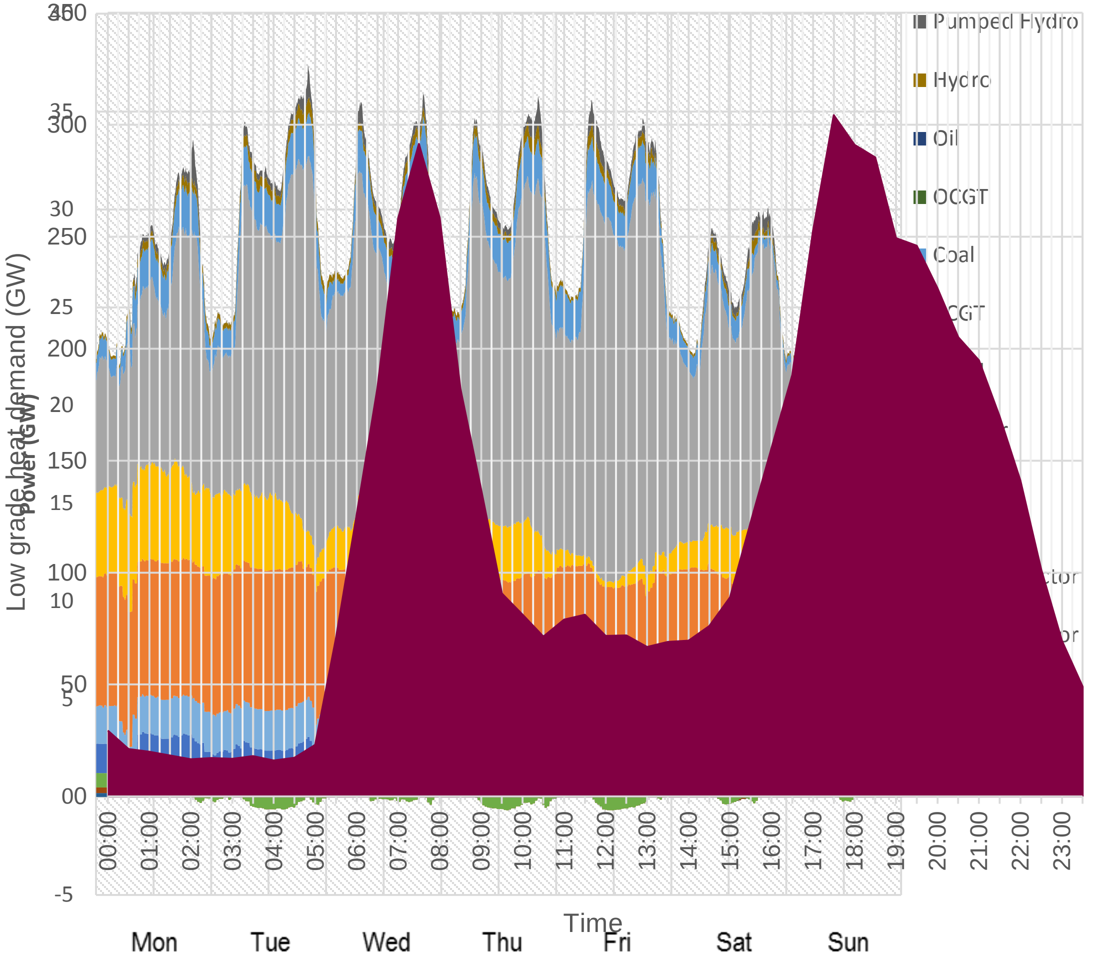
SMR

Hydrogen

CO_2

Balancing supply and demand

- Flexibility (keeping supply and demand in balance) is a key feature of a functional system.
- Energy storage is one means of providing system flexibility
- The ability to provide storage varies amongst the network types:
  - Gas, hydrogen and heat networks all have a level of inherent storage (e.g. line-packing in gaseous pipeline networks); whilst dedicated storage is relatively low cost
  - Electricity supply needs to be in real-time balance; and electricity storage is generally expensive
- Future flexibility options extend beyond just grid-connected electricity storage, for example:
  - Gas and hydrogen fuelling peaking plant to help balance electricity supply
  - Heat storage in homes allowing the load on electricity networks to be reduced at peak times
  - Gas as peak support for heat pumps
  - Managed charging of plug-in vehicles
- How applicable and successful these are also affects the extent to which storage is needed



Variation in gas supply for heating across peak demand day in 2010

UK electricity dispatch by generation type over a week

Based on data from Robert Sansom (2016)

Data from Gridwatch (2016)

Policy and economic factors

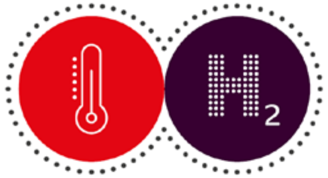
Changes to networks envisioned within the scenarios include:

- Greater interaction (and potentially competition) between energy vectors for power, heat and transport, entailing:
  - more complex trade-offs in investment choices
  - greater flexibility in the operation and balancing of different infrastructure networks
- The efficient creation, location and establishment of new energy network infrastructures at varying scales
- Substantial investment in new energy generation, conversion and storage facilities with a need for economic signals to drive efficient choices and location decisions in relation to network capacity and new connections
- The potential break up of some aspects of national energy network provision, with for example a variety of choices for heat provision reflecting local characteristics, as well as the development of new consumer propositions for home energy services
- Major shifts in the volume and patterns of usage of existing energy distribution networks

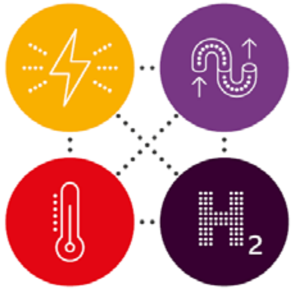
Fresh thinking in governance, market and regulatory arrangements is needed to:

- Incentivise and target investment in substantially adapting and enhancing existing network infrastructures – *e.g. efficient configuration of electricity networks to meet needs of low carbon generation*

- Enable clear decision making and incentivise investment in creating efficiently configured new network infrastructures – *e.g. new heat networks and/or heat-based energy storage*



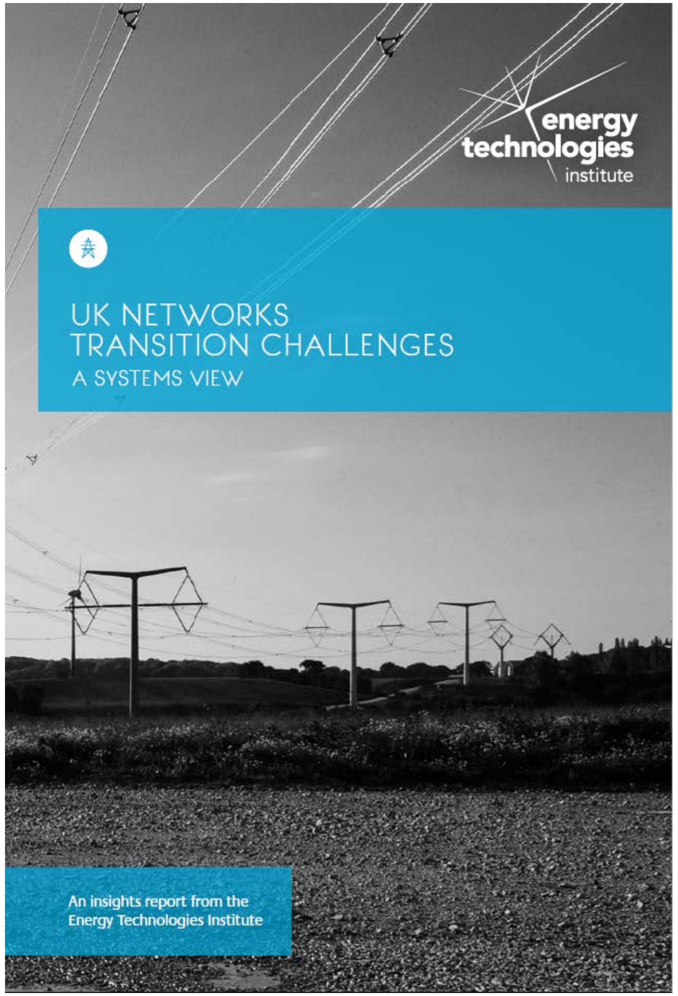
- Ensure that network infrastructures are designed and work together efficiently across vectors in real time – *e.g. enabling efficient interplay of power, heat and gaseous energy vectors*



Conclusions

- Energy networks are a vital part of the energy system
- Over the next decade, decisions will be needed about:
  - which existing networks to enhance or adapt,
  - which new networks to create and
  - how new and existing networks can be integrated to optimise across the whole energy system.
- Factors that will need to be considered, include:
  - Changes in how energy can and will be generated and consumed
  - The ability for different networks to meet needs individually and in unison
  - Transition pathways for generation, demand and the networks that link them
  - Network lifecycle and investment opportunities
- Making robust choices is important as networks can take years or even decades to build; and once they're built cannot easily be moved or changed.
- **Systems thinking is critical** which means across vectors and up and down the energy supply chain.
- Decisions should also be based on well evidenced data and analysis.
- The next decade is critical to develop the evidence, through ongoing research and demonstrations at increasing scale

Available on the ETI’s website



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A SYSTEMS VIEW

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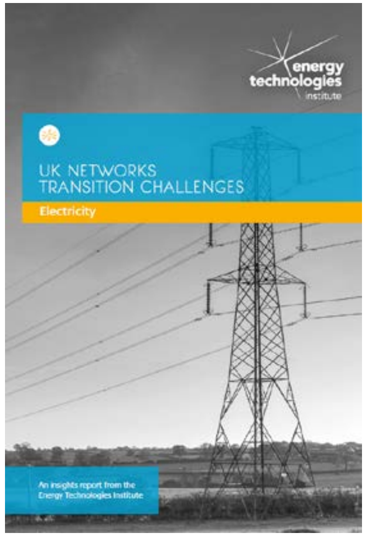

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TRANSITION CHALLENGES
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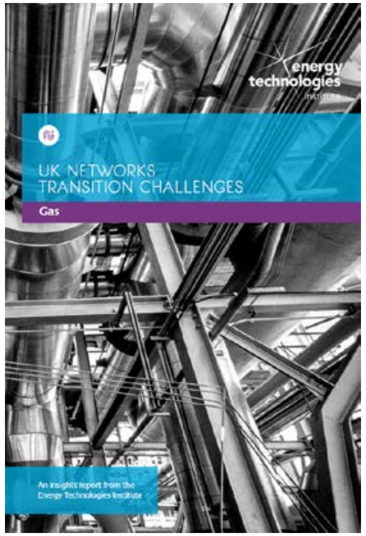

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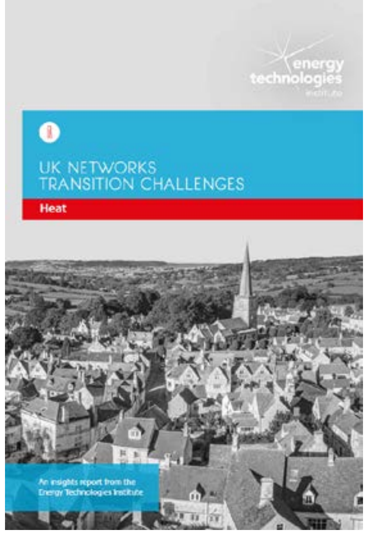

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Heat

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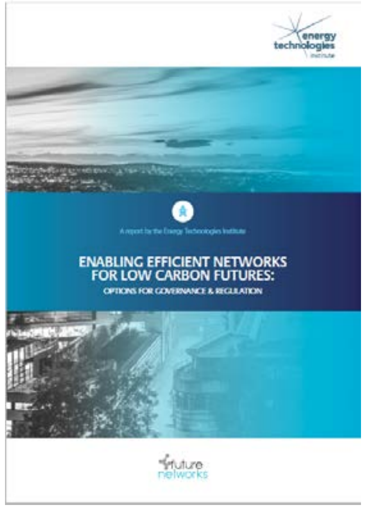

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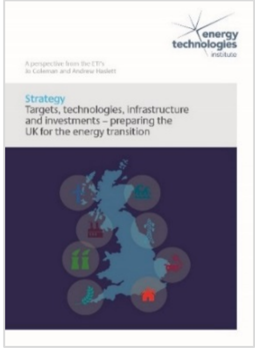
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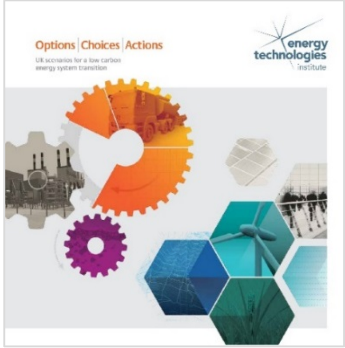
Targets, technologies, infrastructure and investments – preparing the UK for the energy transition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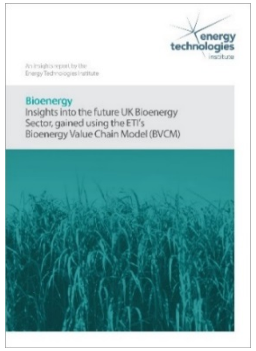
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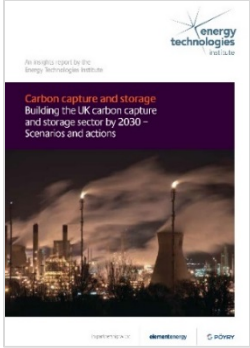
Insights into the future UK Bioenergy Sector, gained using the ETI's Bioenergy Value Chain Model (BVCM)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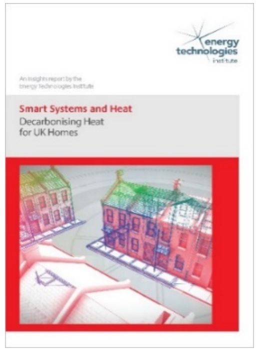
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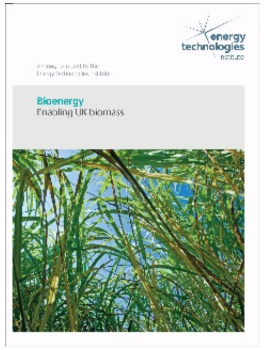
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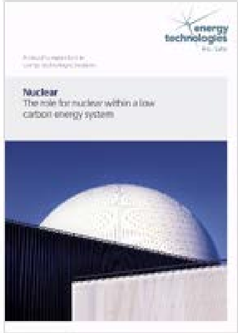
Enabling UK biomass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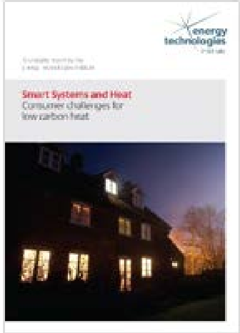
The role for nuclear within a low carbon energy system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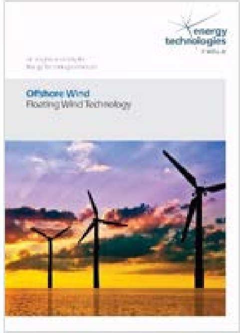
Consumer challenges for low carbon heat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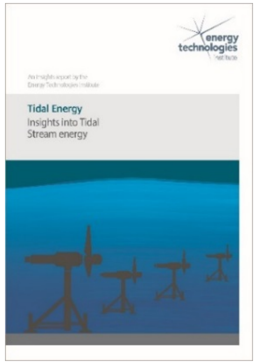
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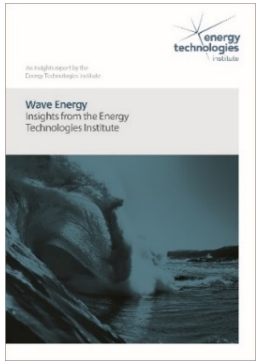
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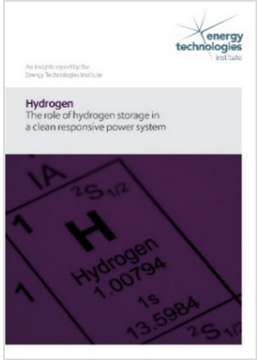
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The role of hydrogen storage in a clean responsive power system


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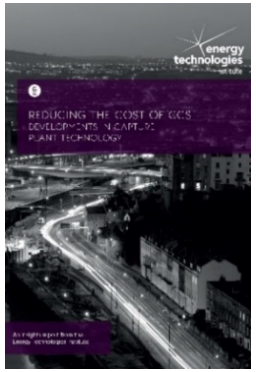
Delivering greenhouse gas emission savings through UK bioenergy value chains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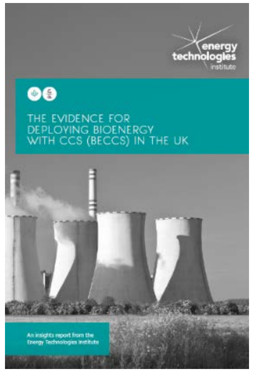
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Registered Office
Energy Technologies Institute
Holywell Building
Holywell Park
Loughborough
LE11 3UZ

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