



Energy Research Partnership

Low-carbon heat project launch event, 11th October 2016

The Energy Research Partnership (ERP) announced its new project on [low-carbon heat](#) at a launch event on 11 October. Attended by a broad range of experts from sectors including construction, utilities, academia, oil and gas, regulators, and research funders, the meeting set out to gain insights to help shape the research priorities of ERP's new project, and to highlight upcoming workshops.

The meeting included the launch of two new ERP reports on [Heating Buildings](#) and [Hydrogen](#), which provide insights into aspects of the transition to low-carbon heat. The discussion on the challenges of delivering low-carbon heat was informed by perspectives from three speakers:

- Peter Bonfield, Buildings Research Establishment (BRE)
- Jenny Hill, Committee on Climate Change,
- Neil Schofield, Worcester Bosch.

ERP's project on the transition to low-carbon heat, aims to add to the current debate about heat by providing insight into the governance and timeframe aspects of the trajectory to 2050 for decarbonising domestic and commercial heat. Building on techno-economic analysis of specific heating technologies it will investigate how top-down and bottom-up aspects join up:

- Implementation: including retrofit practicalities, supply chain development, logistics for customers and utilities, and user acceptance of technologies.
- Systems Implications: including infrastructure requirements, and primary energy demand.

The project's timings complement current interest about heat, including the development of the UK Government's Heat Strategy. It is scheduled to report in July 2017 and will be informed by interviews and workshops in late 2016 and early 2017.

Hydrogen report

ERP Analyst, Richard Heap, summarised the key findings of ERP's new report on hydrogen, highlighting that hydrogen is already entering the UK energy system, providing ancillary services for the electricity grid, back-up power supplies and hydrogen fork-lift trucks. If hydrogen is to play a more extensive role, such as in heat and transport, then it requires a deliberate decision, which includes a plan to ensure it provides long-term decarbonisation and a secure energy supply.

- Surplus electricity would produce enough hydrogen to meet between 3% and 10% of total heat demand from homes.
- For heat, Carbon Capture and Storage (CCS) will be essential, as large supplies of hydrogen will mostly come from steam methane reforming (SMR) of natural gas. Residual emissions from CCS (90% capture rate) and upstream extraction of natural gas will produce hydrogen at about 50 gCO₂/kWh. Importing gas means upstream emissions do not accrue to the UK. CCS capture rates could also increase with investment.
- Primary energy demand per unit of heat supplied will increase due to efficiency losses from SMR. Impact on energy security of long-term importing of gas or hydrogen needs assessing. Reducing heat demand from buildings could offset increase, but this would be in addition to current measures.
- Zero-carbon hydrogen will be needed as global GHG emission targets reduce to zero, beyond 2050. Address upstream gas extraction emissions and develop new production technologies.



- Repurposing the gas grid could decarbonise domestic and commercial heating in cities relatively quickly, e.g. Leeds H21. Supply could expand to other sectors, such as transport.
- Converting the UK's entire gas grid by 2050 would require converting the equivalent of three cities the size of Leeds every year between 2030 and 2050.
- Public trust in the process and companies involved needs to be secured through early public engagement, if repurposing of gas grids is to be successful. Issues that are likely to arise are increased energy prices, safety, and whether hydrogen could be used inappropriately.
- The UK has leading expertise, with companies selling into the international market.

Attendees discussed the following points:

CO₂ storage: If hydrogen from SMR supplied most of the UK domestic and commercial heat demand and a majority of transport it would produce about 200MtCO₂/yr. By 2100, this would fill the ~12Gt of CO₂ stores currently identified, although the estimated reserve could be 78Gt. Should we reserve CO₂ storage for sectors with fewer options, e.g. negative emissions?

Costs: Hydrogen from electrolysis is at least twice as expensive as from SMR and likely to be 10 or 12 times higher.

Wholesale price of hydrogen from SMR would be about double natural gas. Retail price (including network costs, etc.) would be about 40% higher. This should be compared to cost of providing the same heat service from electric options.

Other ways of getting energy from natural gas can be cheaper than SMR for hydrogen (e.g. CHP, fuel cells, district heating), which are being considered in the Low-Carbon Heat project.

Electrolysis: Report assumes a 20% capacity factor for electrolyzers using surplus electricity. It would be expensive to build electrolyser capacity to capture the highest peaks.

It would be useful to compare alignment of load duration curves for UK's heat and power systems. Meeting heat demand from UK homes using electrolysis would require additional electricity generation, over 50GW of nuclear power operating constantly, or 150GW of offshore wind capacity. Large-scale inter-seasonal storage needed to allow summer production to meet winter demand.

International comparators: California is promoting hydrogen in transport by building infrastructure first to reassure users. But California is not directly comparable to UK, as air quality has been a strong driver (as well as climate change) for longer than the in UK, and Californian conditions are different (e.g. grid mix) and is deploying multiple solutions (e.g. hydrogen, electrification).

System-wide analysis: Whole systems analysis can pick up details missed by technical studies. Main conclusion is that switching heat demand to any alternative will be a huge undertaking.

Heating Buildings report

Simon Cran-McGreehin presented on the second report, on reducing energy demand and emissions from heating buildings, highlighting the potential of leading practice (Passivhaus standards) in fabric energy efficiency. The report explores the significant gaps between this leading practice and what we currently see in reality: the "uptake gap" due to lack of ambition for new-build and barriers to retrofit; the "prediction gap" due to limited information and unrealistic forecasts; and the "performance gap" due to poor quality of work and limited inspections.

The report makes six key recommendations aimed at reducing these gaps:

1. A high level cross-departmental group (to include BEIS, DCLG and others) to improve policy and regulation, supported by an expert advisory group.



2. An ambitious regulatory trajectory for building regulations to require better uptake of energy efficiency in new build, and adherence to that trajectory to give confidence for investments in research and training.
3. Improved use of light touch regulation by DCLG to better leverage customer action on energy efficiency, for example the continued use of display of energy certificates in all public sector buildings (and promoting their use in private sector buildings).
4. Development and promotion of products, services and “retrofit packages” that are more attractive, easier and cheaper to encourage greater uptake of retrofit, including with support from heritage groups in promoting options for older buildings.
5. Expansion of the Energy Systems Catapult’s network of test facilities to include tests of heating performance to help improve our understanding of heat use in buildings, including maintaining its buildings trials as a longitudinal study to obtain a long-term view.
6. A greater role for product manufacturers in training and quality control in installation to improve thermal performance in practice, alongside improved use of tests and enforcement by the building inspection regime including genuinely random spot checks.

Attendees discussed the following points:

Overseas comparators: Germany is possibly the best example of using energy efficiency to reduce heat demand, with: a consistent policy with buy-in from the public, zero-interest loans, and an industry that has the skills and aims for high quality. It is not clear that UK would do likewise.

Building regulations: ERP is not in a position to recommend transferring responsibility for building regulations from DCLG to BEIS, but ERP does recommend the creation of a cross-departmental group to aid in the consistency of policies and regulations for buildings’ energy.

Cherry-picking of new buildings to give unrepresentative test results was raised as a real issue by several experts in interviews for the project, but much of the data behind such claims is confidential.

Sector splits: The report does look at the challenges facing demand reduction for different sectors, e.g. social housing, rental sector, private owners.

EU referendum: Leaving the EU would remove the UK’s obligation to meet zero carbon building standards by 2019, but it can be hoped that the UK will retain that ambition, although the cancellation of the Zero-Carbon Hub’s standards for 2016 does not bode well.

Low-Carbon Heat project

Peter Bonfield spoke of the challenge of protecting and informing consumers and creating a viable market that can be trusted.

- The Bonfield review, which is awaiting publication by BEIS, will make a number of recommendations, including establishing a quality mark for retrofit, a consumer charter guaranteeing a certain level of service from everyone operating in the market, a code of conduct, and different codes of practice and standards deployed across different sectors.
- Information is key: Data sources are being made available (e.g. Ofgem data on installations under supplier obligation programmes). An information portal about homes, for the benefit of consumers, will show which measures would be useful. But prediction is hard: we can be very detailed about buildings’ performance, but occupants introduce large variability. Important that householders are more aware of energy performance, but without providing unhelpful amounts of information.

Neil Schofield welcomed the fact that heat was now being discussed as part of the energy debate.

- UK has largest proportion (85%) of homes using natural gas for heat, making it the world's largest single market for gas boilers (bigger even than China).
- Demand reduction is essential; UK is missing a big opportunity by not insisting that new buildings are as efficient as possible.
- Customer attitudes affect uptake of new heating options, e.g. a familiar user experience.
- All-electric heating is unrealistic. Electric heat pumps are right for new-build, but for existing homes consumers would not be happy with the disruption and performance, and because electricity demand would be large.
- District heating is an option in certain locations, to provide certain efficiencies.
- Decarbonising gas is an option, e.g. using biogas from anaerobic digestion.
- Hydrogen poses lots of challenges (e.g. sources, manufacture, CO₂ production, cost), but so did the successful transition from town gas (which was 45% H₂) to natural gas. Hydrogen is similar to methane (calorific value and density, so injectors, etc. are of similar sizes), but also differences (e.g. flame detection and also flame speed requiring different burners).

Jenny Hill highlighted the CCC's work on heating, and offered support for ERP recommendations:

- Bonfield is correct to emphasise the importance of standards, and the need for product manufacturers to take a greater role in standards and regulation.
- ERP is right to call for a new cross-departmental group for buildings' energy policy and regulations, reflecting CCC's "What Works" studies and a Frontier Economics study of governance.
- An expert advisory group is needed, as per CCC's white paper on co-ordination across policies & regulations. Focus regulations on ends rather than means to avoid being onerous.
- Training to up-skill the entire sector could be provided by various routes, and product manufactures are one option.
- Building on the Energy Systems Catapult's research programme is a welcome recommendation, and a longitudinal study is an interesting angle.
- Hydrogen is not a solution for the entire UK, so pursue other options e.g. heat pumps.
- Energy efficiency is essential, and should be integrated with low-carbon energy, as is done in the Energiesprong retrofit packages and in the thinking in the ERP's low-carbon heat project.
- Low-carbon heat options must include options of heat pumps for off-gas-grid, heat networks, and bio-methane injects into gas grids.
- There is no clear voice for consumers in large infrastructure projects, compared with France where all large projects go through a formal decision process involving the public.
- SMEs are a big gap in policy. Should be treated more like households than business customers. In Germany, the KfW bank offers loans for SME energy efficiency improvements.
- Governance will need to be strongly co-ordinated for any large-scale heat decarbonisation plan, to give best solutions for each area and to drive down costs.

Attendees discussed the following points:

Messaging: Main challenge is conveying two types of messages to policy-makers: First, there are urgent needs, e.g. CCS, and the role of consumers. But, second, there are long-term issues that can complicate decisions on the urgent needs, but that should not stop action.

Deployment: Any option will need to convert 20,000 homes per week for 20 years. At some point the sector will have to tell people they can't use natural gas and must switch to a new option. There is currently no single body with responsibility for heat.



Heat pumps can lack space in homes in crowded areas. Heat networks might help, bringing the heat from a CHP 40-60km away.

Stimulating investment: Energy efficiency is an attractive investment for those seeking stable, long-term returns (e.g. pension funds), provided that the sector has suitable quality assurances as proposed by the Bonfield Review.

The Green Deal had good intentions, but placed too little responsibility on the retrofit industry to improve assurance processes; the Bonfield Review recommends remedies to rectify this.

The Energy Saving Trust has an information portal that could be used to analyse and publish data (especially data to be released by Ofgem).

Commercial heating: Most systems designed for high temperature heat, so improving boiler might be easier than invasive changes to radiators needed to install a heat pump. Although even if the boiler is efficient, many buildings have poor distribution networks, which could be easily upgraded. There could be tens of thousands of these. ERP project could try quantifying the potential.

Source of energy: All low-carbon heat options pose the challenge of what the energy source will be.

Hydrogen: Small-scale hydrogen demonstration projects are planned for 2019. Two or three further iterations will be needed before move to deployment of 20,000 homes per week.

Hydrogen-air combustion is very different to natural gas or town gas. An early knowledge gap to fill is around safe combustion. Hydrogen can be best used in fuel cells.

Hydrogen could come from many sources, but need to look at potential sources and applications across the whole energy system. Need to look at potential demand from the transport sector.

The value of excess energy from the large deployment of renewables is not clear.

Hydrogen appliances are being developed, but industry needs Government support.

Globally there are 22 CCS projects operating. A decision should be made in this Parliament, not the next. Without CCS, ETI note it would add £1-2B/yr to the cost of decarbonisation.

Bio-methane: National Grid project to inject synthetic natural gas (SNG) from waste, into gas distribution network. Could supply 25% of UK heat energy, and could be a source of hydrogen. Bio-methane has a clear price: most countries this is two or three times that of natural gas.

Closing remarks

Neil Schofield called for real political will on low carbon heat, with renewed efforts in the meantime to improve energy efficiency, smart controls and the efficiency of heating systems.

Jenny Hill highlighted the need for a narrative on heat that addresses issues of inequality and potential high costs for some consumers.

Peter Bonfield expressed his view that this disparate group of stakeholders, brought together by ERP to discuss low carbon heat, could be invaluable to ministers in developing heating policy.

Keith MacLean noted that BEIS is focused around industrial strategy, so we need to ask how the UK can get an economic advantage out low-carbon heat.