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The Heat Report

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COMMERCIAL SOLUTIONS FROM **BAXI HEATING**

The clock is ticking

By Tim McManan-Smith, editor, the energyst

This report follows up the 2016 heat report and aims to provide views from end users on decarbonising heat, as well as industry stakeholders.

It finds relatively little progress in decarbonising heat over the last two years, though government funding for public sector heat networks is bringing schemes forward, according to an infrastructure investor (see p26).

Otherwise, public and private sector organisations surveyed for the report still have mixed views of the renewable heat incentive; and remain concerned over the capital cost of lower carbon technologies. Yet the majority are at least considering investment in lower carbon heat (see p4).

That is something to build on, but to convert interest into investment will require stable policy and a clear direction of travel from government. Incentives – not necessarily subsidy, but other levers, such as tax breaks or business rate relief – may also help drive demand.

Stakeholders interviewed for the report offered different views about the best pathways to decarbonise heat, but were united on one front: Energy efficiency must be placed at the heart of policy to reduce the requirement for new, capital intensive infrastructure and cost to consumers.

Once heat load is reduced, different solutions may become more viable.

Meanwhile, central and local governments could also help co-ordinate a push to match waste heat with heat demand across the UK's industrial estates, according to some of those interviewed.

HYDROGEN?

Most of those interviewed believe there is no silver bullet to decarbonising heat, that it will require multiple solutions that best fit local infrastructure.

However, there continues to be a strong push for hydrogen as a replacement to natural gas within the existing gas infrastructure.

Hydrogen proponents believe it can deliver significant decarbonisation at a lower cost than other options such as electrification – and that it enables households and businesses to carry on using gas without having to change behavior.

However, a wholesale switch to hydrogen would require carbon capture and storage (CCS) to capture the emissions released in steam methane reforming.

While some may argue otherwise, CCS is not a tried and tested technology and it will not come cheap.

As energy minister Claire Perry said in March: "This is not a cost-effective technology that other countries

are embracing with gusto. Even our friends in Norway, who are a little further along than us in building up [CCS] infrastructure, are struggling with precisely this point, which is, how much do we burden taxpayers or consumers to fund these projects?"

However, Perry also indicated the government would "embrace" the CCS challenge.

"There are enormous opportunities to work with the hydrogen economy ... to decarbonise industrial pools and to decarbonise further our heating system," she said.

"Without CCS and CCUS, I do not believe that we can do that, which is why they are such vital technologies."

ELECTRICITY?

Others believe the hydrogen pathway risks locking the UK into a technology that cannot fully decarbonise heat, putting 2050 climate change targets at risk. They believe resource should be put into smart technologies and heat storage to reduce further a heat peak that can be mitigated by energy efficiency investment.

There will always be conflicting opinions and robust debate is healthy. The indications are that government recognises the need to set frameworks for decarbonising heat without shutting the door on opportunities as they emerge.

The problem is, it doesn't have much more time to deliberate – and tackling heat will make decarbonising power seem like the warm up act.

What this report covers; caveats; sample bias

This report contains a survey on heating options and stakeholder views on pathways to decarbonising heat. The main survey is based on the views of public and private sector businesses and consultants (45 responses, through specific questions relating to technologies deployed have fewer answers). There is also a marked section with the views of heat engineering and gas services firms, based on responses from report sponsor Baxi Group's database (based on a 28-41 responses varying by answer). As such, the sample is relatively small. Also, given those interested in a topic are more likely to take an online survey around it, may not be representative. However, many of the results tally broadly with findings from our 2016 heat survey, suggesting consistency.

Thanks to all those who took the survey, those who provided their opinion in telephone interviews, and sponsor Baxi Group for giving us free rein on the material published.

Brendan Coyne - contributing editor

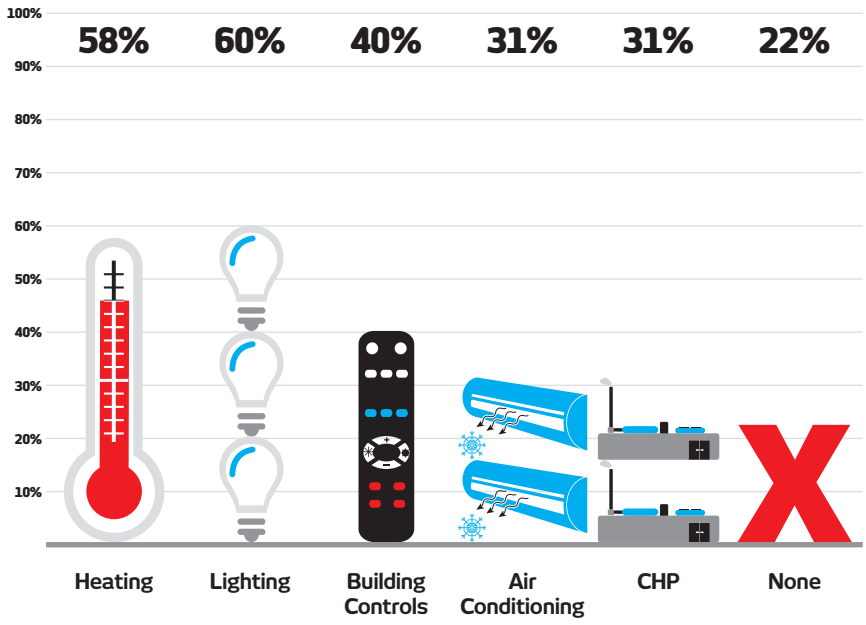
Which low carbon technologies have you installed within your building?

Low carbon lighting and heating are the standout technologies, installed by six in ten respondents, followed by building controls in four in ten buildings.

The split of technologies across responses is broadly similar to the survey carried out for the Heat Report in 2016.

Answers in the 2016 survey were:
Heating 58%
Lighting 77%
Building contols 45%
Air conditioning 31%
CHP 27%
None 12%

Note: Multiple choice, so totals greater than 100.

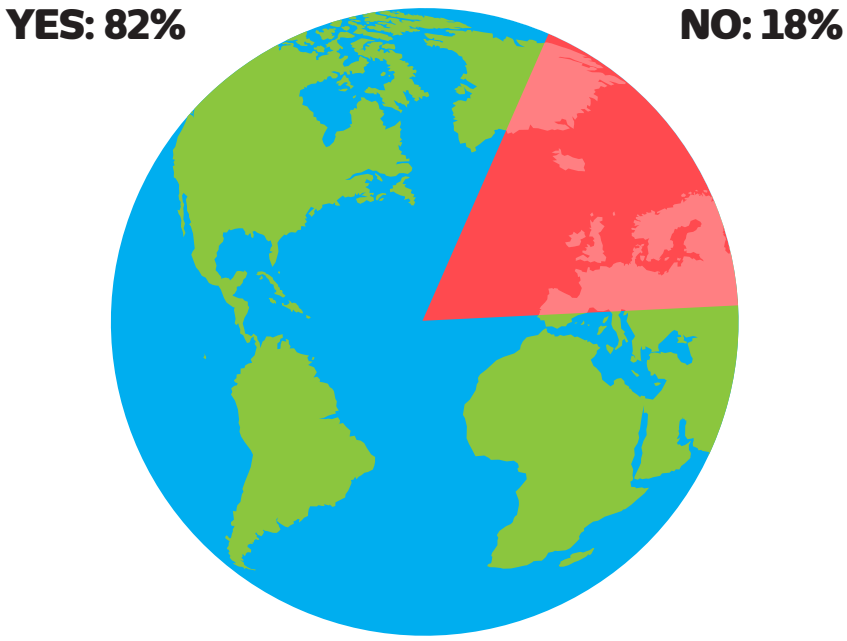


Is your organisation looking at low carbon methods of heating?

The vast majority of survey participants are at least considering low carbon heat solutions.

This is a slightly higher percentage than the 2016 heat report (Yes 76%, No 24%).

The result is promising, though an important question to ask in the next heat survey is to quantify the intent. For example, how likely are respondents to install low carbon solutions within the next 12-24 months.

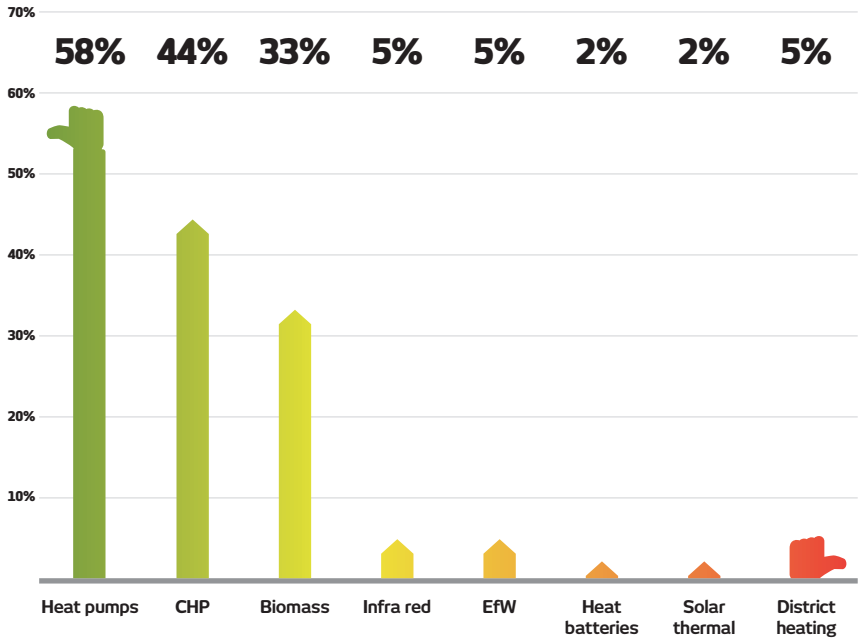


Please specifiy which technologies you are / would consider deploying (i.e. heat pumps, CHP, biomass etc)

Many of those surveyed are deploying or considering deploying more than one technology, hence totals greater than 100.

The answers to this question are broadly in line with the 2016 survey, where heat pumps were also followed by CHP and biomass, with other technologies significantly less popular.

However, in 2016 heat pumps were cited by 19 respondents. This year, they were cited by 25, which may suggest increasing appetite for heat pumps.

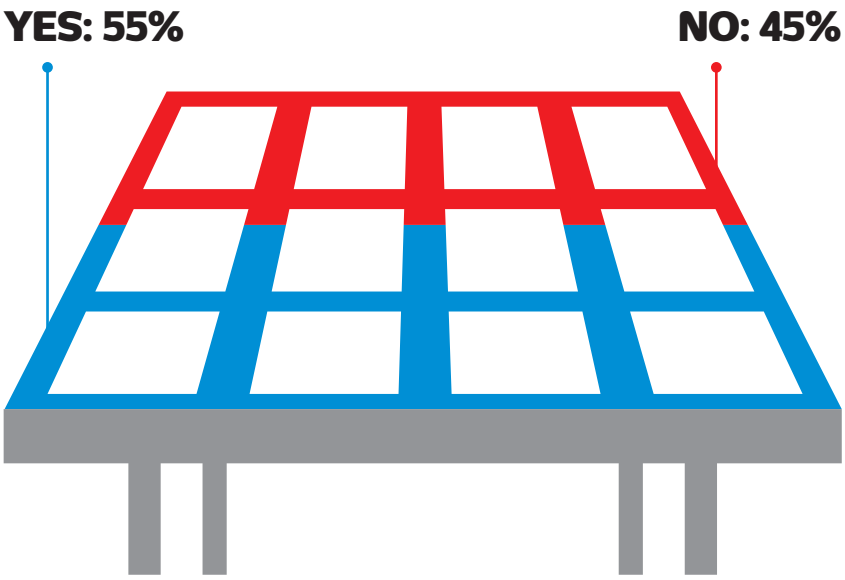


Has the government's Renewable Heating Incentive been an effective tool for encouraging renewable sources of heating?

Respondents are slightly more positive than negative about the RHI's effectiveness.

The findings are almost identical to the survey conducted in 2016 (57% to 43%).

Respondents that do not feel the RHI has been effective were asked why. The survey also asked for views on how low carbon heat might be more effectively incentivised. A selection of these answers are provided on p16.



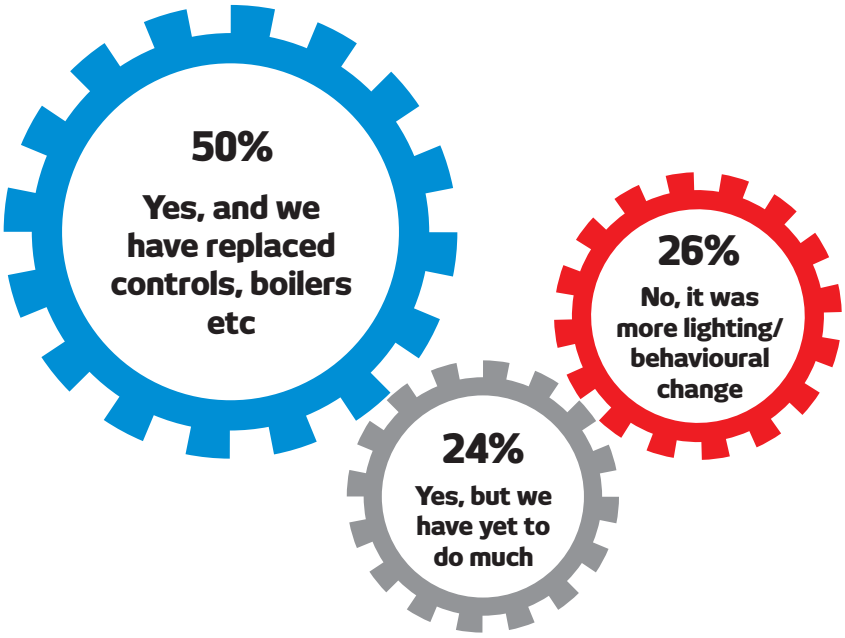
When addressing the optimisation of buildings that your business owns, has heat been a focus of this?

Half of the survey sample have optimised heat within their buildings, a higher proportion than the survey sample in 2016.

A quarter have at least made a start on heat, while a quarter have focused on other options such as lighting and behaviour change.

The 2016 survey found:

40% - Yes and we have replaced controls, boilers etc.
33% - Yes, but we have yet to do much
27% - No it was more lighting/ behavioural change



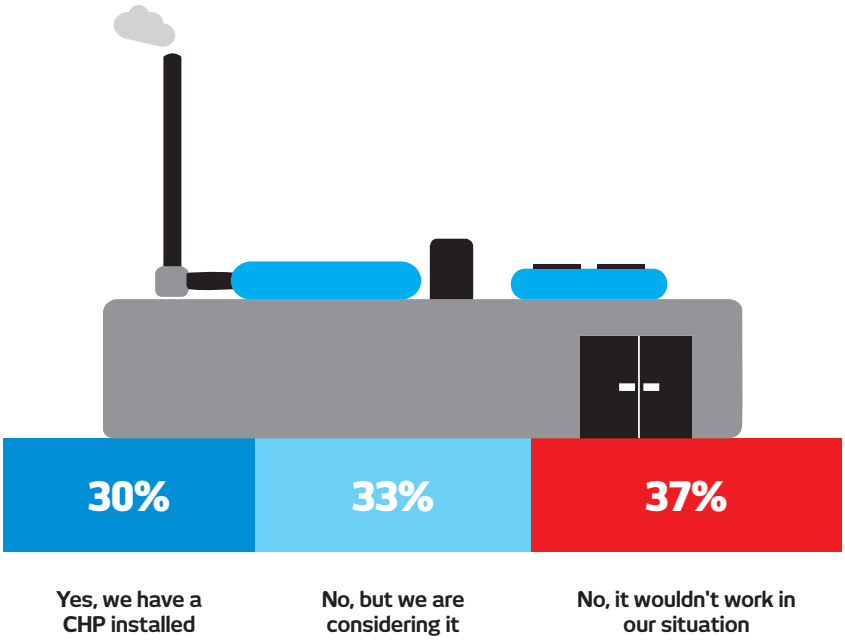
Is combined heat and power (CHP) something that you use?

These findings are almost identical to the survey sample in 2016, which found:

30% have a CHP installed
30% are considering CHP
40% for whom it would not suit

According to latest data (DUKES 2017), there were 2,182 CHP schemes (excluding microCHP) operating in the UK in 2016.

In terms of overall fuel use for UK CHP plants, around 71% is via natural gas, around 12% comes from renewable sources, according to DUKES.



Is your CHP ...?

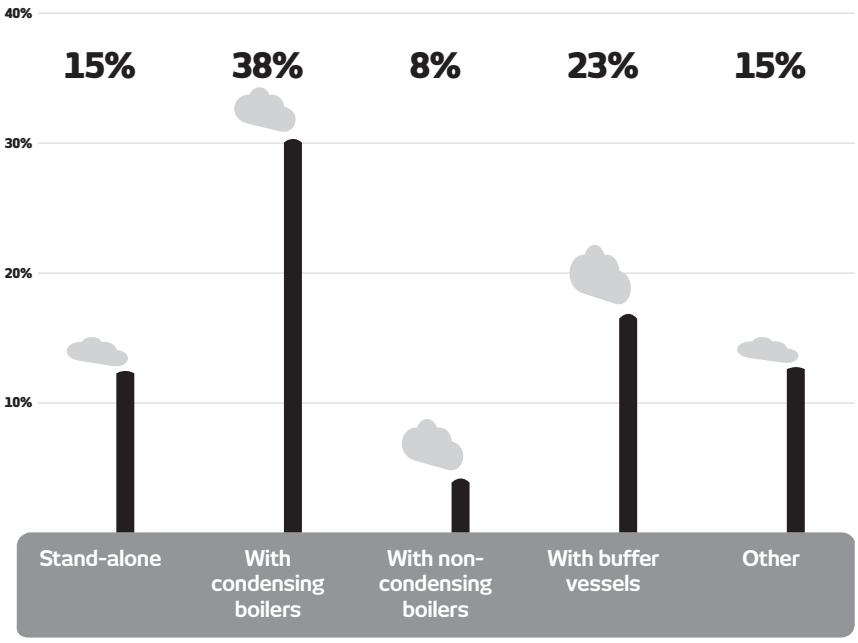
Answers to this question come from a small sample, so the data must be treated with more caution.

But it shows condensing boilers are most popular, followed by buffer vessels.

Respondents with CHP include several universities, an NHS Trust, an automotive manufacturer, a waste management company and a community energy company.

The survey did not ask this question in 2016 so there is no comparative data.

Note: Percentages do not total 100 due to rounding.

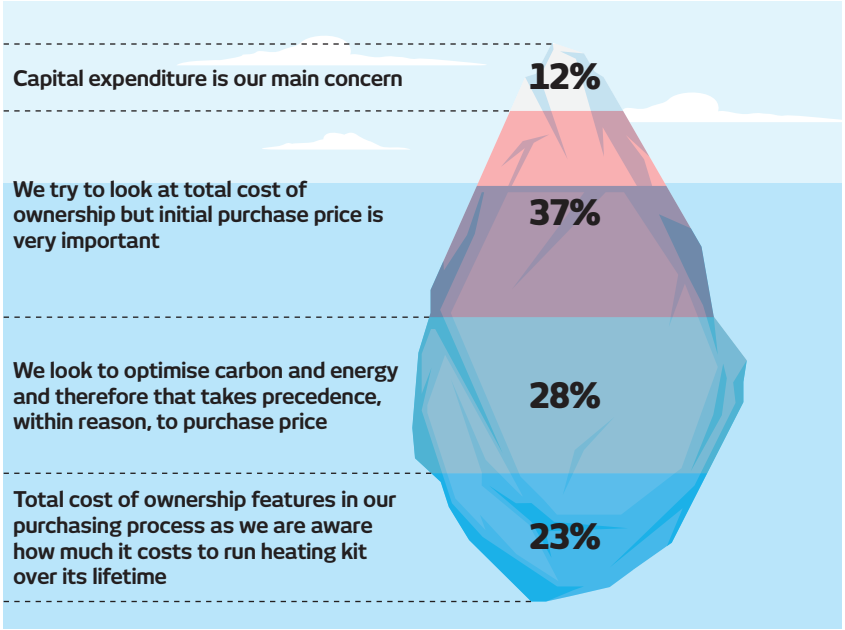


When purchasing heating equipment does your company take a longer term total cost of ownership view regarding energy use and maintenance or is it more on how much it costs to purchase?

Roughly half of survey respondents are driven by initial purchase price to some extent, roughly half take a longer term view.

These findings are fairly similar to the 2016 survey, though may suggest a slight swing towards optimisation/total cost of ownership versus up front cost.

The 2016 survey found:
12% - Capex main concern
44% - Try ... but initial price
21% - Look to optimise
22% - Total cost

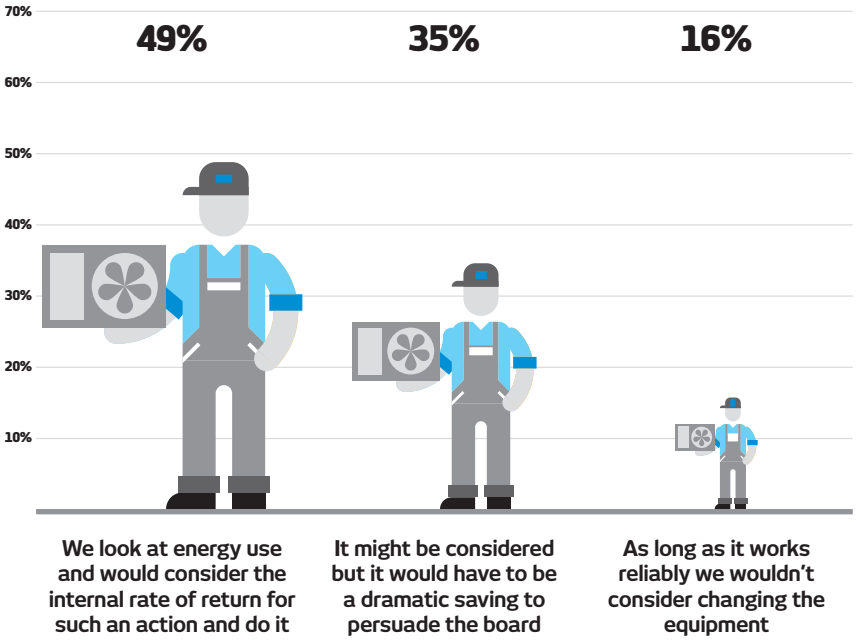


Would you replace old heating technology because of its energy use and the improvement of later generation models or technologies?

Most firms would replace or consider replacing ageing equipment if it delivers energy savings, though for around a third the savings would have to be 'dramatic'.

That is perhaps unsurprising: Heating plant differs to other pieces of kit in that it is usually a significant investment. An industrial boiler, for example, will likely have a life of 25+ years and high capital costs.

Findings for this question are broadly in line with the 2016 survey (56%, 29% and 15%).

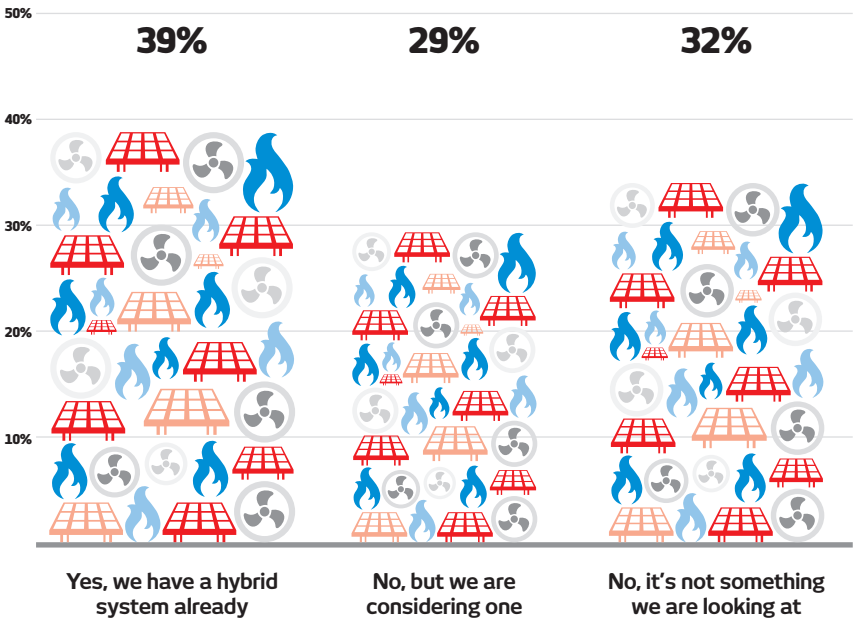


Do you have a blend of technology for your heating requirements? (such as gas boilers, heat pumps and solar thermal)

More respondents say they use a hybrid system in this year's survey than in 2016, whereas fewer say they are considering implementing a blend of different technologies.

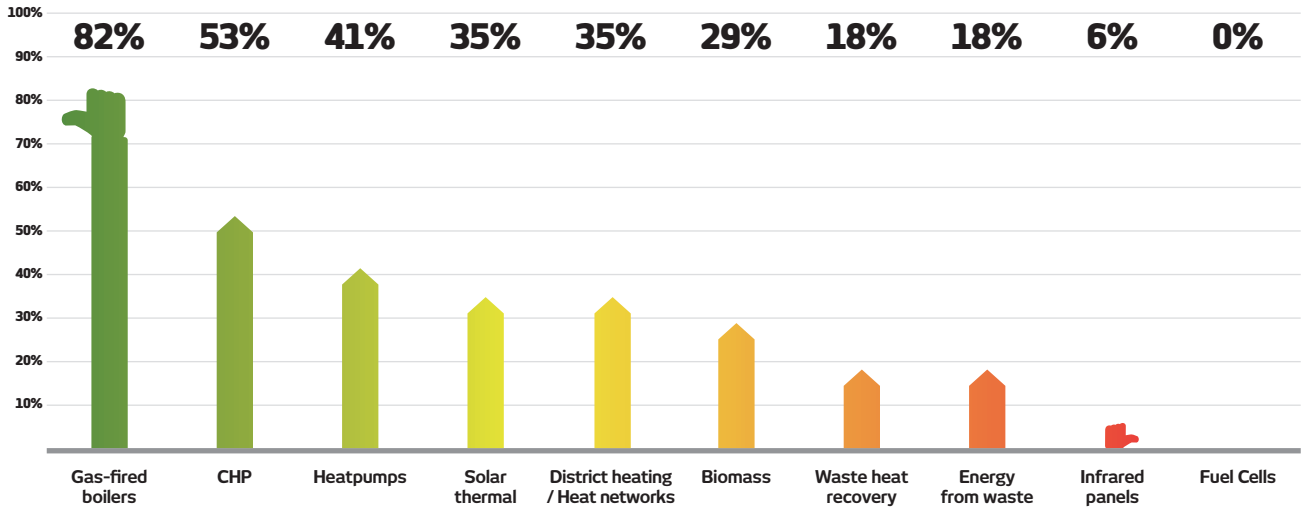
This may be sample bias; those interested in lower carbon heat are more likely to take a survey around the topic, therefore may be more likely to have explored a blend of technologies.

The 2016 survey found:
29% - have a hybrid system
37% - are considering one
34% - are not looking at hybrids



If you have a hybrid system, what are its constituent technologies?

This data comes from a smaller sample, as only 39% of respondents have a hybrid system. The vast majority of responsdents' hybrid systems involve gas-fired boilers, followed by CHP and heat pumps.
As this question was multiple choice, totals are greater than 100.

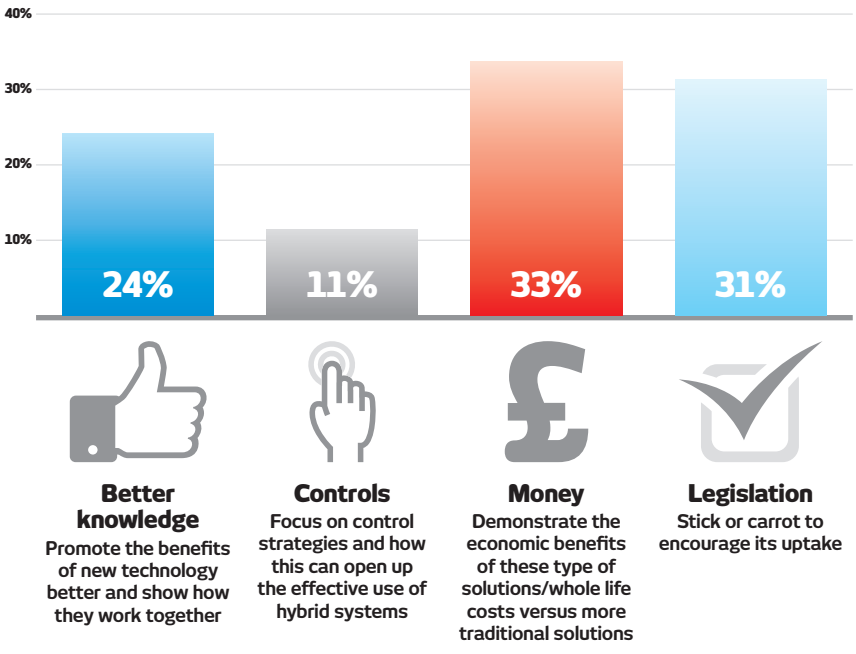


Multi-technology heat solutions can offer an efficient option, what is the best method of encouraging this?

Only a handful of respondents think focusing on control strategies are the best way to drive uptake of hybrid systems.

Demonstrating whole life cost benefits marginally trumps legislation as the primary driver. In conjunction with better knowledge and promotion of new technology, these three elements together may yield results.

However, the survey has already shown that upfront cost is a major factor in purchasing decisions for half of organisations surveyed.

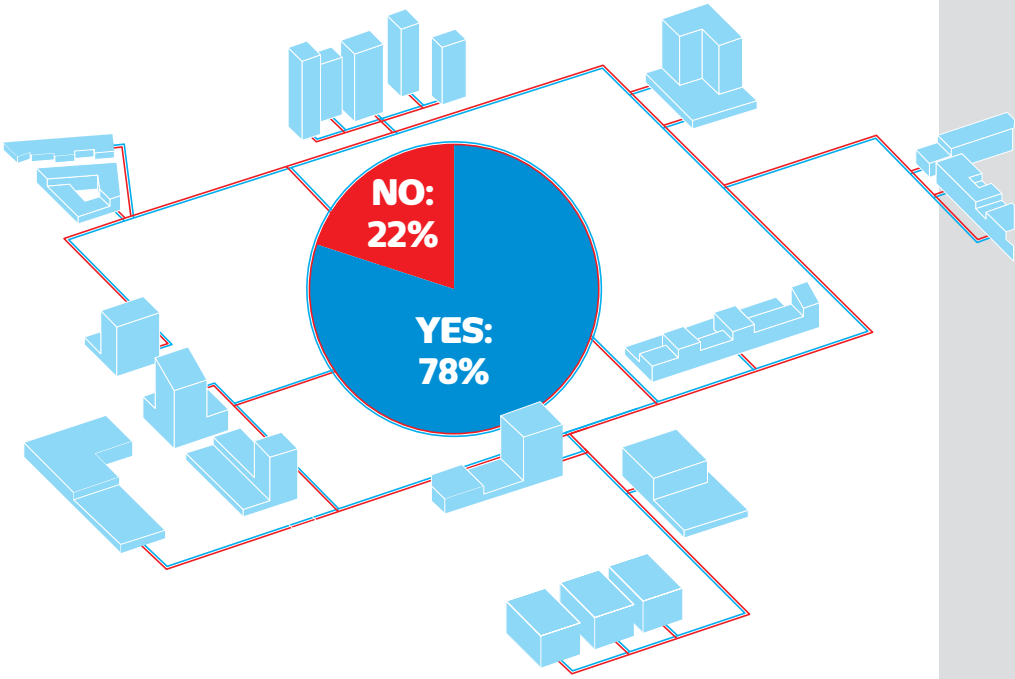


Within the next 5 years, do you see heat networks as a solution to decarbonisation in the UK?

Views on heat networks are virtually identical to those given by respondents to the 2016 survey (Yes 79%, No 21%).

Since then, the government has launched a £320m fund to help local authorities scope and develop heat network projects in a bid to make them investment grade.

Respondents that do not think heat networks are part of the solution were asked why. Answers included: That they are not being built in sufficient numbers; that the economic priorities of local authorities would unlikely include heat networks; financial, legal and organisational challenges; that they are not low carbon; that the gas grid could be 'greened' more effectively.

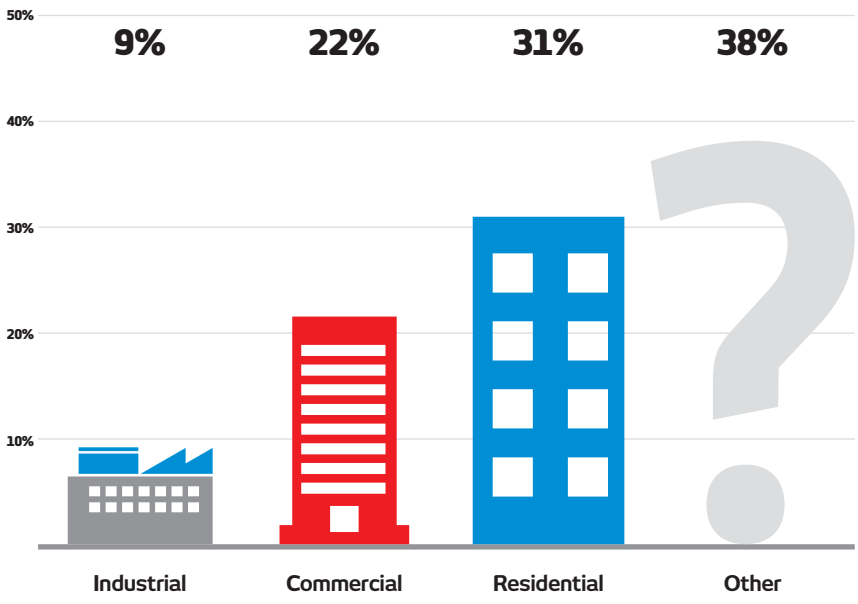


Where do you foresee heat networks best utilised?

Respondents stating 'other' were asked to specify their answer.

Most were a variation of mixed use developments, either industrial and commercial, or industrial, commercial and residential, to help balance heat loads.

Some respondents think heat networks should be city-wide and others that public sector buildings, where possible, should use them.

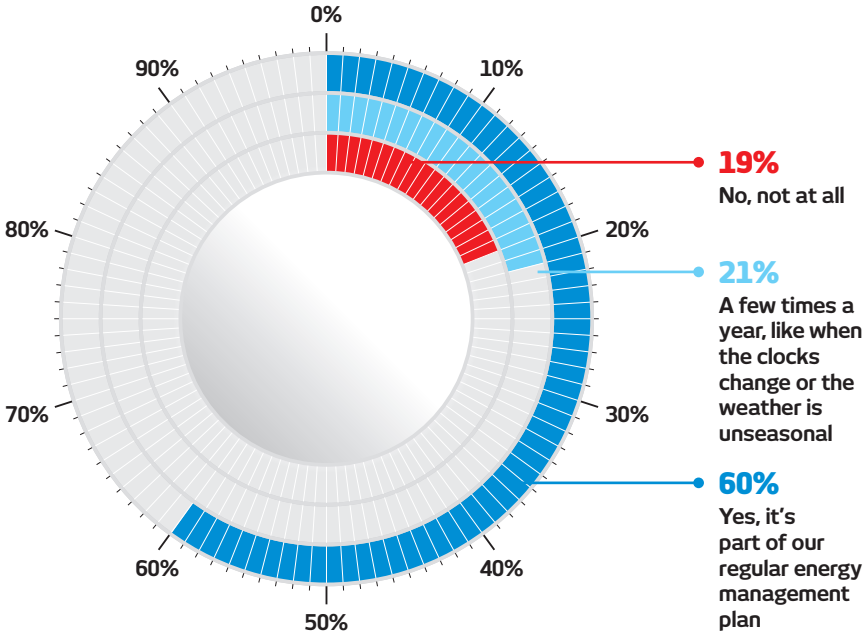


Do you look at heating controls regularly to optimise your heating system?

Most respondents regularly optimise heating systems in order to achieve best bang for buck.

Some heating systems can actually be more cost effective when left to run within set parameters, which may be why a fifth of respondents only adjust or monitor them seasonally.

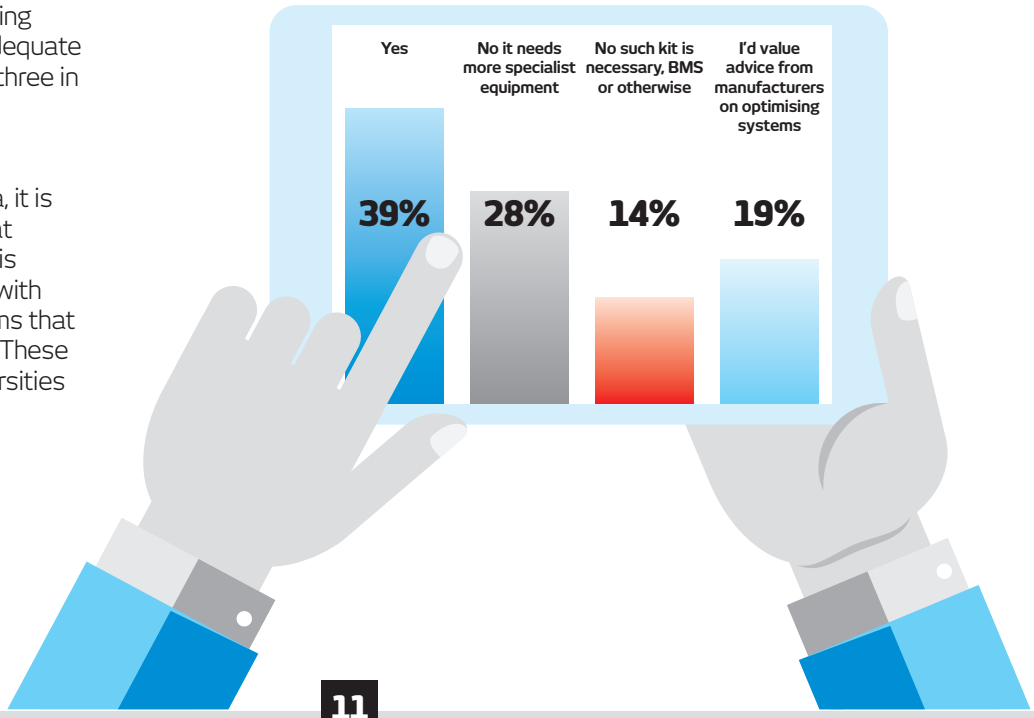
That a fifth do not look at controls at all is interesting. A follow-up survey should probably ask why not.



Do you consider the Building Management System (BMS) a sufficient tool for optimising your heating?

Four in ten think their building management system is adequate to optimise heating, while three in ten think more specialist technology is required.

By filtering the survey data, it is clear that respondents that believe more specialist kit is required tend to be those with more sophisticated systems that use multiple technologies. These respondents include universities and manufacturers.



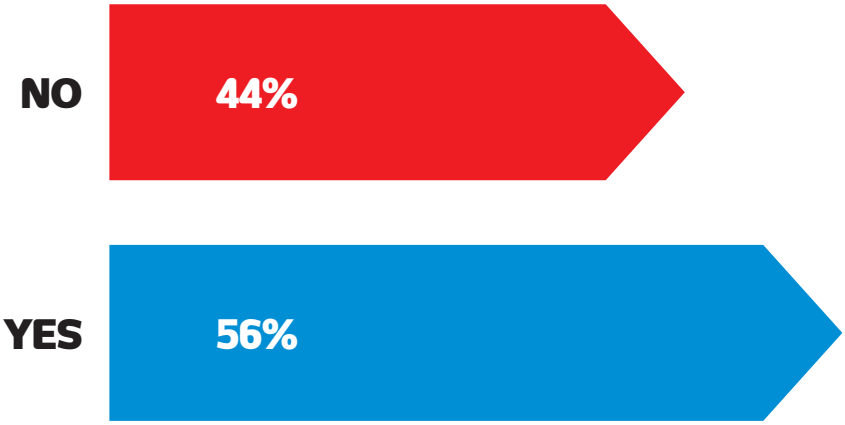
Are you aware of the Energy related Products (ErP) Directive regarding heating products?

The ErP Directive came into force in 2015 and governs product efficiency and emissions.

The aim is to phase out inefficient produts and reduce emissions.

From September this year, rules around Nitrogen Oxides (NOx) come into scope.

It may be that manufacturers are more concerned about ErP than end users, but this year's survey shows a lower level of awareness than in 2016 (69% yes, 31% no).

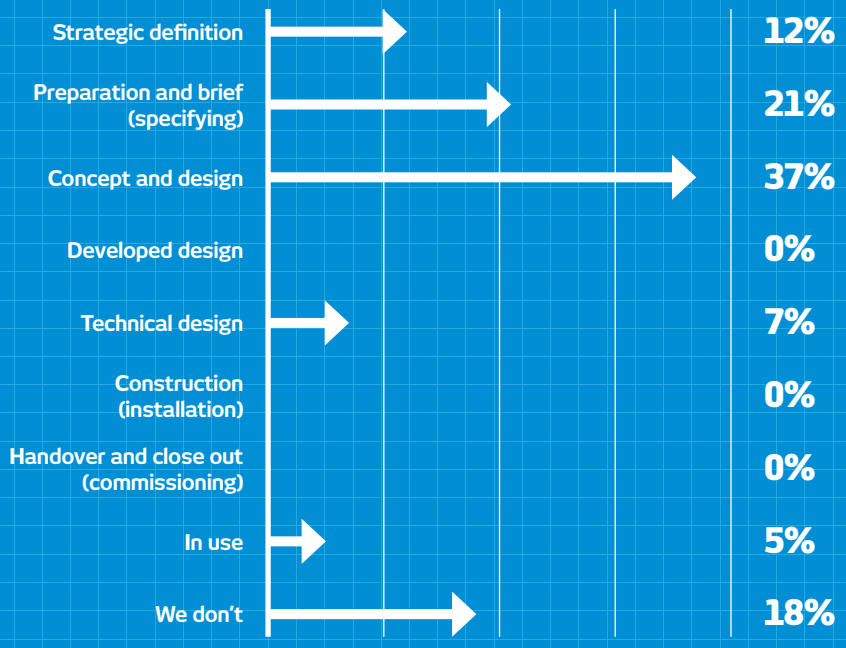


At what stage of the planning process do you consult with the manufacturer to develop the most efficient low carbon plant room?

These results show that manufacturers are generally brought into projects at an early stage, though rarely when projects are being defined.

However, that almost a fifth of respondents suggest they do not consult with manufacturers at all is interesting.

This may suggest that these users trust their consultants and installers to deliver the right solutions, or it may suggest an opportunity for manufacturers to step up engagement efforts with end customers.



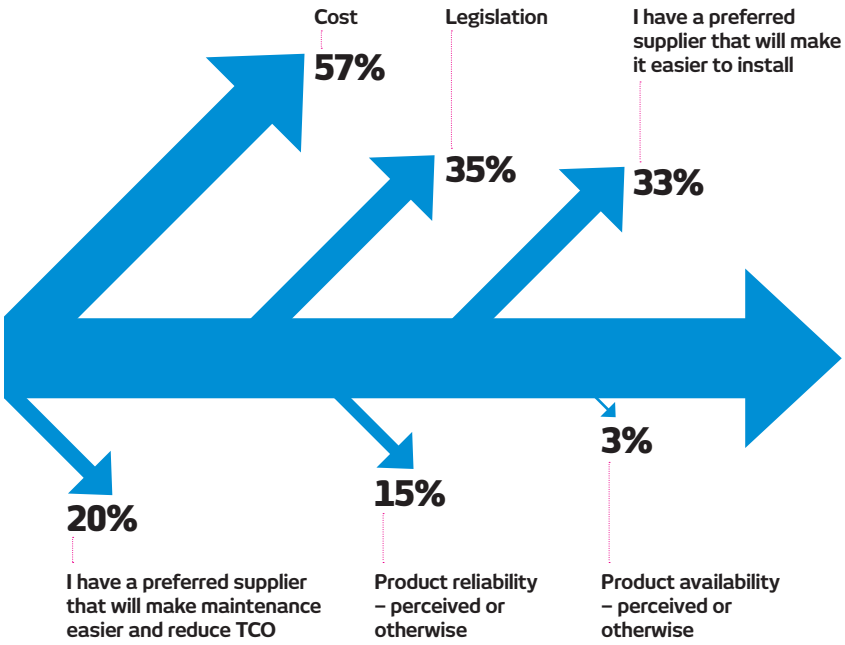
What would be the reasons you would 'break' the design specified for a low carbon plant room?

Cost is the main reason cited by respondents to break the design spec, which tallies with responses around capex/upfront costs as a key factor for roughly half of those surveyed.

Preferred suppliers factor in the decision making process, as does legislation, though it may have been useful to ask respondents to specify which pieces of legislation have a bearing.

Product reliability and availability are minor factors.

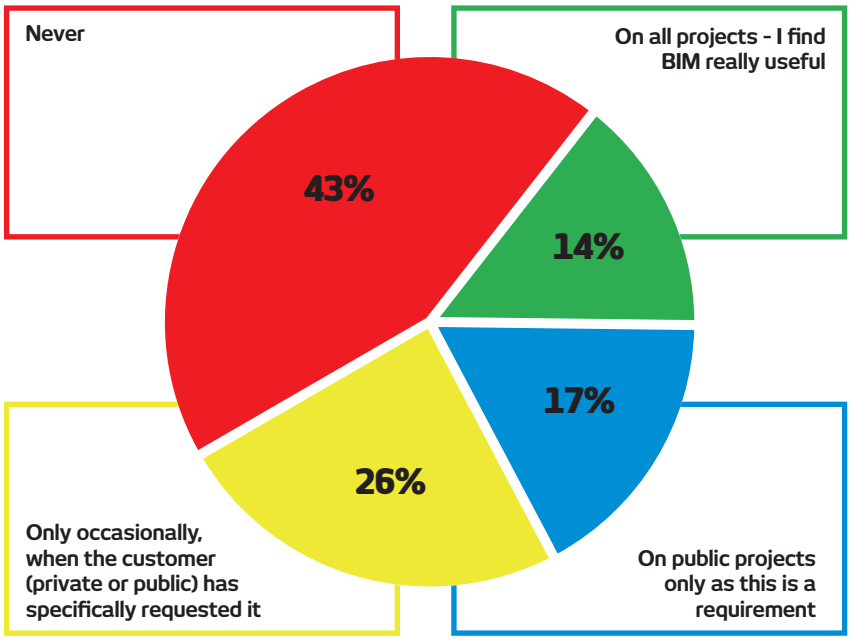
This question was multiple choice, so totals more than 100.



How often do you use BIM as part of your projects?

Building Information Modeling (BIM) software can help in the planning, design and construction of projects, as well as for operations and maintenance.

Respondents that say they always use BIM are largely consultants, whereas those that say they never use it are largely end users.



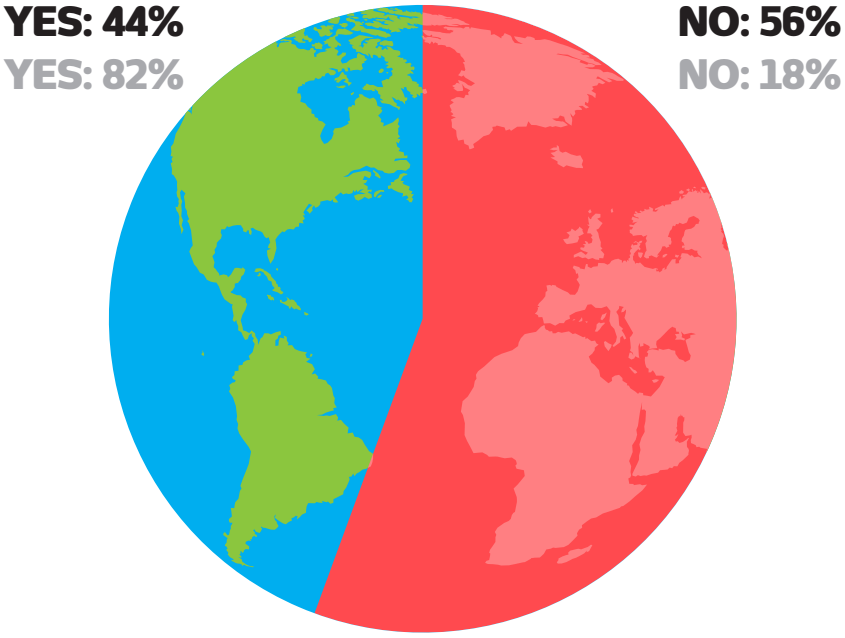
Is your organisation looking at low carbon methods of heating?

Report sponsor Baxi Group also sent the survey to its database. Respondents were mostly from heating engineering and gas services firms.

Their answers show far fewer of these firms are looking at low carbon heating (44% as opposed to 82% in the survey sent to end users and consultants).

This is perhaps understandable, as many of these respondents are primarily focused on gas solutions, which represent the majority of the market.

Note: Bold answers = Baxi survey, light answers = main survey

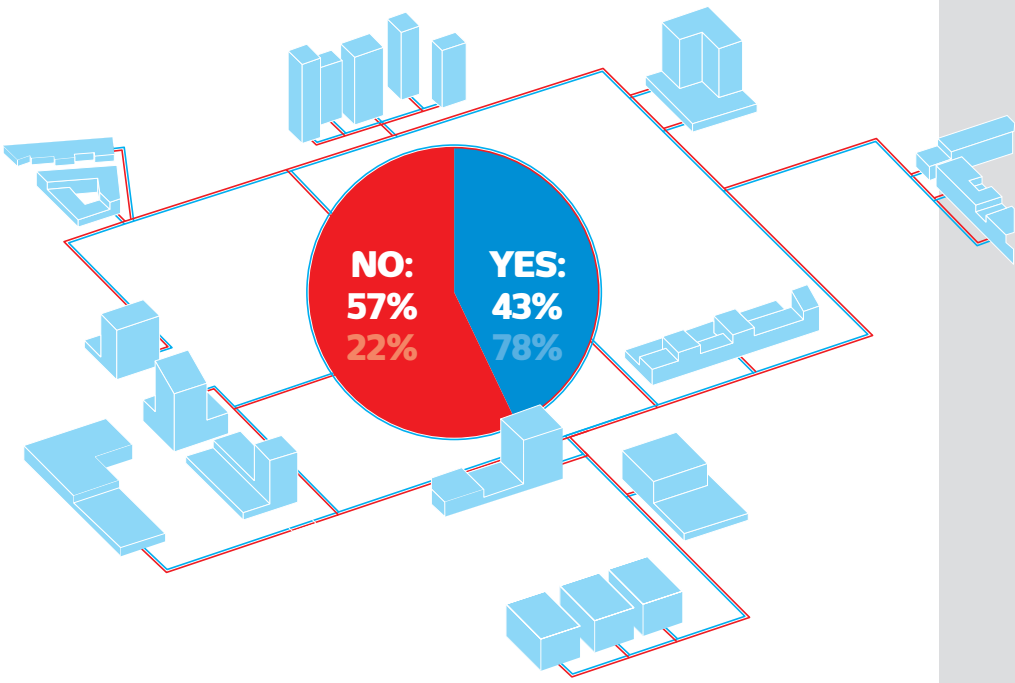


Within the next 5 years, do you see heat networks as a solution to decarbonisation in the UK?

Heating industry respondents are more skeptical that heat networks have a role to play in decarbonising UK heat.

Most do not believe heat networks will play a role within the next five years. Asked why not, many answers revolved around cost and the practicalities of installing major infrastructure.

Others questioned whether economics will stack up for heat network operators if buildings are becoming more efficient.



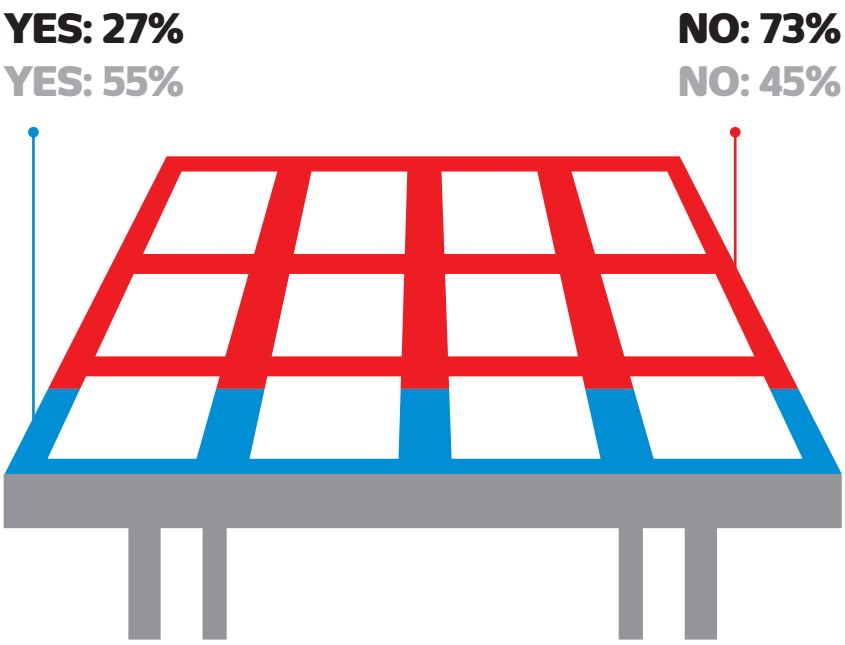
Has the Government's Renewable Heating Incentive been an effective tool for encouraging renewable sources of heating?

Heating engineers are also more definitive on the RHI.

Around three quarters do not believe it has been effective. Asked why not, respondents cite complexity and a lack of knowledge or understanding of the scheme, suggesting poor promotion.

Others said the incentives were not sufficiently high.

Asked what might improve low carbon heat uptake, higher incentives and capital grants were a recurring theme.

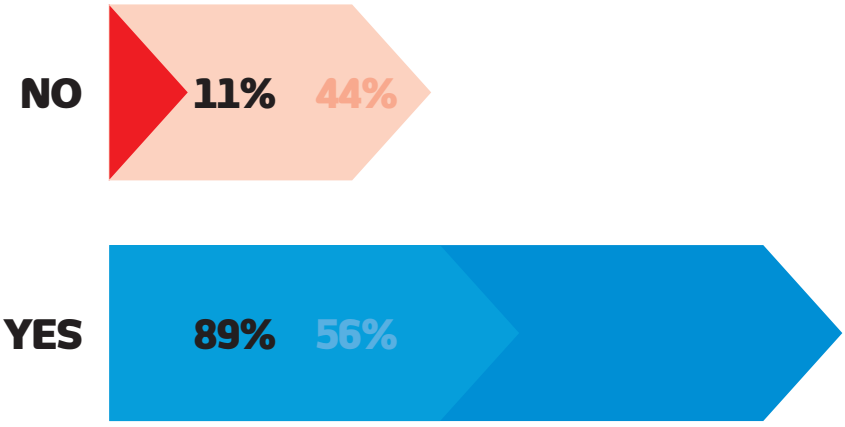


Are you aware of the Energy related products (ErP) Directive regarding heating products?

Nine in ten of this set of respondents are aware of the ErP, a far high proportion than the general survey.

This is perhaps unsurprising given many of this sample are gas and heating engineers that deal with heating equipment and plant for a living.

However, that one in ten are not aware of the ErP directive may suggest a need for further engagement with industry.



Policy and incentives: What do end users think?

Survey respondents are divided on whether the Renewable Heat Incentive (RHI) has been an effective instrument. Some 55% think is has been effective versus 45% that think it has not.

Those that thought the RHI has not been effective were asked why. Responses included: "The funding programme has been abused and not applied fairly."

"Yes [effective] for biomass – not sufficient and too complex for heat pumps."

"It is technically flawed, subsidises some of the least effective options the most and provides £0 for some effective options. It is less beneficial than doing nothing."

"We have not found biomass solutions sufficiently compelling and the requirements of the RHI appear complex and bureaucratic."

"Complication around registering products."

"It has encouraged profiteering rather than sensible heat source replacement."

WHAT MIGHT IMPROVE UPTAKE?

Respondents were asked what might better incentivise or reward low carbon heat. Responses included: "Guarantee that RHI will continue."

"Simplify heat pump incentives. Encourage hybrid heat pumps."

"A cut off date when only lower emissions [technology] can be sold and fitted from then on. Further [deadlines] when all businesses can only [specify] low carbon heat. Starting with major corporations then larger SMEs and down. Another cut off date thereafter for landlords, housing associations etc."

Other suggestions included:

"Cross subsidising the cost of electricity from increased CCL on gas as carbon intensity of the grid decreases, so that it becomes gradually more financially viable to install."

"Stronger enforcement of building legislation."

"Capital grants for district heating."

"Adjust business rates for better EPC ratings; Tax incentive on capital; Zero vat."

"Link Council Tax to heating energy – make greedy buildings pay much more tax."

"Priority planning approval for councils partnering with existing community in heat and power provision for new housing developments; Requirement all councils to ensure boiler replacements utilise renewable technologies. Market incentive for products made with low embedded carbon."

"Any policy that stays its course. Too often incentives are taken away once a project is a success, which makes investors nervous in future."

"Simplicity and clarity – particularly with regards to metering requirements."

"Scrappage schemes for old oil and gas boilers; incentives for thermal storage; innovative heating tariffs."

"A mixture of carrot and stick: basic subsidy, genuinely low interest finance, clear and long term policies, higher tax on burning fossil fuels."

"Increase CCL on gas. Allow direct award of district heat contracts by public sector."

What has the RHI done for us?

The Renewable Heat Incentive is a tax-funded scheme to incentivise households and businesses to switch from fossil to renewable or low carbon heat while developing supply chains. It will remain open to new accreditations until 2021 and non-domestic tariffs are index-linked for 20 years.

Technologies and fuels eligible for payment are: Biomass boilers, air and ground source heat pumps, solar thermal, biogas, biomethane injection, water-source heat pumps, biomass combined heat and power and geothermal.

As at December 2017, the RHI had delivered 78,048 new installations in Great Britain, according to the National Audit Office, well short of expectations at launch. The scheme has been reviewed and refocused more towards off gas grid homes and businesses.

Biomass has taken the vast majority of scheme payments to date.

The non-domestic RHI (to August 2017) covers 17,955 installations that in total have been paid £1.175bn. Of those, 15,843 are biomass boilers, 1,205 are heat pumps, 506 are biogas installations, 309 are classified as 'other', which includes combined heat and power, solar thermal and geothermal. 82 installations are biomethane.

Lifetime payments through the scheme to 2041 are estimated to be £23bn.

According to government calculations, the RHI is on track to reduce carbon emissions from heating by 7 $MtCO_2e$ per year from 2020-21, approximately 1.5% of total UK carbon emissions.

Snapshots of four survey respondents

A local authority energy manager: Is looking at heat pumps, CHP, and says "we have some biomass already".

When specifying heat technologies: "Capex is main concern and as long as kit is working reliably, will not consider replacing it."

Thinks the RHI: has been effective.

On what policy or regulatory measure might best decarbonise heat: "It would be great to see some central government or Ofgem guidance on sleeving arrangements for exported electricity. The holy grail for us really would be in being able to export at any given location within the DNO network and to be able to have access to that amount of electricity to import with a reduction in TUoS charges. I see the solution for decentralised energy as hybrid energy centre systems which can use electricity or fuel to generate heat, and can export, import and store electricity and store heat and distribute heat and electricity through a network.

Does not see heat networks as a solution in next five years because: "I'm not sure that the economic priorities of local authorities will support heat networks."

A senior energy manager at a large IT firm: Is not looking at low carbon heating methods.

Does not think the RHI has been effective: "We have not found biomass solutions sufficiently compelling and the requirements of the RHI appear complex and bureaucratic."

On what policy or regulatory measure might best decarbonise heat: "Simplicity and clarity – particularly with regards to metering requirements."

Does see heat networks as a solution in next five years if they can use waste heat, and sees them applied in industrial sector.

A university sustainability manager: Is looking at low carbon heating, "including heat pumps, CHP, district heat (gas-fed CHP, initially, with the potential to link to waste heat sources in future" and already has some CHP as part of a hybrid system in conjunction with gas fired boilers.

Thinks RHI: has been effective.

On what policy or regulatory measure might best decarbonise heat: "Increase CCL on gas. Allow direct award of district heat contracts by public sector."

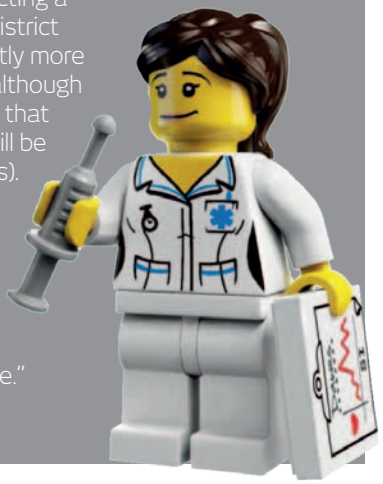
Does see heat networks as a solution in next five years: "For big users or users in heritage buildings which require high temperature heat, they are probably a good solution." Sees them best deployed in "the public sector, provided procurement issues can be solved".

An NHS estates manager: Is looking at lower carbon heating technologies, already has a hybrid, gas-fired boilers CHP system.

Thinks the RHI has not been effective and has instead taken a performance contracting route to help fund lower carbon heat infrastructure.

Does see heat networks as a solution in next five years, particularly for the industrial and commercial sector, with some caveats around cost.

"Yes it is a solution. However, our personal experience was it is too expensive. [Our city] has a long established district heating network, which we considered connecting a new building to. The district heating cost is currently more expensive than gas (although the supplier suggests that in the longer term it will be 10% cheaper than gas). When we compared this to a gas-fired CHP even allowing for writing off some significant sunk costs, the CHP was far more cost effective."



Warm words won't work

Decarbonising the UK economy is the challenge of our times. It will take hundreds of billions of pounds to achieve, possibly more. What are the options?

The power sector is delivering on decarbonisation. Low carbon sources accounted for 50.4% of power generated last year, according to latest government data, overtaking fossil fuels. Emissions from the energy supply sector have fallen 57% since 1990.

By contrast, transport emissions have fallen 1% since 1990. However, global vehicle manufacturers are mobilising, with governments around the world committing to phase out petrol and diesel engines. There is a plan and where there is certainty, results inevitably follow. The plan for heat is not yet clear.

SCALE OF THE TASK

Progress in decarbonising power is the result of relatively stable long-term policy. Yet the UK's total energy consumption remains more than 80% reliant on fossil fuels and about half of consumption is heat-related.

To meet the Climate Change Act's 2050 target of an 80% reduction on 1990 emissions levels, the Committee on Climate Change (CCC) says heat must be virtually zero carbon, to make up for other sectors that cannot fully decarbonise. In its last report, the CCC said only around 4% of heat in buildings came from low carbon sources in 2016.

David Gill, head of customer energy solutions at Northern Gas Networks, puts the scale of the task into context.


Tim Rotheray

"Reducing emissions 80% by 2050 is the biggest energy challenge facing the world today," he said. "It is like having to rebuild your house, from scratch, by Friday."

Gill was speaking on a Monday.

So what are the options: Hydrogen; electrification; heat networks; biogas; hybrids? Most people interviewed or surveyed believe the solutions encompass a combination of technologies and fuel sources. But all said greater energy efficiency is critical .

PRIORITISE DEMAND REDUCTION

"The UK has some of worst quality housing stock in Europe," says Richard Lowes, a researcher at the University of Exeter, specialising in heat policy and governance.

"People almost expect their houses to be a bit mouldy. Single-glazed windows are still a thing. There is so much basic stuff that could take place to cut carbon and improve people's lives. Energy efficiency must be a policy priority."

Tim Rotheray, director of the Association for Decentralised Energy, agrees.

"Energy efficiency has to come first, yet we have seen a real reduction in work on energy efficiency. That is where I would start."

Tighter building standards in both domestic and non-domestic sectors would be useful, noted Rotheray, while Exeter's Lowes believes Passive House should be the de facto housing standard.

INCENTIVISING BUSINESSES

While domestic heat is by far the larger challenge in consumption terms, *The Energyst's* readership is largely industrial, commercial and public sector organisations. What might compel them to invest in low carbon or renewable heat solutions?

Those surveyed for this report offered mixed views on the Renewable Heat Incentive (RHI). Roughly half said it has been effective, roughly half said it was not, citing complexity, bureaucracy and bias towards biomass. Some said it had encouraged 'gaming' or profiteering and the programme had not been applied fairly.

Conversely, others suggested guaranteeing that the RHI will continue would result in the


Richard Lowes

National Grid: Incentivise energy efficiency and heat pumps to hit 2050 targets

National Grid's most recent Future Energy Scenarios states that: "In order to achieve the [2050] carbon reduction targets, there will need to be high levels of thermal retention in homes and growth in heat pumps. For this to happen incentives will be needed to; make homes more thermally efficient, quickly retire gas boilers and encourage the adoption of heat pumps."

National Grid's 'Two Degrees' scenario is the only one in which the UK meets its 2050 carbon targets. It would require heat pumps becoming the main alternative to gas boilers. It also assumes the UK makes 30% energy efficiency gains by 2030.

Climate Change Committee on low-carbon heat

The Committee's most recent report to government made some key recommendations on heat:

"Deployment of low-carbon heat cannot wait until the 2030s. Low-regret opportunities exist for heat pumps to be installed in homes that are off the gas grid, to install low carbon heat networks in heat-dense areas (e.g. cities) and to increase volumes of biomethane injection into the gas grid.

"These opportunities can be started within funding that has been agreed to 2020, although this could be better targeted. Further support beyond 2020 will need to be agreed by 2019.

"Beyond these low-regret measures, key strategic decisions will be needed on low-carbon heat for properties on the gas grid, especially those outside heat-dense areas.

'The main options for reducing emissions from heating in these buildings are electrification using heat pumps and repurposing of gas networks to hydrogen. It is important that active preparations are made so that the Government is well placed to make decisions in the early 2020s, including undertaking hydrogen pilots of sufficient scale and diversity.

"As large-scale hydrogen deployment would require use of carbon capture and storage (CCS), a strategy for CCS deployment remains an urgent priority."

strongest signals and uptake of renewable heat technologies.

The RHI is schedule to close in three years' time, and it is not currently clear whether a modified heat support scheme will replace it.

However, survey respondents suggested other levers, such as business rates and tax breaks could incentivise both energy efficiency and lower carbon heat (see p16).

Lesley Rudd, chief executive of the Sustainable Energy Association, agrees. "Those levers are at government's disposal, but would require a joined-up approach from Beis, Treasury and Housing, Communities and Local Government."

Rudd said the scale of the challenge posed by decarbonisation requires removal of departmental silos: "We are talking about whole economy planning. Decarbonisation is bigger than energy, which in itself is a hugely important issue."

COLLABORATION AND WHOLE SYSTEM THINKING

Bringing the old energy and climate change department into business, energy and industrial strategy (Beis) is positive in that sense, adds Rudd. Meanwhile, energy companies recognise they must collaborate more closely, with regulation and policy starting to recognise the need for 'whole systems' frameworks.

Aligning heat and power more closely can solve issues created by growing penetration of renewables, according to the ADE's Rotheray, while renewables companies are working on ways to use excess renewable generation to create and store heat (see p28-29).

"We are only just starting to scratch the surface of the convergence of heat and power," says Rotheray.

"One way to deal with [intermittency] is to provide flexibility through heat. Heat is inherently storable; it is very easy to store in hot water and other materials and is a cost effective way of disconnecting energy generation and final energy consumption," he adds.

"If you have a thermal store, you can produce heat at times of low electricity or negative prices and use the store to supply at a different time. In that way you can provide not only balancing services but also reduce investment in the power network. Exploiting those synergies is central to cost efficiency of the energy system," says Rotheray.

"If we don't, we will have to build unnecessary infrastructure, and all of that will end up with the customer and their bills. So the primary opportunity is to exploit the synergies that are arising to end up with best value energy system."

FURTHER INTEGRATION

While Ofgem is consulting on how to bring more third parties into innovation allowances, Ian Lock, business development director at Baxi Heating, believes there is scope for regulators to create more integrated frameworks that enable better collaboration between manufacturers.

Big bills cost votes

"Basically, all of the options are expensive and will be disruptive in one way or another," says Richard Howard, head of energy research at Aurora.

Two years ago, while at think tank Policy Exchange, Howard wrote a report on heat that suggested electrification of 80% of homes would require capex of £300bn. While less certain of its estimates, the report suggested a hydrogen approach might cost £200bn.

"Even the more switched on politicians... basically acknowledge that decarbonising domestic heating is going to be really hard and something that is difficult to sell to voters and consumers."

And that's the smart ones.

"So it really is in the difficult box. Decarbonising power is relatively straightforward. For electric vehicles, the clue is in the name. But heat... Nobody is clamouring to put their own money into it, so it becomes very hard. That's not a positive message but that is where I've got to."

But there is one obvious way to reduce peak heat demand, and therefore the cost of decarbonising it, says Howard.

"Energy efficiency is the one easy answer and there is definitely not enough being done on that."

"If you were given the brief to decarbonise a housing development, for example, it would be worth looking at cross-fertilisation of key central services: heat, light and water," says Lock. "There is an interlink between those manufacturers, but no support to explore those links."

"That Ofgem is consulting is great, but how to we get from concept to deliverable opportunity? The clock is ticking."

SUPPLY AND DEMAND

Setting a clear policy framework would better incentivise heating appliance manufacturers to move away from traditional products, although Exeter's Richard Lowes believes manufacturers must also be more flexible.

"There is a role for manufacturers to take the lead," he suggests. "Most of the big players also produce heat pumps as well as gas appliances, but some are quite protectionist and anti-heat pump."

However, if demand was created, Lowes believes any manufacturer would deliver.

Ian Lock

"It is not that capital intensive for them to put up a new manufacturing line if they had demand. So it needs a powerful drive from government [to make that happen] and a lot of these firms would jump in."

HYDROGEN?

While heat pumps are the most cited technology under consideration by survey respondents, installations to date are well below the run rate required to hit carbon targets.

Some stakeholders believe the cost, disruption and behavior change required by a wholesale switch to heat pumps are significant barriers. Gas networks are keen to pursue a hydrogen approach (see p22).

While high levels of hydrogen would require new appliances, gas firms believe it is a less costly and less disruptive approach than electrification, although it hinges on simultaneously developing and deploying carbon capture and storage, which is by no means a given.

However, others believe there is a danger of putting too much faith in hydrogen.

Andrew Haslett

"You would need an awful lot of hydrogen [to deliver UK space and water heating needs]," says Andrew Haslett, chief engineer at the Energy Technologies Institute. He points out that other areas of the economy are "very difficult" to decarbonise without hydrogen, for example, "parts of industry and transport, which would take it away from buildings", he says.

"Can you make enough hydrogen quickly enough and cheaply enough? It is not clear that you can. So ... it is not a silver bullet. There is a danger of hydrogen running away as 'the answer', when it is not yet clear it is a practical answer."

Haslett says policymakers and industry must therefore "be cautious not to drop everything that might be part of the solution".

BIOGAS AND ENERGY FROM WASTE

Biogas production is increasing steadily and may represent part of the solution.

Major energy suppliers are starting to offer 'green' gas backed by Renewable Guarantees of Origin and there is demand from businesses that wish to buy renewable energy, not just renewable power.

According to Energy Networks Association head of gas, Matt Hindle, there are now "ninety plants across the country connected to the gas distribution networks injecting gas [enabling cleaner heat] without any change to consumer behavior".

Hindle points to research by gas network Cadent that suggests green gas now contributes around 1% of demand.

"Cadent's work suggests [green gas] could be taken to around 30% with the right policy and technology development; there is potentially ability to synthesise gas from a wider range of feedstocks, for example," says Hindle.

Cadent is a backer of a gasification plant in Swindon that will this year

Eon: Power's done, now focus on heat and transport

Eon CEO Michael Lewis believes the UK must fully concentrate on heat and transport, with power decarbonisation now in hand.

Speaking at Aurora's Spring Forum, Lewis applauded the policy stability of successive previous governments in delivering renewables.

"[Renewable generation] has been a huge success, but in many ways, that is already done," said Lewis. While there are "some issues around intermittency" to solve, "we have [achieved] renewable, low and zero carbon generation at a lower price than conventional generation. Now we need to turn to transport and heating – and that is where Eon wants to play a key role."

He said heat and transport are at a similar juncture to renewables "ten or eleven years ago" and pointed out that while the UK has succeeded in delivering almost 40GW of renewable generation, "success was far from a forgone conclusion back then".

Lewis said in 2008, Eon had two offshore projects under construction, "both hugely over budget and late". The firm had another two in operation, both beset by technical difficulties. Meanwhile, the London Array project "came that close to not going ahead, and would not have gone ahead unless government had moved to two Rocs".

Giving offshore wind developers additional subsidy at that point, he suggested, was now bearing fruit in enabling the economies of scale that are leading to cost reductions.

"We were about to make an £800m investment decision and needed to know that the government stood behind us, which they did, and created a world class industry."

That foresight should now be applied to decarbonising heat and transport, said Lewis, which is where Eon will focus more fully.

"We believe our capabilities are better deployed where there is still a problem to be solved," he said, suggesting the starting point should be "making the existing system more efficient."

start to produce synthetic gas, or bio-SNG, from household waste for grid injection. The company claims bio-SNG and anaerobic digestion have the potential to deliver 100TWh of low carbon gas per annum, enough to meet roughly a third of domestic heat demand.

Energy from waste is a divisive issue, with concerns from host communities usually strongly evident in planning decisions. But it is a significant source of heat and power in continental Europe. In the UK, energy from waste powers heat networks in Sheffield and Nottingham, and from next year, will do so in Leeds.

WASTE HEAT: COALITION OF THE WILLING?

Less politically sensitive than heat from waste is wasted heat. Baxi Heating's Ian Lock suggests central and local governments could help co-ordinate a push to match waste heat with local demand across the industrial and commercial sector (see p26). He believes most industrial estates across the country could be co-opted into heat matching programmes with the right incentive framework.

Anna Livesey, senior consultant at Ecuity, thinks that concept is worth further exploration.

"There is certainly an awareness issue [around waste heat]. But I expect there could also be regulatory or risk issues. It is complex: Who would you get to drive it and how do you make it appealing to businesses?" asks Livesey.

"Tying it to business rates could be appealing and Ecuity would be interested in modeling that approach; whether it could be linked to other incentives and what would concentrate people's minds on utilising waste heat. Analysing and demonstrating [whether waste heat and local demand] could be co-ordinated would be really valuable."

Matt Hindle

Anna Livesey

KEEP OPTIONS OPEN

While government must set out frameworks for businesses and investors to decarbonise heat, it must do so without picking winners, while being sufficiently decisive and ambitious. Not an enviable task.

"Whatever we do in heat – whether, electricity, biogas, hydrogen, heat networks - whatever route and whatever combination, there will need to be leadership and boldness on part of government in setting that out," says the ADE's Tim Rotheray.

"But industry cannot and should not seek to put this all on government. We do need to move, and government has a clear role in setting the vision and the structure. But industry has a role in saying 'this is what we can deliver'.

"I'm confident that it is achievable, but it takes determination on both sides to make it work," says Rotheray.

"The biggest risk is a reluctance to undertake the of scale of change that we need. Government is rightly proud of the results being delivered in wind and solar; that is what happens when industry and government work together with clear leadership from both sides," he says.

"That now needs to happen in heat."

Hydrogen: The great white hope?

Hydrogen is seen as a key option for decarbonising gas and therefore heat. Some studies suggest it could reduce emissions from heat by almost three quarters, while also decarbonising transport and power. So what's the catch?

The Committee on Climate Change has repeatedly called for "proper" hydrogen trials so that decisions on whether to pursue hydrogen can be taken in the early 2020s.

Proponents of hydrogen believe it is the least disruptive option, because it enables reuse of existing gas infrastructure and is not reliant on behavior change from consumers. It could also enable highly efficient decentralised combined heat and power as well as decarbonise transport, they suggest.

The challenge lies in decarbonising hydrogen production. Hydrogen via electrolysis could be achieved from renewables, but it is expensive and at scale would require vast amounts of renewable generation.

Hydrogen via steam methane reforming (SMR, which uses high levels of heat to crack methane into carbon and hydrogen) is cheaper and more immediately scalable, but its carbon emissions are high.

So SMR requires carbon capture and storage (CCS) to transport emissions offshore and into depleted North Sea wells or salt caverns.

CCS: RISK AND REWARD

CCS features prominently in most 2050 scenarios aiming to limit climate change to non-catastrophic levels.

CCS advocates argue that its component technologies are tried and tested, pointing to projects around the world. Meanwhile, according to studies delivered by the Energy Technologies Institute, the UK has vast storage resources (equivalent to 78,000 million tonnes), and world-class oil and gas expertise.

But convincing investors to back CCS, even if their investors is de-risked by tax- or bill-payers, might prove challenging.

The last government axed the £1bn CCS fund to decarbonise power generation in 2015. This government has so far put £100m on the table. While that sum is insignificant in CCS terms, those backing hydrogen believe CCS is gaining political momentum – this time focusing on decarbonising heat and industry rather than power generation.

'CCS ANCHOR PROJECTS'

The hydrogen trials urged by the Committee on Climate Change are starting to take shape.

A consortium led by gas networks officially launched the HyDeploy project at the end of February. Cadent and Northern Gas Networks believe such trials lay the groundwork for development of CCS hubs.

HyDeploy is funded by bill payers under Ofgem's Network Innovation Allowance programme. It aims to inject a gas blend of up to 20% hydrogen across Keele University's private gas network to determine how much hydrogen could be safely used within existing infrastructure without affecting gas appliances.

Under the HyDeploy trial, hydrogen will be created via electrolysis, which breaks up water molecules into hydrogen and oxygen. But Northern Gas Networks CEO, Mark Horsley, said the firm "makes no bones" about the fact large scale deployment of hydrogen within gas networks will require CCS.

However, he said if hydrogen can be proven safe at significant concentrations within gas networks, it would create "anchor projects


Mark Horsley

for people wanting to build carbon capture networks" and make them "more viable".

David Parkin, director, network strategy at Cadent, admitted that CCS support has a "chequered history" in the UK. However, Parkin said he is "very confident that the government is now focused on delivering CCS ... [Beis] and the Committee on Climate Change have said that the UK will not achieve 2050 carbon targets without it".

PLASTIC ENABLER

Using higher blends of hydrogen in the gas network will require plastic pipes. The UK-wide iron ring main replacement programme is now about 70% complete, according to Horsley, and should be 100% complete by 2032, potentially creating strong alignment for higher hydrogen use in the next decade.

'Award CCS contracts by 2020'

In its 2017 annual report to Parliament, the Committee on Climate Change urged government to get on with developing a CCS strategy. It recommended government set out: 'A new strategic approach to carbon capture and storage (CCS) deployment in the UK, including preparations for possible use in the production of low-carbon hydrogen. CCS could enable large-scale emissions reduction from electricity generation and industry, plus the production of hydrogen. The new approach should include separation of support for CO_2 infrastructure, a new funding mechanism for industrial CCS and some sharing of risks across parties, and with Government, especially where they reflect future policy uncertainty. Contracts should be awarded by 2020 to allow operations at scale in the 2030s.'

Hydrogen options and tradeoffs

Hydrogen can be produced via electrolysis from renewable energy without the need for CCS, but that method is expensive and at scale would require high volumes of renewable generation. However, costs would likely be driven down by economies of scale and using excess renewables to produce hydrogen would simultaneously solve challenges within the power system.

Delivering hydrogen through steam methane reforming (SMR) is cheaper, but without CCS, will push up emissions.

A paper published in July 2017 by the Sustainable Gas Institute at Imperial College outlines estimates of the range of CO_2 emissions from producing hydrogen. It states:

'The highest and most variable emissions come from fossil fuel routes to produce hydrogen that do not include CCS. These technologies are likely to produce carbon intensities greater than current gas networks. CCS is therefore needed to ensure this gas is low carbon.'

The paper continues: 'Emissions estimates for SMR with CCS are between 23 to 150gCO_2 eq/kWh, while for electrolysis using renewable electricity sources the range is from 25 to 178gCO_2 eq/kWh. The carbon intensity of heat might be between 26 and 167gCO_2 eq/kWh for methane-based hydrogen and 27 to 198gCO_2 eq/kWh for hydrogen from electrolysis, assuming a 90% efficient hydrogen boiler. Heat pumps with 250% efficiency using the same electricity might deliver heat with a CO_2 intensity of 10 to 71 gCO_2 eq/kWh.'

HYDROGEN APPLIANCES

While gas appliances manufactured after 1996 are designed to operate with a hydrogen mix up to 23%, the government is funding a £25m project to determine implications of higher hydrogen blends for equipment such as cookers and boilers. Horsley suggested the Beis appliance funding and Ofgem innovation allowances indicate that "government, regulator and industry are ensuring the requisite [hydrogen] elements are joined up".

PROFIT BEFORE PURPOSE?

Horsley rebutted claims by The Energy Research Centre suggesting gas networks may be "promoting [hydrogen] options which clearly cannot deliver a transformation to low carbon heat ... as a means to progress their own financial agenda".

"That is not fair comment," said Horsley. "There is not a silver bullet in any solution and we do not preclude that as an industry. We very much support the work of the electricity sector, but different circumstances require different solutions. So I can categorically state that [progressing a financial agenda] is not the case.

"We are very confident about the technology – hydrogen production is a known technology – but there is potential to use the pipe network for other bio- or synthetic gases. So we think the project has a real merit, but, at the same time, we are not precluding other solutions."

WARM LEEDS

Northern Gas Networks (NGN) is also exploring hydrogen use in Leeds to determine whether the city - and ultimately the rest of the UK's gas networks - could be incrementally converted to hydrogen.

The H21 Leeds City Gate project suggested converting gas networks across the UK to hydrogen could cut emissions from heat by 73%, if CCS infrastructure is in place, according to NGN. The firm estimated the cost of converting the Leeds city network to hydrogen, including CCS infrastructure, would be around £2bn. Of that, just over half (£1.05bn) relates to changing household and business appliances, with just under half (£970m) relating to hydrogen and CCS infrastructure.

NGN claimed if funded under the current regulatory regime, converting Leeds to run on hydrogen would have "negligible impact on customers total gas bills".

However, the gas network said Ofgem would need to provide "clear direction" that networks must make provisions for hydrogen conversion within their next price controls, which are currently out for consultation.

Meanwhile, NGN said government would need to commit to a hydrogen conversion strategy by 2021/22.

CCS: DAMNED IF YOU DON'T?

The government's Clean Growth Strategy put CCS, or CCUS (carbon capture, usage and storage) back on the table. It announced a CCUS cost reduction taskforce, which is scheduled to report back to government by the end of 2018, and £100m of potential CCUS innovation funding.

MPs questioned energy minister Claire Perry in March about the government's appetite for CCS, with Alan Whitehead, MP for Southhampton Test, stating "£100 million will not get us anywhere near our CCS target".

In response, Perry highlighted concerns around cost:

"There are only 21 at-scale CCS plants working in the world today, 16 of which rely on capturing the carbon and using it for enhanced oil recovery. This is not a cost-effective technology that other countries are embracing with gusto. Even our friends in Norway, who are a little further along than us in building up the infrastructure, are struggling with precisely this point, which is, how much do we burden taxpayers or consumers to fund these projects? That is a real challenge."

However, said Perry, "we are not going to bow down before it; we are going to embrace it."

There are "enormous opportunities to work with the hydrogen economy and with heating systems, to try to bring this work together", added Perry. "We understand completely the need to decarbonise these industrial pools and to decarbonise further our heating system. Without CCS and CCUS, I do not believe that we can do that, which is why they are such vital technologies."

Hydrogen the cheaper option?

A 2016 report by KPMG, commissioned by the Energy Networks Association suggested a hydrogen pathway using CCS could be £150-£214bn cheaper than electrification, although its estimates do not include the ongoing cost of maintaining North Sea carbon storage facilities.

Electricity: Too much, or too little ambition?

Electrification of heat was seen as a key policy objective in the early part of this decade, but appears to have receded in recent years, largely on grounds of cost of meeting winter peak demand.

The government and much of industry now talk about a 'whole systems approach' that involves greener gases, such as hydrogen and biogas.

Given the relatively low uptake of electric heating systems to date, this could be viewed as pragmatic. However, others believe it will result in the UK failing to meet carbon reduction targets.

ZERO EMISSIONS OR BUST

Richard Lowes focuses on heat policy research at the Exeter Energy Policy Group. Prior to that, he spent seven years working for a gas network company, where part of his remit was to determine the future of the gas grid in a decarbonised economy.

"I couldn't make it work," he says, "and that was my job".

Lowes says a hydrogen route, as pursued by some gas companies (see p22-23), will not sufficiently decarbonise heat.

"My concern is that if you take the hydrogen route, you end up in a worst case scenario, because you have spent time and money yet still end up with residual emissions," he says.

"To meet Climate Change Act and Paris targets, emissions from heat need to be absolutely zero by 2050. That is non-negotiable, because it is possible to get to zero emissions from space heating, whereas other sectors cannot get to those levels."

ENERGY EFFICIENCY FIRST

Richard Lowes

Heat peak: Over the top?

The 350GW winter peak heat load for space and hot water heating often referred to by industry and government came from a 2014 PhD project by Dr Robert Sansom, based on 2010 data.

As Exeter's Richard Lowes points out, 2010 was the coldest in 25 years, and while systems must be designed for peaks, he believes increased energy efficiency, smarter controls and storage would significantly smooth those peaks.

National Grid appears to agree. While its most recent Future Energy Scenarios document outlines annual demand rather than winter peak, it's 'greenest' scenario, Two Degrees, shows the highest uptake of heat pumps and the lowest overall annual electricity demand (from the residential sector). However, that assumes a 30% increase in energy efficiency. National Grid said that scenario would require incentives for energy efficiency, support for heat pump adoption and to quickly retire gas boilers.

Similarly, National Grid's Two Degrees scenario does not predict a huge increase in total electricity generation, from roughly 340TWh to 420TWh, with the mix dominated by wind and nuclear power.

Lowes believes electrification of heat and heat networks deployed in urban areas is therefore a better pathway. But he says energy efficiency must be a policy priority.

"We should focus on reducing demand above anything. The UK still has some of the most inefficient buildings in Europe, and high levels of fuel poverty," says Lowes.

"If we can reduce demand significantly, and the government choses to support that approach, it will be a much bigger driver for carbon reduction. Once you have lower demand, the non-gas solutions become more obvious," he adds.

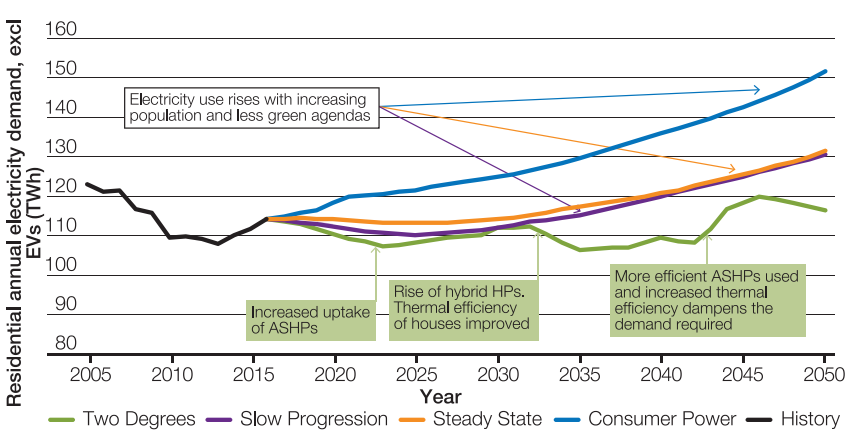
Lowes believes heat pumps, storage and smart technologies can then manage peak demand.

"The peak heat aspect is a big thing at the moment, but in 35 years time, if we have done everything we can do to prepare the building stock for decarbonisation, the peak will be much lower," he says.

"I'm not saying there will not be a big winter peak, but it is a lot smaller

Figure 3.10
Annual residential electricity demand

Source: National Grid FES 2017




Jim Cardwell

than some people will have you believe."

An electrification pathway would require more low carbon generation as well as major investment in distribution networks.

"More electricity will be needed but I don't think we should be scared about that; it will just displace gas investment," says Lowes, who suggests that would also reduce energy security concerns.

"It is not easy – but every way you look it is challenging and I think we have to meet it head on."

NETWORK INVESTMENT

Ofgem frowns on speculative investment in network capacity, but does incentivise distribution network operators (DNOs) to make 'smarter' investments. It has also sanctioned trials around electrification of heat.

Northern Powergrid has relatively few constraint issues on its network, due to its industrial legacy. But it has started to build a smart grid 'backbone' to better manage higher demand or changes to load patterns should transport and heat start to factor.

The £83m 'Smart Grid Enablers' project will add communications technology to around 8,000 substations so Northern Powergrid can better monitor and control them, with controls upgrades or replacements planned for 1,900 substations over the five-year project.

Head of trading and innovation, Jim Cardwell, said while heat policy "is very much at a crossroads," networks must prepare for all outcomes, hence beginning to digitise its grid.

"There are a wide range of scenarios on how decarbonisation may proceed, but our job is to understand all of them and ensure we are prepared to support electrification of heat if it goes that way," says Cardwell. "But we will ultimately be led by the consumer."

Reversible heat pump boost

According to latest government data (DUKES), heat pumps contributed 2.1TWh of renewable heat in 2016, roughly 4.6% of all renewable heat, which is dominated by biomass. Overall, DUKES data suggest the UK met 6.2% (46TWh) of overall heat demand (740TWh) in 2016 with heat from renewable sources.

However, only heat from dedicated heat pumps is included in the statistics, making reversible air-to-air heat pumps (RAAHPs), which can provide both heating and cooling, an unknown quantity.

To date, the majority of RAAHPs have been assumed to provide mainly cooling for businesses. However, a recent study for Beis by energy consultancy Delta-ee suggests the majority also provide heating.

Delta-ee's surveys of large and small companies, plus installers, gave a mean figure of 73% of all RAAHPs being used to provide part or all of the heat load in the buildings in which they are installed.

It suggested in 2016 a total of 8.2 TWh of renewable heat was produced by reversible air-to-air heat pumps, almost four times that contributed by hydronic heat pumps. Taking Delta-ee's findings into account, government now believes the percentage of renewable heat in the UK in 2016 was 7%, which may prove useful should EU 2020 targets be enforced post-Brexit.

HEAT PUMP CHALLENGES

Northern Powergrid completed one of the UK's largest heat pump trials in 2014 as part of an innovation project. Around 380 air source heat pumps were installed to understand customer behaviour, economics and network effects.

"We gained an understanding of the impact of electrification of heat load, and trialled tariffs that incentivised customers to stay off peak," says Cardwell. "Although [tariffs] successfully reduced peak load, the project did identify barriers – particularly retrofitting," he continues.

"Some of the equipment is quite bulky and requires intrusive internal modifications in people's homes," says Cardwell. "So that is a barrier to acceptability." Moreover, he says, "the operating mode is different; people have to change behavior and the operation of the heating system is quite a dramatic change".

Cost aside, Cardwell says that presents "some barriers" to electrification of heat, "but we do have investment plans in place to ensure we can support that scenario".

NERVOUS ENERGY

However, other DNO projects indicate that even low heat pump penetration could create challenges.

Western Power Distribution conducted an innovation trial with gas network Wales & West Utilities that suggested hybrid heat pump and gas systems might be more manageable and would enable 'fuel arbitrage' to avoid peak power costs.

The DNO claimed even a 6% penetration of traditional heat pumps would lead to a 16% increase in peak demand.

At present rates of installs, however, most DNOs have little to fear. Northern Powergrid said current levels of installation are around a third of its assumption for the regulatory period; just 809 were fitted in its region in the last year.

Across the UK around 200,000 dedicated heat pumps have been installed to date (excluding reversible air-to-air heat pumps, see box), with numbers relatively static at around 20,000 installs a year.

PREPARE FOR PICK UP?

However, changes to the Renewable Heat Incentive may start to take affect over the next couple of years, particularly for ground source heat pumps: If two homes or more share ground loops, they can qualify as district heating and receive 20 year non-domestic subsidies versus seven year domestic RHI payments.

Moreover, payments will be based on deemed heat taken from Energy Performance Certificates, removing the need for metering equipment and its associated costs.

Whether businesses start to look more closely at electrification of their heat load remains to be seen. To date, the lion's share of non-domestic RHI payments have been made to biomass systems. However, according to the sample of firms surveyed for this report, heat pumps figure in their plans more prominently than any other technology.

Heat networks: Getting warmer but lower carbon sources required

Heat networks are seen as a crucial plank of decarbonising heat, particularly in urban areas. The Committee on Climate Change says up to 20% of UK building heat could come from heat networks by 2050.

Government has committed funding to help local authorities move forward with heat networks, which are challenging to co-ordinate, implement and finance.

While this has helped heat network projects move closer to implementation, step change may require a regime change, according to The Association for Decentralised Energy (The ADE).

The Association believes heat networks should be regulated and investors – and consumers – afforded some protections.

The ADE published report earlier this year spelling out key challenges for heat networks: Investors do not commit until heat customers are assured but heat customers will not sign up until there is a viable proposition in front of them.

Meanwhile, risks of underperformance or stranded assets compound risk, driving up the cost of capital and therefore costs to consumers.

Moreover, consumers do not have the same protections as other regulated energy sectors – once they are on a heat network, they can't just switch supplier.

The task force appears open to an existing regulator taking on heat networks, or a new one being created.

That regulator would oversee a framework hinging around a proposal called 'Demand Assurance'. This would allow developers to submit heat network plans to a regulator and, if approved, provide regulatory protection for some parts of the investment should heat customers fail to appear on time, or at all.

As a minimum, protection for investors would cover the cost of capital for demand shortfall, the report suggests.

To receive financial guarantees, heat networks would have to sign up to a set of minimum standards, including consumer protections around service and price.

The task force said further work was needed to determine who picks up the tab for investor guarantees, and whether these should be socialised.

Energy minister: Heat network investment 'may require further reforms'

Speaking at the launch of the ADE's report, energy minister Claire Perry acknowledged the challenge of decarbonising heat. While she believes the UK may be approaching a "tipping point" in terms of unlocking investment, Perry suggested "further reforms" may be necessary to "help create the conditions for a sustainable [heat network] market to emerge in the 2020s."

Heat networks: an investor's view

Amber Infrastructure invests in heat networks. Origination director Jenny Curtis was interviewed for the 2016 Heat Report, when she said that local authorities must improve project scoping to attract investor interest. She said poor data, planning and leadership was undermining otherwise viable projects.

Some progress has been made since then, suggests Curtis, but much more is required.

"A lot more schemes have come to market in the last couple of years and the quality of those schemes has generally improved. But they are still some way off being a standard investible asset class," says Curtis.

"Procurement and resources within local authorities is still an issue. The government's Heat Network Delivery Unit has done much to get good guidance out in the market. But our experience is that these projects are not cookie cutter. There is only so much standardisation that can be done – and that is the challenge."

Jenny Curtis

Meanwhile, Curtis points out that heat networks are not currently a low carbon solution.

"There is still a gap in government policy in terms of decarbonising heat. There is a push for gas-fired heat networks at the moment, but longer-term, they will not provide the levels of decarbonisation we require to hit targets," she says.

"What are the next steps: hydrogen, green gas, heat pumps? More long-term thinking is required in future proofing these schemes."

Asked whether the heat network market should be regulated, as suggested by the ADE's report, Curtis is cautiously supportive.

"We always treat our heat network investments as if it is a regulated market," she says. "I think it's inevitable that regulation will come and we would welcome that as long as it is commercially reasonable – because all of this does add cost to schemes."

Curtis offers qualified support for the 'Demand Assurance' instrument

How to decarbonise heat networks?

Heat networks, even where fired by gas from a central plant, should be more efficient and therefore lower carbon than lots of small individual boilers. But how to cost-effectively decarbonise them to meet long-term targets is not obvious.

The Committee on Climate Change's 2017 report to parliament suggested 'low-carbon heat sources [for heat networks] can include waste heat, large-scale (e.g. water-source) heat pumps, geothermal heat and potentially hydrogen'.

The ADE's shared warmth report was not prescriptive about how heat networks might be decarbonised, other than suggesting lower carbon heat sources, waste heat sources, or demand reduction could be options.

It also warned that the costs of decarbonising heat could make schemes more expensive and potentially uneconomic, so called for heat network decarbonisation to be "aligned with wider heat decarbonisation policies".

To date, the government's HNIP vehicle has awarded funding primarily to gas-fired CHP projects.

WASTE HEAT: COALITION OF THE WILLING REQUIRED

Waste heat is one option to decarbonise heat networks. But even where sources are close to demand, leadership, coordination and resource are lacking.

Baxi's Ian Lock believes a coordinated push could help to harness heat currently being wasted at industrial estates across the UK. For example, a factory with waste process heat could provide heating to other businesses on the estate.

Should businesses themselves not take the lead, with heat producers approaching heat consumers?

"Possibly, but synchronising the budgets, finance and strategy of different businesses to achieve a common goal is no easy task," says Lock. "That doesn't mean you should not attempt to do it, but it requires a vehicle to kick it off."

With government support, Lock believes an industry body in conjunction with Local Authorities and business partnerships could create such a vehicle.

"You haven't got to look for a heat map in terms of industrial losses," says Lock, "but where is the vehicle to do anything about it?"

mooted within the ADE's report as a way of protecting investors and consumers, but acknowledged that such instruments are "difficult" for government accounting structures, "therefore may not be the solution".

If local authorities could supply anchor tenancies earlier in the process, Curtis believes it may be a more practical way to derisk investment. Moreover, heat should no longer be viewed in isolation by local planners, Curtis suggests.

"Amber Infrastructure increasingly sees this [heat] sector as part of the smart cities agenda. We invest in solar, storage, EV chargers," she says.

"Where you can link those projects together in one area, it often makes more economic sense; while the risks can be greater, you can end up with a stronger project."

Waste and renewable heat networks:

- Sheffield's heat network uses an energy from waste incinerator for its main source of heat.
- Nottingham's district heating scheme gets its heat from waste burnt at the Eastcroft Energy from Waste facility.
- Islington Council's Bunhill network is mainly CHP-fired, but is working to incorporate heat from the Northern Line tube.
- Leeds City Council heat network will start supplying council homes and businesses from spring 2019 with waste heat from the Leeds Recycling and Energy Recovery Facility.
- Enfield Council has started to supply heat to homes on the first of its three heat networks, which it says will use some waste heat from industrial estates, along with CHP.
- The Kingston Heights development in Kingston-upon-Thames, which serves a hotel and domestic flats, uses the Thames as a heat source via a heat pump.
- Borders College is receiving around 95% of the heat required at its Galashiels campus from a system that uses sewage heat via Scottish Water's treatment works via heat pumps.

Standards issue

Baxi's Ian Lock believes one technical issue that affects heat network plant choice and economics needs to be solved sooner rather than later. He thinks the BESA test methodology for heat interface units (HIUs) risks skewing towards instantaneous solutions rather than storage solutions.

As a result, there is concern within industry that those planning heat networks may not receive a like for like comparison.

"At this point we believe the BESA HIU test regime document should not be considered as a key specification requirement. The scope of the current regime is very narrow and only caters for a very specific sub-set of product types on the market, therefore many products will fall out of the current scope and cannot be assessed," says Lock.

"We understand industry bodies are involved in the debate here and expect a more holistic approach to be adopted, but clearly time is of the essence to ensure that all viable technical solutions for a given project are afforded the same opportunity."

Emerging solutions: What else might decarbonise heat?

Many bright minds are trying to harness renewable and lower carbon heat to deliver broader system benefits. Below are a handful of projects at varying stages of maturity in the UK and Germany.

A WEEKEND HEAT STORE

Chris Sansom is Associate Professor in Concentrating Solar Power at Cranfield University. His UK research focuses on novel materials for seasonal heat storage, most notably phase change (PCM) and thermo-chemical materials.

Interviewed for the 2016 Heat Report, Sansom outlined his belief that Magnesium Sulphate Heptahydrate, or Epsom salts, could be a viable material for seasonal heat storage. The idea is that adding water to the salts causes a reaction that creates heat at around 80 degrees C, which is viable for space heating and hot water.

Two years on, Sansom says the Epsom salts research has moved forward, but remains some way off commercialisation.

However, Cranfield University's energy and facilities management department has tasked Sansom with assessing whether he can deliver heat storage for the University's growing campus, where heat demand is now more than its CHP system and biomass boiler can deliver.

20MWH: FIVE-YEAR PAYBACK

The project is to develop a 20MWh heat store that can store excess heat from the biomass boiler over the weekend, ready for the demand pick-up on Monday morning.

Because the system requires a specific temperature of 90 degrees C, Sansom will use a slightly different form of salt, Magnesium Nitrate Hexahydrate.

Sansom's students have designed the storage tank - roughly a five-meter cube - and the initial assessment is that the system delivers a five-year payback. The next step is to take a more detailed proposal to the board. Sansom thinks it will go ahead, though potentially at a smaller scale.

"It kills two birds with one stone for the University, not only improving energy efficiency, but supporting their own research and students as well," says Sansom.

"So I think it will go ahead in one form or another, and hopefully become a good demonstrator that heat storage can be achieved economically."

Fuel cells?

Fuel cells were supposed to be the next big thing in the mid-Noughties, but are taking some time to mature. However, West Sussex-based Ceres Power, backed by FTSE 250 firm IP Group, believes its technology, when operated as a CHP plant, could help decarbonise both heat and power.

The company completed a one-year small scale residential trial in September 2017, involving five houses in London and the South East. Ceres said the units provided most of the houses' power (80% on average) and all of their hot water. It claimed the units save up to 2 tonnes of CO_2 per household, with "near zero" NOx and SOx emissions. The fuel cells were connected to existing natural gas infrastructure, but can also take biogas or hydrogen where available, which would further reduce emissions.

The firm has joint development agreements with Nissan, Honda and Cummins for its solid oxide fuel cell technology.

CORRUPTED BY POWER?

Asked why progress on decarbonising heat appears minimal, Sansom says it "isn't necessarily a policy issue, more that we have just become so fixated by electricity that heat has been left out".

He believes solar thermal, heat storage, heat recovery and heat networks sectors should "promote and market" the opportunities for renewable heat more aggressively - and may find the market more receptive now that the PV sector "is in a lull".

TURNING WIND INTO HEAT

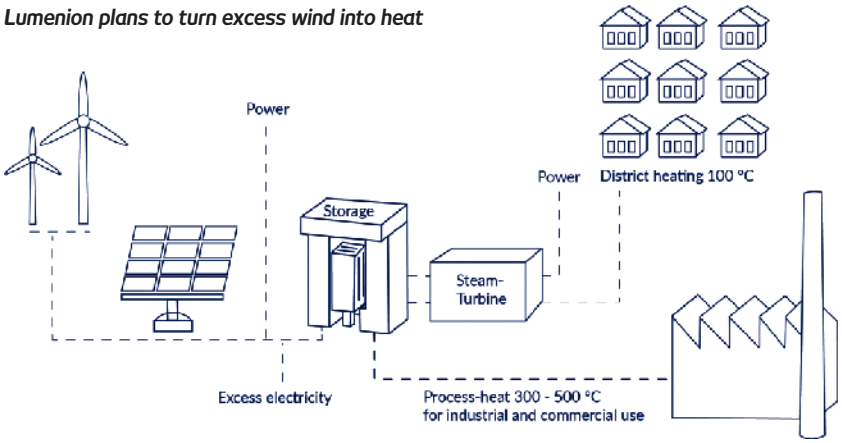
Physicist Alex Voigt agrees there has been too much focus on electricity. He is trying to couple heat and power through a wind-powered CHP his firm Lumenion is working to commercialise.

The system uses excess wind to create and store C02-free heat. The company claims the insulated heat store can then either provide process heat at 300-500 degrees C for industrial and commercial applications, lower temperature heat for district heating, or convert heat back to electricity to smooth peaks via a steam turbine.

Speaking at Aurora's Spring Forum in March, Voigt told the conference that decarbonising process heat is a significant opportunity – 100TWh in Germany alone.

Caerau Colliery: Plans for renewable heat. Credit Walt Jabsco/Flikr

Lumenion plans to turn excess wind into heat



HOT ROCKS

Siemens Gamesa is also looking to deploy wind-powered heat storage, and says it will commission a 30MWh system based on 1000 tonnes of insulated 'hot rocks' at an aluminium smelter in Hamburg by spring 2019.

However, the firm plans to convert the heat back into electricity, with the government-supported project aiming to demonstrate renewable power can be stored more economically than traditional storage and be harnessed to provide power over a 24-hour period.

MINE WATER

Energy minister Claire Perry recently threw her weight behind projects to turn old mines into sources of renewable heat.

Speaking at a Westminster debate in March on energy efficiency and the Clean Growth Strategy, Perry said she is "really interested" in geothermal mine water technologies and offered encouragement to developers.

"If there are groups out there that are interested in promoting this and suggesting what can be done in a cost-effective way, bring it on," said Perry. "We have already dug the holes [the mines], lets see whether we can get some more benefit for those communities."

It comes as local authorities in old mining areas start to look at whether the pits can still provide community value. Bridgend County Borough Council has secured European funding to turn the old Caerau colliery into a source of renewable heat, while Nottingham City Council says it is starting to examine the potential of mine water.

DEEP GEOTHERMAL

Deep geothermal projects are also underway in the UK. They involve drilling deeper than traditional geothermal projects to extract higher temperature heat.

Geothermal Engineering Ltd (GEL) is currently involved in projects in Cornwall and Scotland. The United Downs project in Redruth, Cornwall, plans to drill down to 4.5km in order to extract water at around 190 degrees C. That would enable power generation as well as heat storage. Drilling is scheduled to commence in May.

The GEL project in Scotland, in partnership with Arup, gained planning permission in March and is set to commence drilling to a depth of 2km. The hot water extracted will be used to deliver heat to a network at the old Johnnie Walker bottling plant in Kilmarnock, which is being turned into a mixed-use development, called The Halo.

Halo effect: Deep geothermal a go-go at the old Johnnie Walker plant

Can emerging business models decarbonise heat?

Half of organisations surveyed for this report indicate capital cost is a key factor in investments. Meanwhile, half said that they either would not replace ageing kit provided it still works, or that only 'dramatic' savings would spur action.

Could new service models backed by institutional capital provide a solution? Perhaps, but firms to date appear wary of funded 'energy-as-a-service' type structures, and outside of the public sector, energy services contracting has not been as successful in the UK as abroad.

But financiers are stepping up engagement. They believe they can create attractive propositions within the industrial and commercial sector.

The Green Investment Group launched an Energy Services Agreement at the end of 2017, a pay-as-you-save model designed to fund energy solutions and deliver financial benefits from day one without sitting on balance sheets. Other finance providers and energy companies offer variations on that theme.

The Group is keen to invest in energy projects, says Richard Braakenburg, senior vice president of Energy Solutions at the Green Investment Group. But says too often, finance is an afterthought, leading to inappropriate risk allocation for third party capital and unsuitable energy services agreements, "which have to be ripped up and begun again". So the Group is attempting to move "closer" to I&C firms, earlier.

"Speaking with energy managers, we have found that they are typically constrained by fairly strict payback hurdles. The energy manager knows there is a huge amount of potential improvement, but can be subject to a drip-feed of capital investment budgets over several years," says Braakenburg.

"Because we focus on internal rate of return (IRR), we are happy to take a longer-term infrastructure-type view."

ACCOUNTING RULE CHANGE

Some 'as-a-service' models now also include embedding staff within client sites to operate assets and ensure agreed savings are delivered. Part of that is down to new accounting rules coming into force next year. IFRS 16, comes into force on 1 January 2019 and requires virtually all leases to be recognised as on balance sheet. It may also require businesses to cede a degree of control over assets provided as a service. It will be interesting to see if efforts by financiers to more aggressively target I&C companies can unlock greater investment in energy efficiency and heat projects, or whether ceding control is a material concern for end users.


Richard Braakenburg


Nick Keegan

NO THANKS, WE'RE BRITISH

For now the UK lags behind European counterparts in pay-as-you-save energy investment, according to Nick Keegan, senior consultant at energy efficiency specialist EEVS.

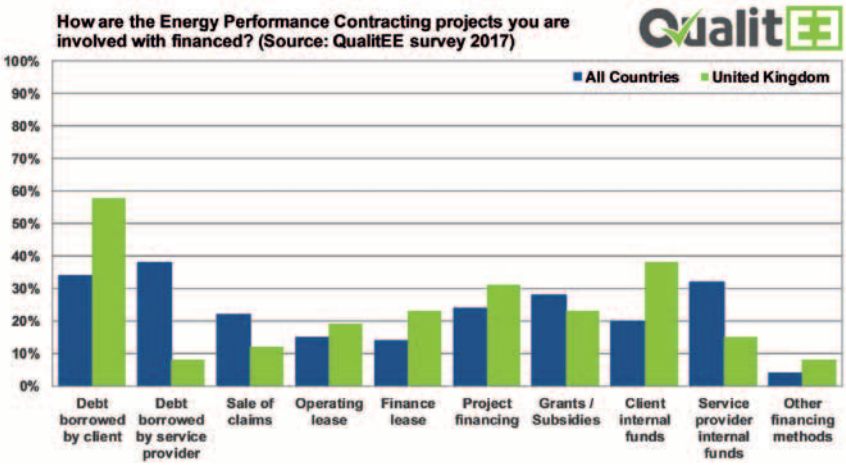
Keegan is involved in the pan European QualitEE project, which aims to drive standardisation – and tackle lack of trust – by developing quality assurance schemes for energy services in the UK and other European countries.

A recent QualitEE survey found that while the full range of financing options are in use for energy performance contracts in the UK, most projects use the client's internal funds or debt arrangements, in contrast to European counterparts.

Keegan says this "suggests that the UK market is not yet achieving the nirvana of financed pay-as-you-save energy services models that many pin their hopes on to unlock the 'high hanging fruit'", such as lower carbon heat projects.

The QualitEE research however suggests finance affordability rather than availability is the key issue.

Keegan says the affordability issue, in respect of finance for energy services, is thought to be linked to a lack of standardisation in the market, which leads to high due diligence costs for investors. He says this is a key challenge the QualitEE project seeks to solve.



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