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nationalgrid

The future of gas

Domestic Heat



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Foreword

by **Tony Nixon**

Strategy and Innovation Manager

Everywhere in society consumers are more connected, educated and sophisticated than ever, with instant access to information online and a growing amount of data to help them make the right buying choices to suit their circumstances.

Everywhere – it seems – except the energy market. Switching suppliers is easy, but when it comes to understanding the range of energy types and the right option for them, even engaged consumers are flummoxed. Solar panels, gas boilers, heat pumps – it's a world of jargon with no single place where they can go to understand the options or make meaningful comparisons.

If the UK Government and industry are serious about reducing energy demand by 2050 and meeting their carbon reduction obligations¹, they must define a strategy to help change customer behaviour.

In a nutshell, I'd say the solution is complex in its simplicity: innovation, investment and education. We need industry to innovate; and Government and industry to invest and educate so consumers are able to change their behaviour.

Education

We have a great opportunity to help customers become change advocates by providing them with better information about the products and technologies available, and the benefits they can deliver both in cost and carbon terms. Research shows that consumers spend an average of 6-9 minutes each year interacting with their utilities². Is this because they aren't interested, or because too little information is presented, or because the information fails to tell a compelling story? By focusing on education – whether it's direct from industry or through Government and the media – we can help empower customers to make decisions to reduce their energy usage as well as become a powerful force for change themselves.

If energy companies change the way they communicate and interact

with consumers, supported by clear Government policy and incentives, consumers will begin to change their behaviour more rapidly. The information provided about bills and tariffs must be more meaningful and easy to understand, and demonstrate how small changes in behaviour can have a significant impact on their bills. This will help reduce demand and our carbon footprint.

In fact, the energy trilemma itself (establishing a balance between affordability, security and sustainability) feeds directly into consumer benefits: reducing energy use = lower bills + longevity of supply + a healthier planet. This kind of logic can be understood easily by the next generation of customers, so wouldn't it make sense to teach energy awareness in citizenship studies on the national curriculum now?

Innovation & technology

While there seems to be an abundance of new products and services which are more efficient, more environmentally friendly and enable customers to better manage their energy use, it can be really difficult to understand them in detail. And with over half of fuel bill expenditure going on heating and hot water in a typical UK household, should we be focusing less on appliance efficiency and more on the total system efficiency of homes?

The Gas Distribution Networks also have a big role to play in ensuring the network is flexible enough to accommodate innovation aimed at efficiency and decarbonisation. Looking at local solutions designed around specific needs or the use of new fuels by replacing natural gas with renewable gases, such as biogas and hydrogen, are just two options that are already being explored.

Investment

I don't think we should be looking at a one-size-fits-all approach. European member states have different solutions in their own geographies, and within the UK, there is no reason why we would not expand this principle to counties and cities. In addition, pathways for supply and technologies need to be flexible and decision making needs to be a joint effort. If Government can provide a simple policy framework accompanied by a clear set of incentives, the energy industry can then focus on solutions. Combine this approach with a consistent education campaign for consumers to help become part of the decision-making process.

The time is now

That's not to say that steps aren't being made to address some of the issues, but I feel that now is the time to take bold measures and make a leap towards significant demand reduction. The challenge is urgent and we invite Government, the rest of the industry and my fellow consumers to join us to define the narrative and set the course for change to 2050. We'd like to know what you think so please join the conversation.



Tony Nixon

Strategy and Innovation Manager

The challenge

The UK Government faces a significant challenge: how to meet consumer demand for heat while reaching decarbonisation targets and ensuring that energy supply is secure. These are the competing demands of the ‘energy trilemma’.

We know consumers like gas because it is easy to control, reliable and familiar, and supported by a mature market of suppliers, boilers, installation and maintenance. We also know that heating demand is falling because more people are insulating their properties and buying more energy efficient boilers³. And in the context of the energy trilemma we can be fairly certain their main driver for customers is affordability, i.e., to save money. But when it comes to the question of how they can use less energy on a daily basis, the options are less clear, as is the extent to which their action might be reducing their carbon footprint. In terms of having a guaranteed supply of energy, the challenges for industry and government are considered in the other chapters in this series.

And so we need to consider the role of industry, technology and education in changing consumer behaviours.

Education + Technology

Improving consumers’ knowledge about the cost of their energy use, both in terms of £s spent and their carbon footprint is where we must focus efforts. And it’s not just about pushing information out there; industry has to be consistently listening and responding as consumer knowledge grows and behaviours begin to change.

- One of the easiest ways to change behaviour is to appeal to the pocket. Energy companies must think about how consumers use a range of information sources and plan strategies to reach them. Consumers are hunting for information with supporting evidence, so give them what they want in language that speaks to their needs.
- Targeting the right information, to the right people, at the right time is essential and so more granularity about consumer needs across regions and demographics is required: their

energy use, their wants and needs, and how industry can influence consumer behaviour and become flexible enough to meet energy demand to 2050.

- Policy makers also need to better understand what drives consumers to change their behaviour and reduce demand when developing incentives. Are the current and planned incentives flexible enough for consumers? Do they really reflect industry and customer needs?

Industry + Education

By 2050, the UK’s population is expected to have grown by 24 per cent, making it the biggest country in the European Union⁴. Even with significant electrification of heat and measures to reduce usage itself, there will still be a gap between supply and demand. Renewable gas is a realistic option to help meet this shortfall but as an industry we still have some work to do to meet all the demands of the energy trilemma.

- National Grid’s Future Energy Scenarios show a fall in heating demand as customers choose more insulation and more efficient boilers but even with the most optimistic scenario planning gas will continue to be required for heat, particularly during peak demand. The industry must shape itself accordingly.
- It would take billions of pounds of investment to provide 100 per cent electrification, with no guarantee of power at peak times. The challenge is to provide flexibility to ensure there is not supply shortfall on the coldest days and at other peak demand points.
- We need to better understand how gas can make a significant contribution to low carbon heat and how we can use the existing gas and electricity networks more efficiently, to maximise their value.

- As an industry we also have a role in protecting customers from scams and mis-selling and we can help by being more transparent and better engaging with customers about their energy usage and the benefits of changing behaviours with evidence and testimonials of savings.

Technology + Industry

New hardware, software, gizmos and gadgets seem to be launched to the market all the time, designed to make our lives easier and budgets more manageable, but when it comes to heating our homes we seem to be reticent to take that leap forward. Providing the right products and services is one part of the solution to meeting the UK’s carbon targets and ensuring supply continues to meet demand but there are still many challenges consumers, industry and government need to address.

- Reducing demand and decarbonising heat can only be achieved through innovation and investment. The challenge is to understand what that innovation looks like and who pays to develop and bring ideas on stream.
- Whilst consumers are starting to adopt new technologies such as smart thermostats, upfront investment is still required. Can a different model encourage more people to take part?
- New technologies take time to mature - it took double glazing 53 years! While incentive schemes to improve home energy efficiency have been around for a long time, up-take of cavity wall insulation is slow, and needs to increase to meet emissions and fuel poverty targets⁵.
- Can we better align incentives to help reduce other housing costs, such as creating Stamp Duty related incentives for householders to make energy improvements, supported by funding for new technologies?

Protecting the fuel-poor

It is imperative that any move to reduce demand and decarbonise domestic heat does not increase the number of families living in fuel poverty – those with low income but high energy costs. Living in a cold home can affect physical and mental health, with older people, children, and people with disabilities and illnesses at greater risk⁶.

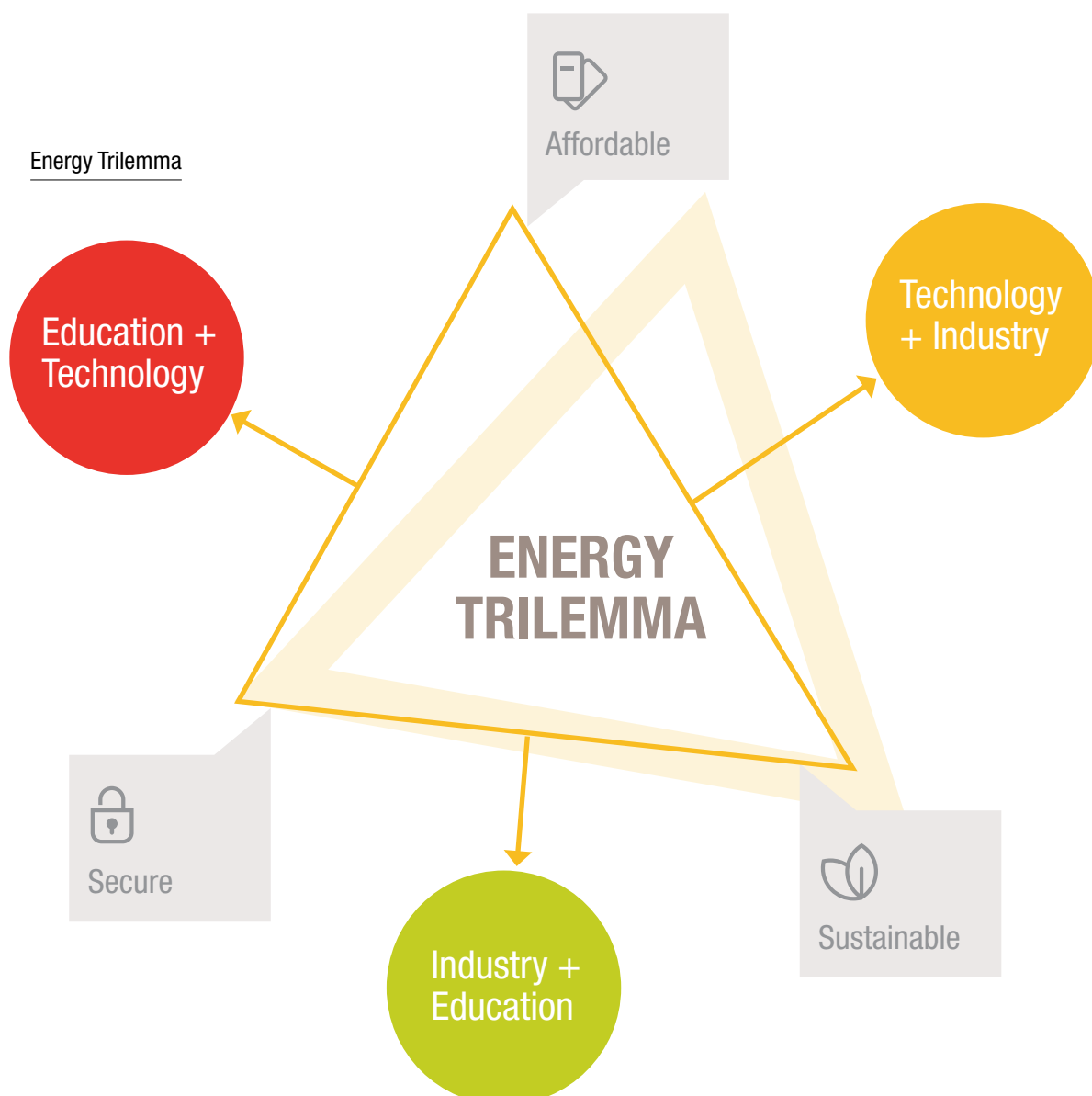
- A person is living in fuel poverty if, to heat their home to a satisfactory standard, they need to spend more than 10 per cent of their household income on fuel and they are in severe

fuel poverty if they need to spend 20 per cent or more of their income on these costs.

- National Grid Gas completes an average of 8,000 fuel poor connections every year to address affordability, which also helps reduce carbon emissions.
- In 2013, the number of households in fuel poverty in England was estimated at 2.35 million (around 10.4 per cent)⁷.
- Fuel poverty currently affects the lives of over 350,000 people in Wales⁸ and reached 940,000 in 2013 in Scotland⁹.

The UK Government and policy-makers must ensure future heat policy provides long term certainty for customers.

Energy Trilemma



Where are we now?

For a better understanding of what consumers want, need and expect from domestic heat, we should look at energy consumption trends over the last 40 years, and more specifically at the reductions in demand made over the last 15 years.

Factors affecting domestic energy consumption include the number of households, the energy efficiency of households, population size and household income.

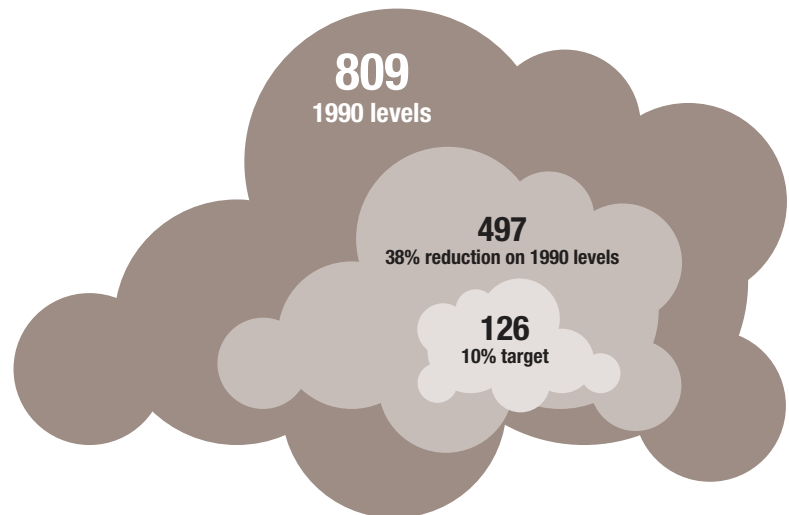
Since 2000, the overall progress for energy has been positive:

- Energy consumption per unit of household disposable income has fallen by 34 per cent
- Energy consumption per household has fallen by 27 per cent
- Energy consumption per person has fallen by 26 per cent¹⁰

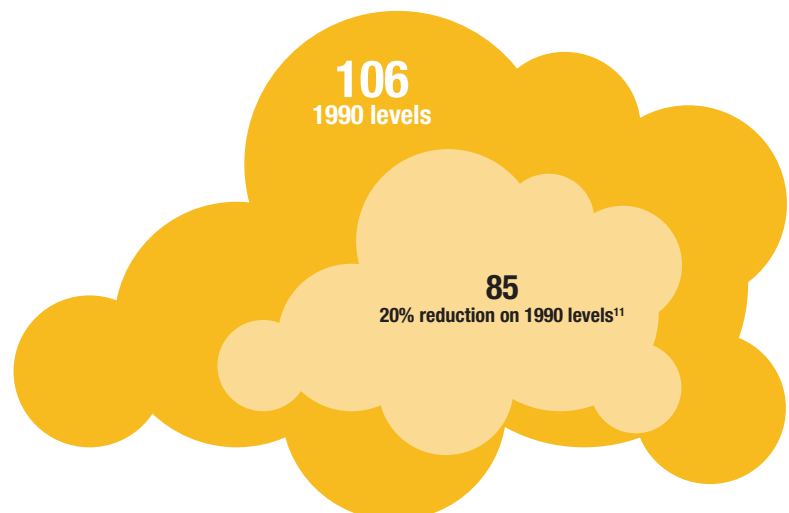
However, while we have seen total carbon emissions reduce by 35 per cent, decarbonising domestic energy is challenging, with only a 20 per cent drop since 1990.

Using less household energy will help meet carbon reduction targets. But achieving this will require industry to become better at communicating to consumers the value and benefits of changing behaviour.

Overall greenhouse gas emissions (MtCO₂e)



Building emissions (MtCO₂e)



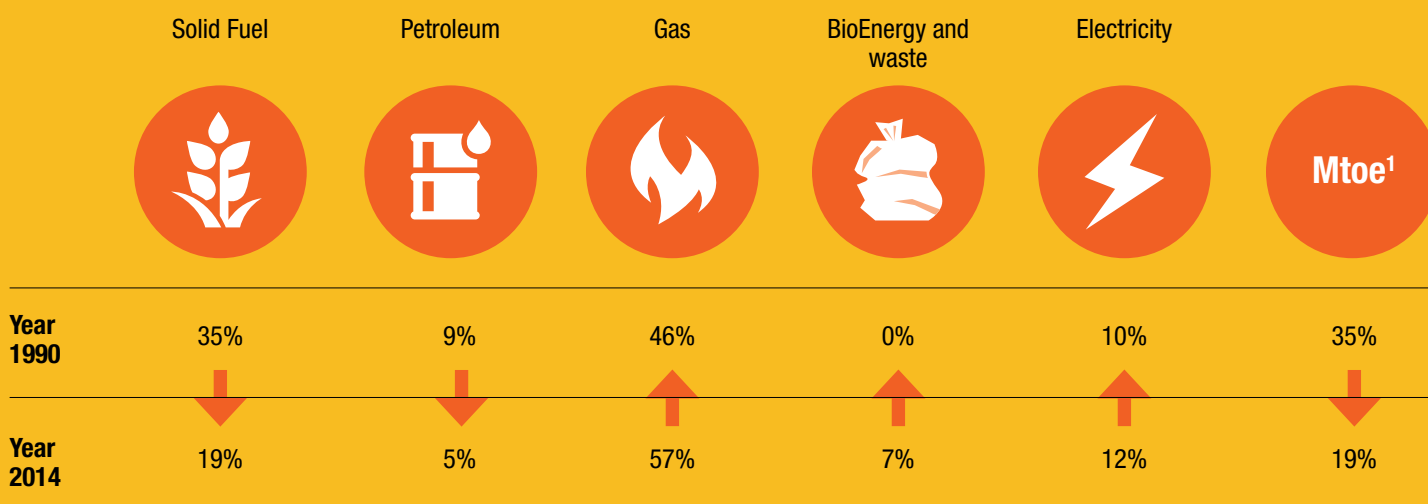
MtCO₂e refers to Million metric tons of carbon dioxide equivalent. This measure is the aggregate of different greenhouse gases into a single measure, using global warming potentials.

2050 target allowing for International Aviation and Shipping (IAS)



Gas has been the leading consumer fuel of choice over the last 25 years. How do we decarbonise the gas volume to help meet our carbon reduction targets with little or no disruption to our customers?

Domestic energy consumption by fuel



1 Million tonnes of oil equivalent (Mtoe) – toe is the unit of energy released by burning one tonne of crude oil¹²

What our customers are saying

There's a gulf between what our customers are saying now and what they could be saying in the near future. Right now customer insight is influenced by a range of factors including service level, cost of energy, and information supplied to them about energy use, sustainability and security. But while many consumers know the name of their energy supplier, they couldn't say which tariff they're on. And they have an idea of how much money they spend but not how much energy they use.

It would seem that influencing consumers is easy. Speaking in 1998 about the Apple iMac, CEO Steve Jobs said, "People don't know what they want until you show it to them"¹³. Similarly, the energy industry has an opportunity to harness data and produce smarter meters giving consumers real-time, at-a-glance information showing them how changing their behaviour can reduce demand, and more importantly, demonstrate the impact on their energy bill.

So what are customers telling us and what does a typical consumer look like? In 2015, the Gas Distribution Networks conducted consumer research into the role of energy and customer perspectives and their findings are illustrated in the customer profiles opposite.

And what do we draw from this research? The key headline has to be that consumers would much prefer to be on gas and have all of its benefits easily accessible because it is seen as the most affordable, most controllable and convenient energy option.

At the moment, consumers don't know how much energy they use; how much energy and money they could save if they used less; why they might use less or when they might use less. They simply don't know because there's no way of knowing. To make the information transparent and engaging we need smart technology supplying real-time information with comparative data about energy usage.

Smart technology is evolving

At National Grid, we have been thinking 'what next' for our customers as more and more data on energy usage becomes available to them. Quite soon, they will be able to capture data that calculates the adjustments they need to make to ensure they are using the correct amount of energy for their circumstances. The information could be shown on their smart device to give them a better idea of energy efficiency and help them identify the reasons for seasonal variations in energy usage. It could show them what to do to help reduce waste, save money and cut carbon.

Currently, consumers don't know if the amount of energy they are using is correct, taking account of the outside temperature and other factors. They may ask: why is my heating bill higher today than yesterday? Was it driven by the outside temperature? Or did I do something different?

We believe the gas industry can help provide access to information that will help customers understand these effects and their own energy usage, and be empowered to take action.

How will smart thermostats work in future?

Process showing how industry data integrated with smart technology could give consumers more control.



1. Assess your house

Quickly estimate your home's energy efficiency with basic questions about property type, age, size, heating system and insulation. Add more details for greater accuracy, such as light fittings and other energy controls.



2. Within day energy usage

Smart technology device shows, in real-time, how much money you are spending to heat and power your home.



3. Your energy efficiency feedback

For heating, the gas industry would show usage data for comparison. Similar could be done for electricity to capture summer vs winter usage. Customers could also access more detailed information about home energy usage and performance at any time, and make comparisons to help them use the right amount of energy to suit their needs.



4. Act now

Customers could use this real-time information to change the amount of energy they use, if necessary. There would also be links to energy saving options for customers to explore, such as The Energy Loop (see pages 18-19) to help them make smarter energy efficiency choices.

1

MULTI-FUEL RURAL**KEY FACTS**

- William lives in a large farmhouse in rural Scotland with his wife and two daughters

ENERGY MIX

- No mains gas
- Uses oil boiler, wood burning stove and Calor gas for cooking
- Uses portable electric heaters in winter

KEY ATTITUDES

- Energy is a fairly high priority
- Accepts higher energy costs in rural area, but they're increasing
- Happy to cut expenditure via major changes not just turning off appliances etc
- A hassle sourcing best prices for energy – has four bills

“We have to buy in our own oil, wood and gas bottles so energy is something I think about a lot, it's quite often on the to-do list.”

2

OFF-GAS RELUCTANT**KEY FACTS**

- Geraint lives in a 3-bed detached house in Wales with his wife and two young kids

ENERGY MIX

- Uses oil boiler for heating and hot water
- Has electric for cooking and extra heating

KEY ATTITUDES

- Energy is often on his mind
- Disgruntled at price of oil as keeps rising – like electricity
- Wants to reduce energy bills but doesn't know how – feels he missed out on solar when feed-in tariff rose
- Wants mains gas for convenience and lower bills

“Gas would be cheaper than what we use to heat the house now.”

3

ELECTRIC-CENTRIC**KEY FACTS**

- Fatima lives in a suburban terraced house in London with her husband and two kids

ENERGY MIX

- Uses gas for cooking
- Inherited all-electric heating system from previous owner

KEY ATTITUDES

- Doesn't think about energy
- Wants to reduce energy usage as bills increasingly costly
- Wants gas heating because it's cosier and cheaper
- Not keen on small changes to reduce usage like unplugging appliances or low energy bulbs

“I'm envious of people with gas, gas heating creates a much cosier, warmer heat than electricity, it's much better for cooking and it's cheaper isn't it?”

4

GAS GUZZLER**KEY FACTS**

- Duncan lives in a suburban semi-detached house in Leeds with his partner and their dog

ENERGY MIX

- Uses gas for cooking and central heating

KEY ATTITUDES

- Rarely considers energy
- Thinks he's probably paying too much and has switched provider in past, but pain outweighs the gain
- Lacklustre about reducing energy usage
- Interested in energy changes that are quick and free

“Energy's invisible to me. I only ever think about energy if it's not there when I need it.

But I can't remember the last time that happened. Or maybe when I get my bill, but that's about it.”

How can consumers reduce their demand?

If changing consumer behaviour is central to reducing energy demand, what can be done to drive that behavioural change, and by whom? Industry can make a number of interventions, which include presenting better information more frequently, developing on-the-go technological solutions, and educating consumers about saving money – the primary driver for action. But consumers themselves also can take the initiative to reduce their energy consumption by up to 30 per cent.

Although DECC's Public Attitudes Survey 2016 shows a high percentage of consumers think about the amount of heat they use, the extent to which 'thought' translates into 'action' is unclear.

- 75 per cent of people have given a lot or a fair amount of thought to energy saving in their homes. 56 per cent of this 75 per cent said the primary reason is to save money.
- 72 per cent of people said they paid either a lot or a fair amount of attention to the amount of heat they use in their homes.
- 46 per cent of people leave the heating on when they go out for a few hours¹⁴.

The opportunity

Industry and energy companies could capitalise on this groundswell of consumer interest by supplying easily-digestible, meaningful information through relevant channels to help them make the best choices to reduce demand.

We know new technologies and efficiency measures aren't adopted overnight, but we should be realistic about timescales for uptake. Various incentive schemes have been implemented over the years, with varying degrees of success. So what does the opportunity look like?

- Smart thermostats are beginning to catch on. As they become GPS-enabled, they will reduce demand by 10 per cent.
- Replacing A-rated boilers at current levels will reduce demand by 10 per cent.
- Solid wall insulation in another seven million homes would reduce demand by 10 per cent.

Housing

Housing is being built to ever increasing standards of energy efficiency, but the fact remains that 80 per cent of the houses that we'll be living in 2050 have already been built. It's this existing housing stock - which equates to millions of homes - that presents a challenge as it will have to undergo an extensive programme of retrofitting.

Government and EU strategies are unclear about how to achieve targets for greenhouse gas reduction; energy saving targets; and decreasing CO₂ emission levels in the building sector by up to 91 per cent by 2050¹⁵.

Insulation

Consumers have shown a strong appetite for installing loft and cavity wall insulation¹⁶. While the costs of solid wall insulation make it prohibitive¹⁷, there was a surge from 2014 – 15 when the Green Deal Home Improvement Fund supported over £35m of installations. This shows the positive effects of government incentives and consumer education.

Although it could take 15-20 years to pay back solid wall insulation, it only takes about two years to realise the financial benefit of loft insulation for a centrally-heated, three-bedroom, semi-detached house¹⁸. Irrespective of energy source, should consumers not insulate their homes anyway?

Boilers

Boilers account for 55 per cent of annual energy bills, so encouraging consumers to opt for more energy-efficient models will reduce demand and bring cost savings. For example, a semi-detached house in England, Scotland or Wales could save £120 per year by converting to an A-rated condensing boiler with a programmer, room thermostat and thermostatic radiator controls¹⁹.

After significant research, the Energy and Utilities Alliance (EUA) recommends legislation for new boilers to include heating controls because it would contribute to improving energy efficiency.

Smart thermostats

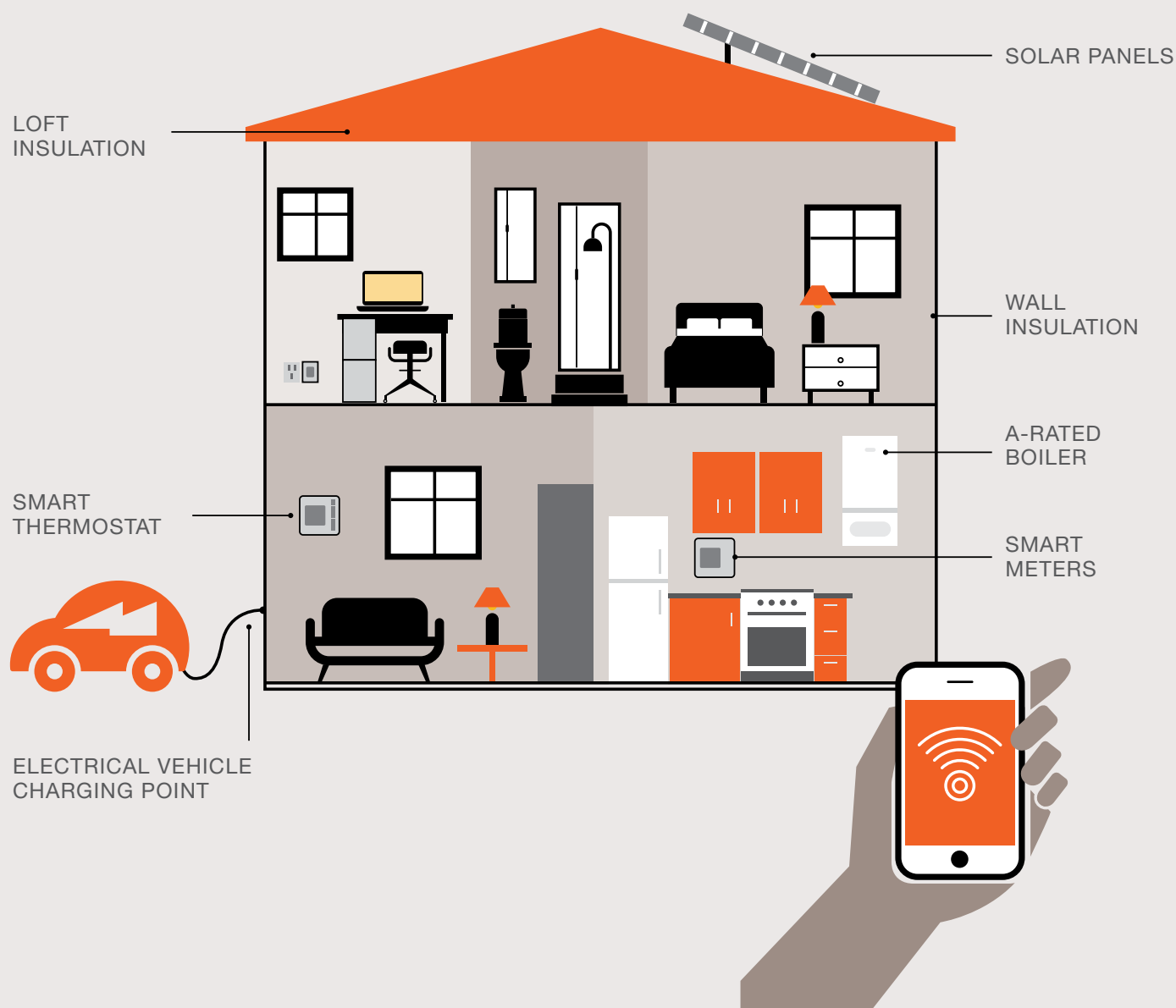
Smart thermostats are the future, and they're here. Affordable and user-friendly, they give consumers real-time information about energy use, the amount of money they could save by altering their behaviour and – crucially – the power to make an immediate intervention to reduce demand.

The UK market has grown rapidly in the past few years. There are between 200,000 and 400,000 smart thermostats now in use²⁰, costing an average of £200 for the device and installation²¹. This is a solid base of early adopters, but how can we build on this to reach critical mass?

The connected home

We live in a world of big data and very soon this information will be used to control everything from household appliances to autonomous vehicles. For example, our home freezers will power down automatically at periods of peak demand

and the dishwasher will magically start at night when demand is lower and energy cheaper. We have the opportunity to use this data to help consumers reduce their domestic energy demand and save money.



Energy improvement measures



- In 2013, around 13.3 million homes (70 per cent of the total housing stock) could still benefit from at least one energy improvement measure.
- 9 million homes could potentially benefit from replacing an existing conventional central heating boiler with a condensing boiler, 5.4 million homes could benefit from installing cavity wall insulation and 5.3 million could benefit from improving loft insulation.

- Some 10.8 million homes could benefit from one or more of the lower cost measures, most commonly installing cavity wall insulation (5.4 million) or installing or topping up insulation (5.3 million).
- Overall, 12.1 million homes could potentially benefit from one or more of the higher cost measures, the most common of which was replacing an existing conventional central heating boiler with a condensing boiler²².

- Government must continue to offer a strong range of domestic heat incentives.
- Industry needs to influence consumer behaviour with meaningful information through relevant and modern communications channels.
- Housing regulations should include stipulations to install energy efficient boilers in new builds.



Alternative technologies for heat and hot water

In a typical UK household, more than half the money consumers spend on fuel bills goes towards providing heating and hot water. As fuel costs rise, having an efficient and cost-effective heating system is vital, and it's one of the main interventions consumers can make to save money and reduce their carbon emissions. With a move away from appliance efficiency to overall system efficiency, what are the leading technologies available today?

Developing energy efficiency products

Our Future Energy Scenarios (FES) assume that greater technological developments in the energy market will happen over time with more products coming to market. The scenarios also predict that prices for these technologies will become more competitive as supply chains develop; they will also be well marketed leading to faster deployment rates.

So, how much can these technologies contribute to carbon reductions and how difficult is this to achieve? There are a number of variables:

- Has the energy generation been decarbonised or not?
- What levels of incentives are required to get consumers to change?
- Can the existing utility networks support the change or is new infrastructure required?

So what are the benefits of these new technologies?

Air source heat pumps

- Could reduce energy bills and improve EPC rating
- Renewable energy source could lower carbon emissions
- Low maintenance
- Cost-effective alternative to installing new gas main, so good for new, purpose-built sites
- Integrated internet monitoring available

Gas source heat pumps

- High-efficiency solution for low grade heating and hot water generation
- Can be used on their own or in conjunction with commercial boilers
- Reduce carbon emissions and improve building environmental ratings

Solar

- UK government's Feed-in Tariff scheme pays consumers for electricity generated
- Surplus electricity can be sold back to the grid
- Cuts carbon footprint

Alternative technologies for heat and hot water

The graphic shows how technologies can contribute to decarbonisation against both our FES Slow Progression and Gone Green scenarios supply and generation mix in 2035, plotted against the challenges faced in deploying these technologies.

By using these we can identify what is required from both the Government and

industry to help decarbonise the energy we use in buildings for heat and which technologies will help us to get there.

Whilst it's unlikely there will be a single technical solution that works for urban, suburban and rural locations to achieve our goal of reducing carbon emissions, we have a clear opportunity to use our gas

and electricity networks and technologies to meet the targets. This will include supporting renewable gases to avoid additional infrastructure changes. What we need to find is the "sweet spot" where the best technologies can be easily adopted for each locality or household.

Ground and air source heat pumps

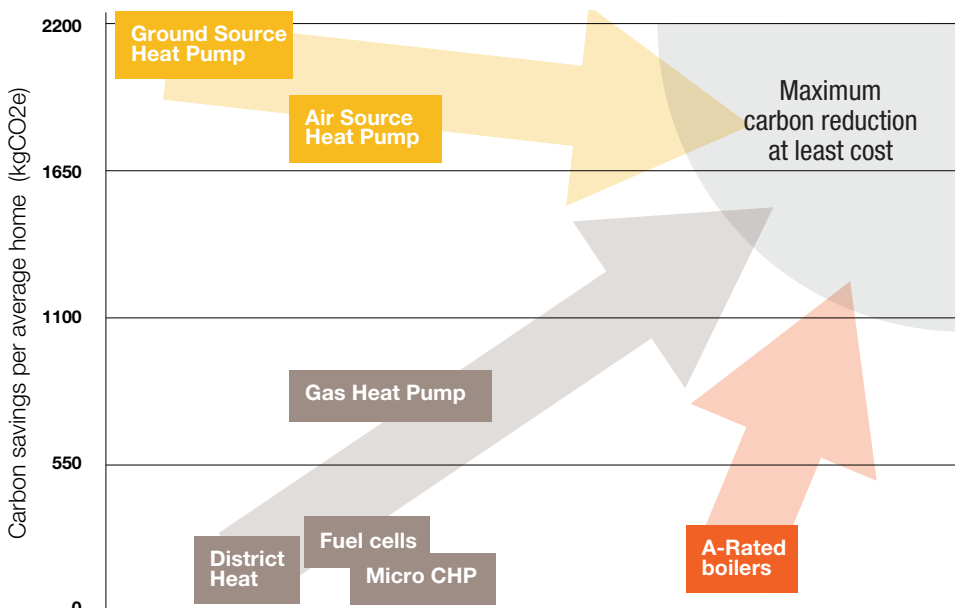
Strong consumer incentives will be required to encourage a wider take-up of these solutions in new builds and to support further infrastructure development. At present there seems to be considerable consumer resistance to installing air source heat pumps in existing homes and ground source heat pumps in homes, potentially because of their high initial cost, but they do offer significant carbon savings very quickly.

Gas heat pumps, district heat, fuel cells & micro CHP

Again, strong consumer incentives will be required to encourage a wider take-up as they are less familiar technologies. Similar challenges regarding costs to purchase and install at the outset but they do provide options between all electric and renewable gas solutions, with less need for significant change to any existing infrastructure. In terms of the carbon reduction households can achieve, this can vary significantly and is very dependent on whether the energy source is low or zero carbon.

A-rated boilers

Whilst these seem to be the easiest option for consumers, with no change needed in the home or to the existing infrastructure, and a much lower initial cost take up is still slow – perhaps because a new boiler tends to be aligned with the existing system or boiler reaching the end of its life. These new boilers also offer moderate carbon gains per household, although if combined with the development of renewable gas or a hydrogen network the gains become considerably more substantial.



Notes

- District Heat analysis on carbon savings is very sensitive to the energy source assumed and requires significant infrastructure development. We cover this topic in more detail in the next section.
- In our analysis we have assumed 2,411 KgCO₂e for an average home. A combination of energy efficiency and the technologies shown can contribute to significant reductions in carbon for buildings.
- See the glossary for a brief description of the technologies.

Consumer: Resistance
Infrastructure: Change
Cost: Higher

Consumer: Acceptance
Infrastructure: Existing
Cost: Lower

District heating

District heat is a way of providing heating and hot water to multiple residential properties via a network of insulated water pipes carrying residual heat from industry and commercial properties.

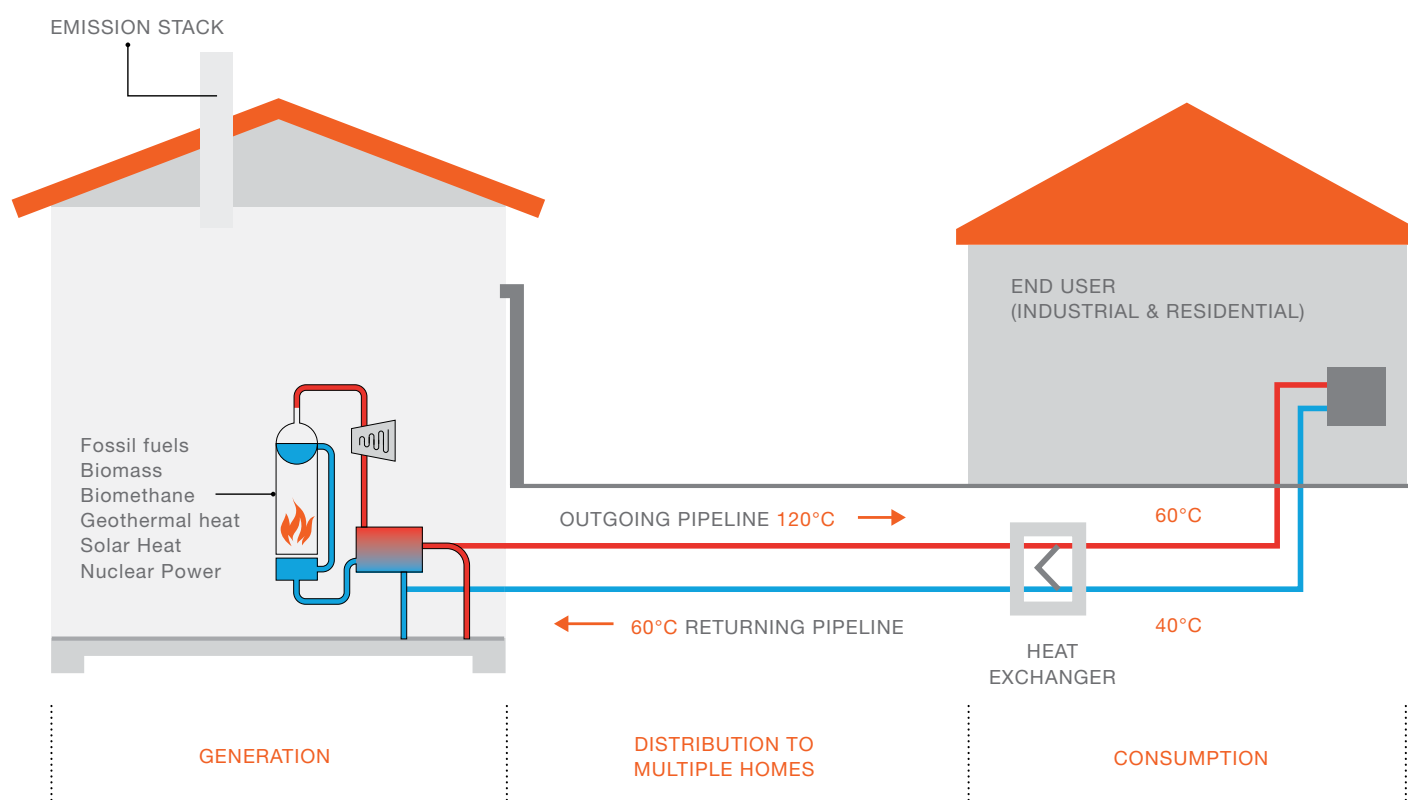
District heat networks can vary in size and length, carrying heat just a few hundred metres between homes and flats, to several kilometres supplying entire communities and industrial areas. Networks are easily extended by adding more heat sources along the way.

Using valuable energy that is often wasted in power generation or industrial processes, heat networks remove the need to generate additional energy. They

also allow for economies of scale, as the generation of heat in one large plant can often be more efficient than producing in multiple smaller ones.

A range of energy sources can be used including biomass, geothermal heat, energy from waste, solar systems, heat pumps and conventional boilers. For consumers, district heat provides communities with low-cost, low-carbon heat and hot water.

How district heating works



District heating

Government policy

The UK Government and the Committee on Climate Change (CCC) believe district heat schemes should support the decarbonisation of heat²³. In the UK, around 2,000 heat networks already supply approximately 210,000 homes and 1,700 commercial and public buildings – with another 150 schemes under development.

Where does it work best?

District heat networks offer the highest benefit in densely populated areas. Our analysis shows the potential for district heating solutions are focused around the UK's larger cities: Birmingham, Manchester, Sheffield and Peterborough.

Looking at the total potential, we have developed two scenarios for district heat across four cities of differing sizes – as laid out in our Future Energy Scenarios.

	Birmingham	Manchester	Peterborough	Sheffield
Current no. homes connected to gas	386,000	180,400	73,000	220,300
Current no. of homes off gas	24,700	24,600	1,200	9,600
Potential no. of new District Heat connections by 2050 (Gone Green)	106,882	52,206	11,930	63,291
Potential no. of new District Heat connections by 2050 (Slow Progression)	54,660	49,507	11,644	62,412

See reference²⁴ for figures in this table



Which areas would be suitable?

With an increasing UK population, the government supports the building of new houses, particularly on regenerated brownfield sites. The National Infrastructure Delivery Plan 2016 - 2021 sets out the Government's pledge to build 400,000 new homes by 2021 and ensure that 90 per cent of suitable brownfield sites have planning permission

for housing by 2020. These developments will be most suitable for district heating, particularly if the source of heat is residual from industrial or commercial processes.

Local authorities will play a critical role by setting the strategic context and initiating the development of district heat networks, because they have local knowledge, organisational capacity and key functions as planning authorities and service providers.

Pros and cons of district heating

Pros

- Efficient: saves energy as user only pays for heat used, and can help reduce fuel poverty.
- Reliable: heat and hot water is always available.
- Save money: no need to buy a boiler and maintain own heating appliances.

Cons

- If you have an electric heating system or no central heating you will need to install radiators or underfloor piping.
- Laying the infrastructure is disruptive; railways, major highways and waterways increase costs.
- Space required for the central energy centre and fuel storage.
- Limits consumer choice and penetration is key for scheme viability.
- Use of waste heat may need back-up systems, such as natural gas CHP units.
- Heat network schemes are unregulated, with customers unable to switch and obliged to sign long term contracts for up to 20 years.

Gas and electricity demand

The fluctuation in gas demand over the year is much more pronounced than for electricity. This is largely because of seasonal temperature and daylight hours changes having a greater effect on the amount of energy we use for heating, rather than lighting.

There is far more opportunity to influence gas usage rather than electricity, but this does not mean that there aren't efficiencies to be made in relation to electricity. If we are to meet customer demand in future, it is clear that both gas and electricity energy efficiency will play a role.

There are many available and emerging technologies being developed by industry with support and incentives from government. Like all technology, there are early adopters who help to drive the price down and who, along with effective education and marketing, bring other consumers in their wake.

From a community perspective, initiatives such as district heat offer consumers the opportunity to benefit from cheaper heating and hot water with a reduced carbon footprint. As well as incentives from central government, district heat also relies on support from local government.

Put simply, technologies on their own won't get us where we need to be. They are a critical part of the solution, but require incentives from government, innovation from industry and support and education from energy companies – and consumer appetite – to reduce demand and cut our carbon footprint.

Rolling out renewable gas

The cheapest way for the UK to meet its low carbon ambitions is to use the existing gas grid, a view supported by Government-instructed research into long term security of supply²⁵. This means the existing gas infrastructure has a key role to play in supplying low carbon energy for the foreseeable future, and using hydrogen could bring greater certainty about energy security.

Hydrogen is seen by many experts as one of the best clean alternatives to fossil fuels, if it can be created using carbon-free renewable energy and delivered through existing gas networks. The result would be a zero-carbon domestic energy source. In practical terms, cooking and heating with hydrogen would be the same as using conventional gas, so there would be no need for consumers to change their behaviour.

Is it safe?

Safety is a top priority when considering any gas for domestic heating, cooking and lighting. For example, town gas, which contains 45-60 per cent hydrogen, was only introduced because it had a very good safety record.

The Hyhouse project was set up to measure the safety aspects of concentrations of natural gas and hydrogen at a two-storey farmhouse. Funded by Scottish and Southern Energy (SSE) and DECC, experiments concluded that the impact of a hydrogen explosion would be lower than natural gas.

Although further work is required around leakage detection, hydrogen should be treated with a similar level of risk as any other gas supplied to domestic and commercial buildings. The Health and Safety Executive observed that installation requirements for domestic hydrogen are covered by existing gas safety regulations²⁶.

How would hydrogen arrive in the home?

There are two ways to use hydrogen in the UK; either mixed with natural gas or as a complete substitute for natural gas. While each scenario has a different cost and carbon reduction outcome, they would need to help solve the energy trilemma of affordability, security of supply and sustainability. From the perspective of security and sustainability, hydrogen is appealing.

National Grid is currently researching the transmission and use of hydrogen as a substitute for natural gas with a pilot project at Keele University which will see part of the campus running entirely on hydrogen. We know the network is capable of a full conversion programme because this was done from 1967-1977 when it switched from carrying town gas to natural gas.

Heat, cooking and appliances

Like natural gas, hydrogen can be easily used for cooking, and it can also produce carbon-free electricity and heating via a hydrogen fuel cell. Producing electricity with a fuel cell cuts overall household emissions by 40 per cent compared with running on gas alone²⁷. The only emissions from a hydrogen system are medical grade oxygen and chemically pure water (in space astronauts drink water produced from burning hydrogen rocket fuel)²⁸.

The cost of converting a home to hydrogen

Industry and Government will have a role to provide clear communication to consumers of the benefits, incentives and likely costs of a switch to hydrogen. Slight modification to household appliances would be needed, and in some cases, replacement, and buildings would be fitted with hydrogen meters and sensors.

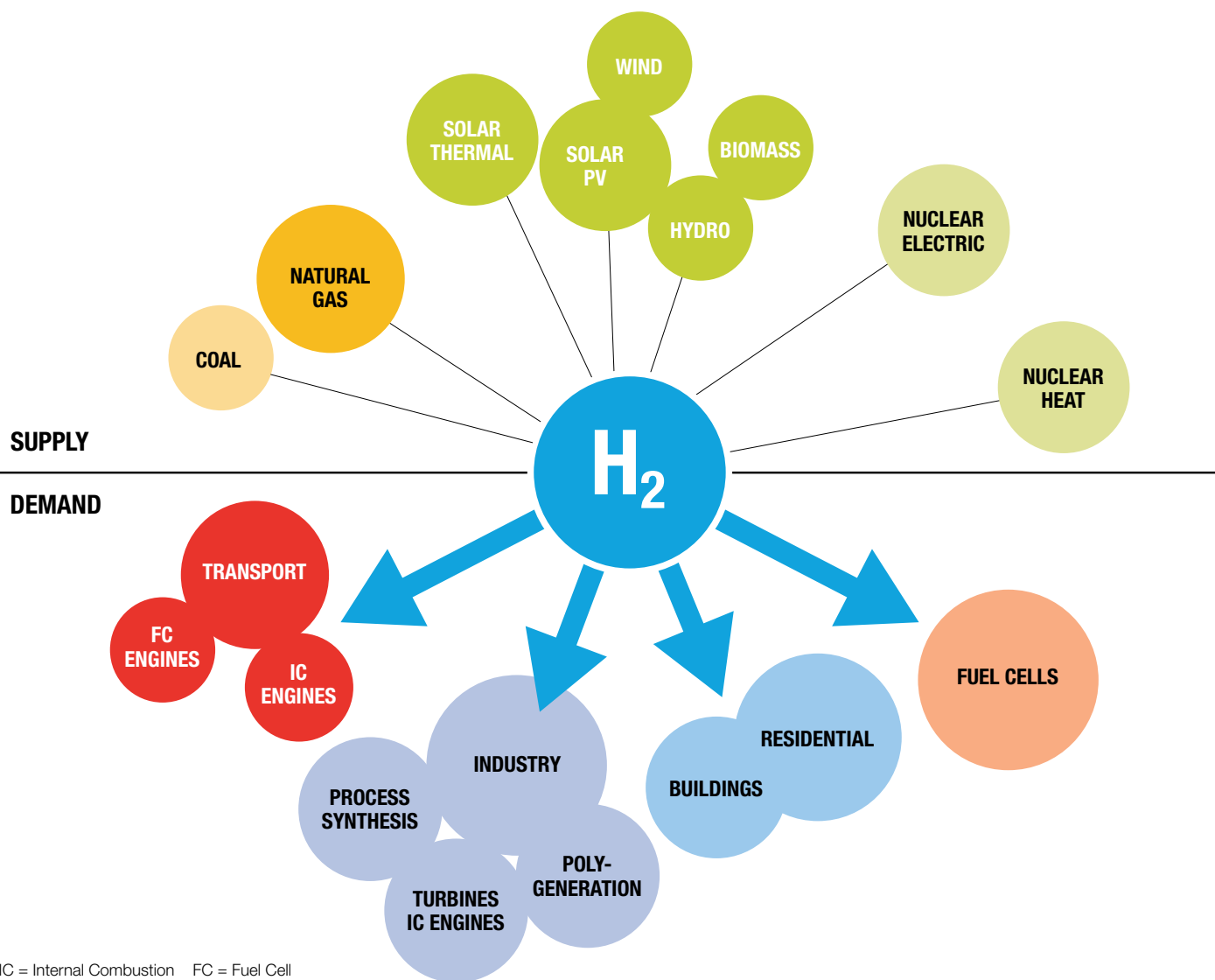
The estimated cost for converting the average home is around £3,500²⁹ and includes:

- New condensing boiler (installed) £2,000
- New gas fire (installed) £750
- New cooker £250
- Miscellaneous including meter £500

A report by E4tech³⁰ states that economies of scale should reduce conversion costs in large towns, while operational costs such as inspections and maintenance will remain similar to natural gas. As residents in Bridgend, Wales discovered with their district heat scheme, 80 per cent of consumers could not afford the upfront costs involved with switching to alternative forms of energy³¹, which highlights the issue of affordability with alternative technologies.

Next steps

As previously noted, the industry is currently assessing the impact of a move to a full hydrogen network, including how to replace existing processes. This could result in some 'no regret' decisions to ensure we have the building blocks in place, ready to make the transition if and when the time comes.



Hyhouse, two-story farmhouse

The gas industry is currently assessing the impacts of introducing hydrogen into the network.

Empowering consumers to act

Customer research carried out by the Gas Distribution Networks draws a very important conclusion. People are completely reliant on energy, and while few actually think about it, they do value the benefits it brings, such as warmth, light, cooking, entertainment and connectivity.

This helps to explain why consumers are reluctant to take action to save money, reduce demand and cut carbon, even when faced with a range of options to help them achieve these goals. And it is compounded by a fragmented energy market, which makes people cautious because of shifting government policy and increasingly high energy prices. So if there's no lack of choice, what can the industry do to help empower consumers to act?

The Gas Innovation Summit 2014 – hosted by the Energy Innovation Centre – explored the sector's challenges and opportunities. A set of customer-centric ideas emerged around consumer care, including the needs of people living in

fuel poverty and off-grid. The industry concluded it would only achieve these ambitions through better collaboration for the benefit of all.

The Energy Loop

The response is The Energy Loop – an online platform designed to help consumers make the right choice based on an analysis of their circumstances and manage the installation process.

The Energy Loop drives customer choice and inclusion, and transforms how people across the UK access the most efficient energy options for homes, small communities and local generation schemes.

Homeowners and whole communities can take a journey from education to action, giving them control of their energy choices and making them feel empowered.

The Energy Loop in action

- **Find It** gives customers information about their energy options and connects them with trusted installers and funding sources
- **Fund It** connects people and communities with funding sources for energy projects
- **Build It** connects energy developers with industry and helps them identify areas of demand

Steps to empowerment



Discover and connect: Consumers answer a few simple questions about their home, and in seconds receive a selection of options tailored to suit them. The pros and cons are clearly explained, with helpful information communicated in plain English.



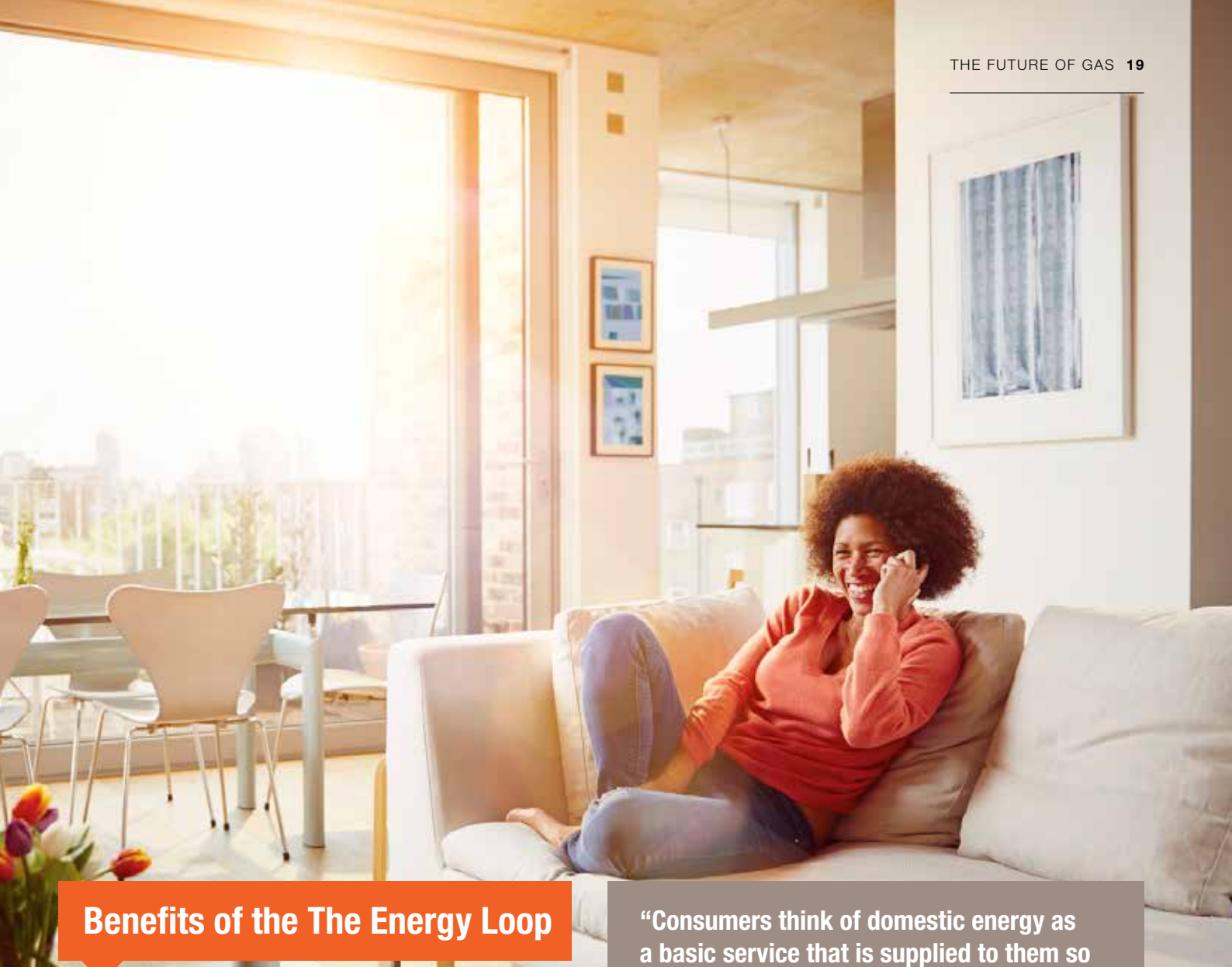
Select: Shortlist in hand, consumers can quickly connect with qualified local installers. Estimates are displayed in one place for easy comparison so customers can make decisions with confidence. Users also receive information about financing and repayment plans so they can pursue the best long term investment.



Manage and deliver: When an installer has been selected, The Energy Loop helps customers:

- Easily schedule home visits
- Exchange information and documents with the installer
- Track progress
- Protect their deposit until the project is complete

Local authorities will be able to explore community energy projects along with local information about interested parties, and installers can see demand for particular technologies so they can tailor their services.



Benefits of the The Energy Loop

- Empowers people to make the best energy efficiency decisions for homes and communities
- Could deliver significant benefits to fuel-poor and off-grid customers
- Could benefit those with a 'traditional' gas or electricity energy connection
- Gives customers and local authorities joined up information
- Offers opportunities for installers, builders and manufacturers

“Consumers think of domestic energy as a basic service that is supplied to them so perceptions are driven by when something goes wrong. Futurewave [now branded The Energy Loop] is important because it gets into this space and it will help customers to have a better experience when dealing with energy companies. Futurewave is innovative and collaborative, and it's for these reasons that we at Ofgem are supportive of it and we look forward to seeing what comes from it.”

David Gray, Chairman, Ofgem

THE ENERGY
Loop

The ambition

So can reality meet the ambition?

This paper addresses three key challenges to help customers reduce their demand for domestic energy by 2050 in the context of the energy trilemma: the need for innovation, education and investment.

Gas offers an easy-to-control, reliable and familiar option for customers. Coupled with a mature market of suppliers, products and maintenance it's hard to see how or why we could make a case against the continued use of gas for domestic heat. But that doesn't mean customers should be complacent – we need them to actively participate in making the right energy choices to suit their own circumstances.

Therefore, it is absolutely essential that industry and Government act as one to understand and influence what customers want and deliver the right intelligence – via innovation, investment and education. This will empower customers to take more responsibility, make better decisions and become active consumers rather than passive bill-payers.

There are many wins that industry, Government and consumers can make together to ensure that gas remains a key component of the domestic heat market, delivering affordability, security of supply and sustainability to the middle of the century.

The goal

The Climate Change Act established a target for the UK to reduce its emissions by at least

80%

from 1990 levels by 2050



Education

Energy companies need to drive behavioural change through communication

Consumer information must be more meaningful and easy to understand

Demonstrate how small changes can save money, reduce demand and take us closer to decarbonisation

Reducing energy use = lower bills +

longevity of supply + a healthier planet



Consumer intelligence

In a typical UK household, more than half the money consumers spend on fuel bills goes towards providing heating and hot water

Gas customers – over

23 million
across the UK

Usage – we currently use

321 TWh

to heat our homes and cook
(82 per cent of space heating is provided by gas, 85 per cent of hot water is provided by gas and 53 per cent of cooking is powered by gas)

Approximately

1 in 10 households
in England is living in fuel poverty

**ACT
NOW**

Urgent action

Government to provide a simple policy framework with a clear set of incentives

To change consumer behaviour through better, more agile communication strategies from industry and energy suppliers

Industry to push more technological innovation

Framework + incentives + communication = industry investment in customer-led solutions

Innovation and investment

- New information apps such as the The Energy Loop enable customers to make the best choices – giving the right information, in the right format, whenever a customer wants it
- 30 per cent efficiency savings are possible for homeowners already – 10 per cent from cavity wall insulation, 10 per cent from A-rated boilers, 10 per cent from smart thermostats
- Energy can become a local decision as options for small communities and local generation schemes are made simple and straightforward – moving from appliance efficiency to overall system efficiency
- Customer control - The “big data” that will be used to run connected homes, cars and appliances will align so customers can easily track how much energy they have used, how much they have spent and crucially, when they can use less and save more

Towards a zero-carbon future...

Hydrogen is an ultra-low-carbon fuel, the burning of which produces only vapour.

Repurposing the gas network to carry hydrogen would only require small specific changes.

No significant modifications would be required to customers' properties.

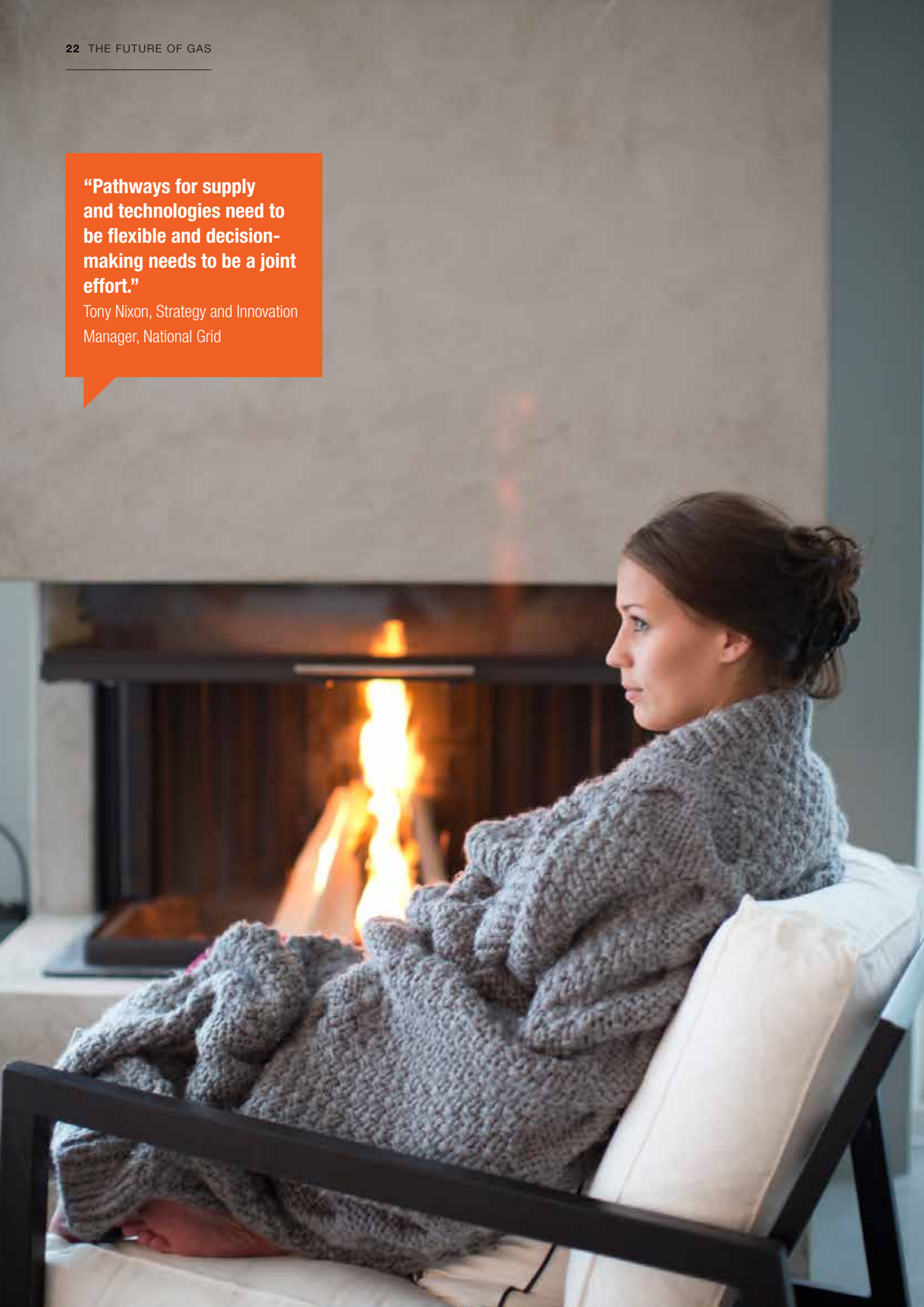
When it comes to heating and cooking, hydrogen can be used without the need for consumers to adapt anything in their homes.

THE ENERGY

Loop

“Pathways for supply and technologies need to be flexible and decision-making needs to be a joint effort.”

Tony Nixon, Strategy and Innovation Manager, National Grid



References and glossary

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Glossary

Combined heat and power (CHP)

A system whereby both heat and electricity are generated simultaneously as part of one process. Covers a range of technologies that achieve this including micro-CHP for domestic use.

Fuel cells

Stationary fuel cells can efficiently convert pure hydrogen or natural gas or other gaseous hydrocarbons into electricity and heat similar to combined heat and power generation. When the energy source is hydrogen there are no emissions from the process.

Heat pumps

Device that takes advantage of the latent heat that exists in the air, ground or in bodies of water. Heat pumps can be used as hybrid systems, where gas is used to ‘top up’ and meet heat demands at peak when the heat pump is likely to run at its lowest efficiency.

Solar power

Solar panels, such as photovoltaics (PV), capture the sun’s energy to generate electricity to run household appliances, lighting and potentially heat hot water.

Other publications in this series

The Future of Gas series seeks to address the challenges and opportunities to help the UK move towards a low carbon economy. These include efficiency measures that customers can take to reduce their consumption, and new sources of gas that could deliver energy in a more sustainable way. Look out for the following publications:



Introduction to the Future of Gas
 Overview of the challenges in meeting the UK's carbon reduction targets



Supply of renewable gas
 The benefits of renewable gas in relation to the energy trilemma



Transport
 The potential role for gas in the HGV transport sector
Coming soon



Network capability
 How our networks and network investment will look in the future
Coming soon

For more information about how to get involved please contact us at

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The papers will be published online at

nationalgrid.com/futureofgas