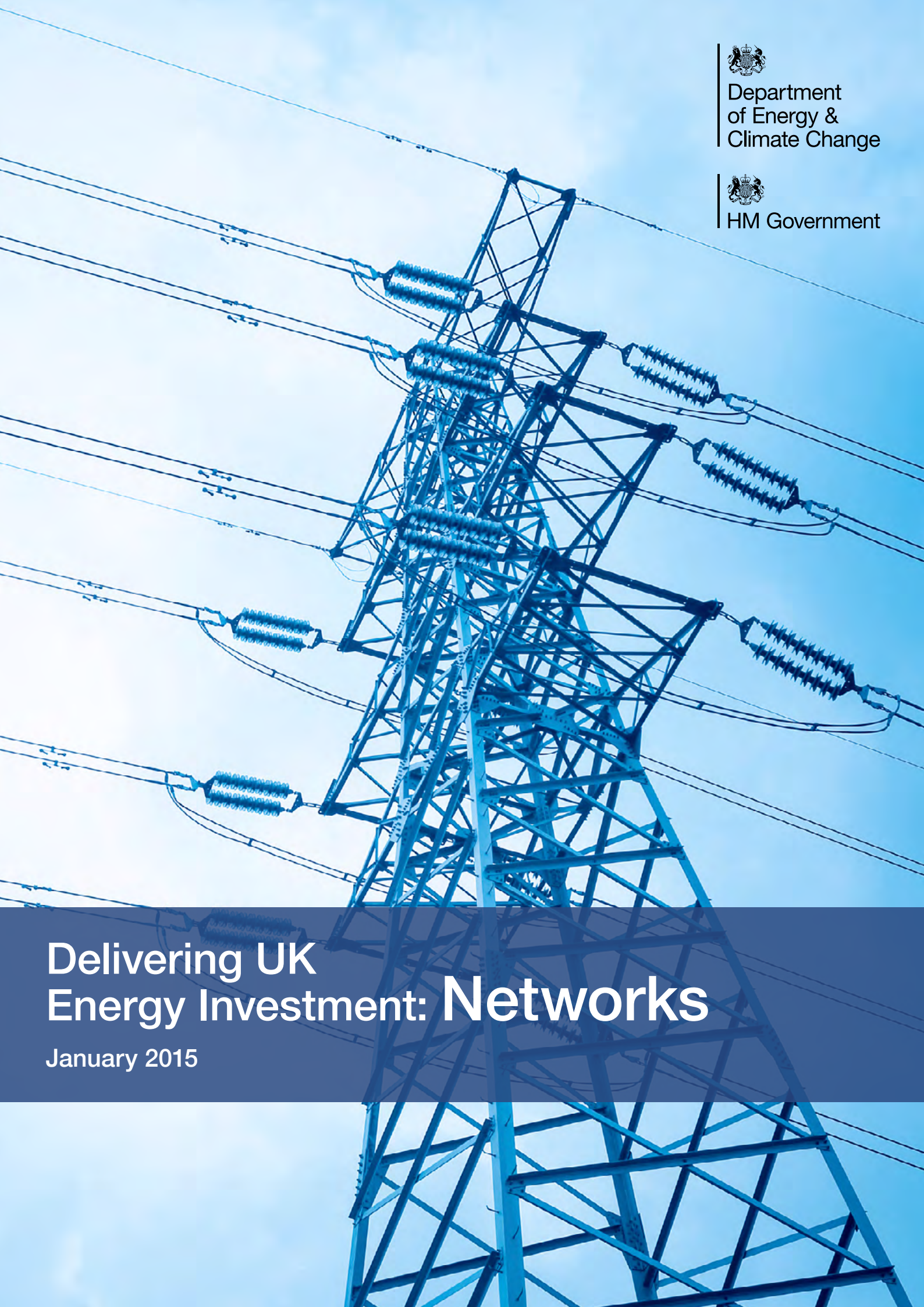


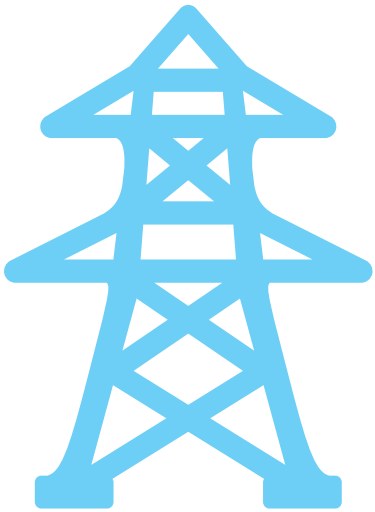
Department of Energy & Climate Change

HM Government

Delivering UK Energy Investment: Networks

January 2015

Contents



Ministerial Foreword

Energy security is one of the Government's highest priorities. And for energy security to be maintained it isn't sufficient to simply guarantee access to the raw materials – gas and oil – or make sure we have enough electricity generation capacity. We also have to make sure that energy flows seamlessly into people's homes and to our businesses, so when a switch is flicked or a boiler fired up – gas and electricity is actually delivered.

Resilient energy networks are critical for energy security. They are the vital arteries that carry power round the country: the electricity grid, the power-lines and substations; the gas network, pipelines, storage facilities and import terminals; and the integrated heat networks being developed that can provide efficient, reliable heating to whole communities.

While our existing networks have served us well historically, they are ageing and out of date. Not only do we need to rebuild our energy networks to ensure resilience, we need to expand them so we can take advantage of the new types of low carbon energy generation such as offshore wind. We need to modernise them so we can take advantage of the new ways of controlling power flows that digital technology offers – developing smart grids that are much more responsive and can deliver better energy efficiency and higher energy savings.

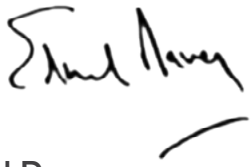
This Government has a strategic approach to upgrading our energy networks. Although the infrastructure challenges for electricity, gas and heat are all different, our energy security requires they are seen as an integrated whole. Our energy networks are being upgraded and expanded in a rolling programme over a decade or more to ensure that all new generating capacity is connected as it comes on line, and our gas systems are flexible as North Sea production declines.

The Department of Energy and Climate Change (DECC) has been working with Ofgem and the many agencies in the sector to deliver clear strategic direction and to make sure any financial or technological barriers to modernisation are swept away. This report details the challenge in each area and how together we are acting to drive investment into network modernisation.

We have made a good start. On electricity, there has been over £16 billion of investment in our networks since 2010. This includes not only new offshore and onshore transmission links, but also weather proofing the network to ensure that it remains robust during storms and floods. Our gas network has seen £3.8 billion of upgrades since 2010, new storage facilities, better import infrastructure and old pipelines replaced. In the area of heat networks, 91 Local Authorities in England and Wales are being supported by central government to develop and expand community and city-wide heat networks.

But there is still a lot more to do. As our energy system changes our energy networks will have to adapt too as we move to a green, energy-efficient and climate-friendly system. Smart grids will need to become the norm, so we can make the flows of energy hyper-efficient. The grid will have to deal with many new connections as new renewable technologies come on line and our transport system is increasingly electrified.

As this report demonstrates, the Coalition Government has put in place a robust framework for the future of our energy networks, and the investment we need is flowing into the system.



Ed Davey

Executive Summary

This report is our first in-depth look into investment in the UK's energy networks – the pipes and wires that transport energy across the country from point of generation to point in our homes and businesses to meet our everyday energy needs for power and heat.

Whilst historically these networks have served us well, they are ageing and, if left, would not meet the changing requirements of our energy needs such as new and lower carbon electricity generation connecting in new locations, greater interconnection with other countries, and smarter consumers taking more control and local communities playing an increasingly active role in the generation and purchase of energy. We also need to take advantage of the abundance of untapped heat resources through investing in heat networks.

This Government has understood this challenge and is responding – a significant investment has already been delivered. Between 2010 and 2014 there has been over £16 billion of investment across our electricity networks, £3.8 billion across our gas networks and electricity interconnection projects worth £1 billion have been delivered.[1] From 2014 to 2020 an estimated £34 billion investment could be required in our electricity networks and £7.6 billion across our gas networks, from 2014-2021.[2]

The Government has awarded 91 Local Authorities with almost £7 million in grant funding, to support £10 million of heat network development studies in the coming year. These projects could represent between £400 million to £800 million of capital investment opportunity over the next 10 years and will deliver the UK's third piece of significant energy network infrastructure.

The UK is rated the most energy secure country in the EU, and fourth in the world as a whole. The UK is now seeing some of the largest network infrastructure projects in Europe and we are in the process of making our networks, smarter and more intelligent and more resilient in the way they deliver energy. By 2050, smart grids will reduce the cost of additional distribution reinforcement by between £2.5 billion and £12 billion.[3] With a growing role for heat networks, some models show technical potential to supply as much as 43% of heat demand in buildings by 2050.

We have record levels of low carbon generation, from different locations and technologies. This is changing the availability and predictability of our generation capacity, with the introduction of more intermittent renewables, reducing the incentive for fossil fuel based capacity and increasing the need for storage based solutions. We are seeing changing flows of gas as we draw less on domestic reserves and are increasingly importing gas through interconnectors or liquefied natural gas (LNG).

Between **2010-14**, there has been over **£16 billion** of estimated investment in electricity and **£3.8 billion** in gas networks.[4]

The way we heat our homes and businesses is slowly beginning to change, with the increasing use of renewable heating systems like biomass boilers and electric heat pumps, albeit with gas set to remain dominant in heating for some time. Such changes will however impact on how our homes and businesses are heated and how we manage heat in the overall energy system. Over the coming years, we'll also see the accelerated take-up of electric vehicles.

Our network system will have to be more efficient. No longer can we afford to waste energy through poor management and infrastructure we need to take advantage of every single resource at our disposal. At the same time, we need to ensure our network is safe and resilient to a changing climate, including storms and flooding.

This transformation creates a huge network investment challenge, which if not met could severely undermine our energy security by increasing the risk of blackouts. It would hamper generation deployment and our ability to keep our energy flowing across the country, resulting in higher bills for consumers in the long run.

Record and Challenges

	Record	Challenges	Government action
Electricity	Since 2010, over £16 billion invested in onshore & offshore electricity networks	Ageing infrastructure unable to cope with changing generation and needs Increasing risks of blackouts, increased costs	Strengthen, upgrade and extend the network New, world leading regulatory regime to deliver investment, reduce costs and stimulate innovation Increase interconnected capacity with other countries – interconnectors eligible to participate in Capacity Market from 2015 Support for smart grids – £500 million to support the testing and trialling of new smart grid technologies
Gas	2010-14 £3.8 billion invested, c.11,500 jobs supported by investment in GB gas networks 2010-14 c. £1 billion invested in gas storage and import infrastructure, supporting 70 jobs 2010-14 c. £300 million invested to ensure safety and reliability of the National Transmission System, supporting c. 4,000 jobs each year	Increasing imports as domestic resources decline changing gas flows Increased variability from gas with renewable generation Ageing infrastructure, less safe and resilient	Efficient, safe and reliable service Ofgem introduced competition to drive down costs and improve customer service in gas distribution networks Government is working with European Commission to reduce Europe's gas reliance on major suppliers and increase resilience to geopolitical shocks Gas Network Innovation Competition offers up to £18 million per year for Gas network companies for the development and demonstration of new technologies
Heat	The value of the total UK district energy market is expected to rise from about £350 million in 2010 to about £530 million in 2015 This includes an increase in total capital investment from c. £115 million in 2010 to c. £215 million in 2015	Supply of heat from networks is starting from low base – currently only 2% of heat demand Lack of capability & capacity in Local Authorities who are instrumental in establishing heat networks Lack of low cost finance for Local Authorities Need for better design / innovation Lack of heat consumer protections	Established the Heat Networks Delivery Unit to support Local Authorities to develop heat network projects to become investable propositions – to date £7 million in grant funding supporting £10 million of heat network development studies Launched £7 million Small Business Research Initiative (SBRI) Heat Networks Demonstration competition Supported industry-led initiatives to improve consumer protections and technical standards

Between **2014** and **2020**, an estimated **£34 billion** of further investment may be needed in electricity and **£7.6 billion** in gas networks.[5]

While we respond to the challenges today, we must look to the future and prepare for an energy system that will look remarkably different to what we have today. A future with more diverse types and sources of generation, where more energy is generated locally and consumers have a greater role in how they manage their energy use. At the heart will be the need for flexibility, responsiveness and reliability in order to meet this challenge. We must look across all our energy networks and understand the interdependencies, barriers and solutions to producing the most integrated, efficient and resilient system to meet our future needs.

Our fossil fuel based system has met our needs but is carbon intensive. Technological advances mean more innovative and greener types of generation such as biomethane, low carbon hydrogen and gas from anaerobic digestion plants and deep geothermal can cost-effectively compete and give consumers more control over their energy management through the use of smart meters and community action. This will create different pressures on the system.

To deliver this, our networks will need to be reconfigured to make them smarter, more local and integrated – bringing together the use of electricity, heat and gas to maximise efficiency, reliability, reduce costs and respond to these differing needs. Smart grids and heat networks with the use of storage will play a central role. With a more multi-functional system able to join electricity generation, heating storage and demand-side response, the grid will be able to respond to the more flexible needs of our changing generation mix and habits.

Consumers will be able to play a more active role in sourcing and management of their energy through mediums such as smart meters and start to benefit from using energy at the cheapest times of the day. There will be significant opportunities for smaller, non-traditional players and communities to participate in generating, storing, transporting and selling energy, maximising competition and bring much needed diversity to the system, helping to reduce cost overall.

Government will not be complacent. We have a good record but need to do more to fully utilise the framework we have created for future. There are huge infrastructure projects to deliver, our links to other nations need to increase and the programme of modernisation to make our networks smarter and more responsive must continue apace. As we do this, we must continue to cut carbon emissions, drive efficiencies, decrease costs for consumers and exploit the potential wider economic benefits, including jobs and exports. Networks are the heartbeat of our energy system, they are the arteries through which energy flows, giving life to our homes and businesses. Their importance has been misunderstood and unappreciated for too long. This Government recognises the central importance they play and is taking the action needed.

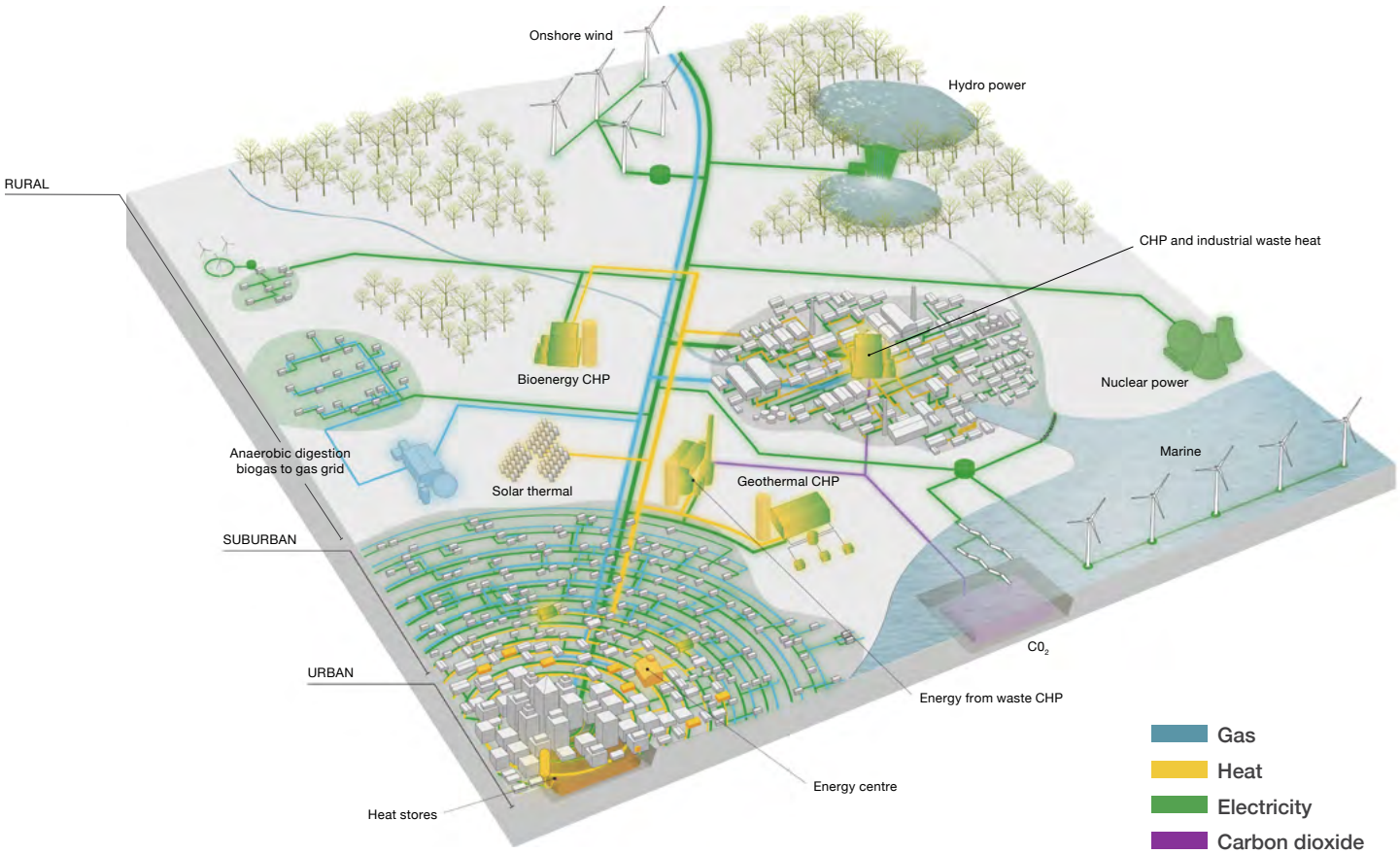
£400 million to **£800 million** of capital investment opportunity for heat networks over the next 10 years.[6]

Report coverage

The report sets out the essential components of a modern energy network – electricity, gas, and heat. For each section it examines the investment delivered, the challenges ahead and what this Government is doing to proactively achieve this, before concluding with a vision of what the future of networks might look like.

It builds on the Energy Investment Report published in July 2014[7], which provided a comprehensive assessment of the investment across UK energy, the investment challenges and opportunities in the future, while delivering our long term climate change objectives.

This report demonstrates the far-reaching reforms that Government and the regulator, Ofgem, have carried out since 2010 right across the energy network sector. These reforms, combined with a clear strategic direction from DECC mean that despite a challenging economic background, the UK is now recognised as one of the most attractive investment destinations in the world.[8]



Importance of heat in an increasingly integrated energy system. Courtesy, CHPA.

Electricity

The challenge

Strengthening our electricity network is critical for maintaining energy security and ensuring we can meet our wider energy needs. Whilst historically our network has been among the most reliable in the world, much of it was built in the 1950s and 1960s and designed for a different era. With rapid increases in renewable generation capacity – over £30 billion invested in electricity generation, principally in renewable technologies since 2010, with significantly more planned – and the first new nuclear stations coming on in a generation, our electricity network is no longer fit for our changing energy mix. If left, our ageing network would not have been able to cope. Much of the new low carbon generation would not have been able to connect, the network would be less resilient and vulnerable to flooding and storms, with greater threats of power interruptions, economic growth would have been impaired and long term costs to consumers higher. The Coalition Government understood this position and was clear that a significant programme of investment well beyond anything seen in recent history was required to strengthen, upgrade and extend the network, and make it smarter to ensure it was fit for purpose.

How we have fixed it

The investment has already begun. Since 2010, over £16 billion[9] has been invested in onshore and offshore electricity networks. Ofgem estimates that investment in onshore electricity transmission and distribution networks has increased by more than 20% between 2010-11 – 2013-14 and the previous four years.[10]

Government policy and a stable regulatory framework are creating the right conditions for investment in electricity networks. The pioneering new RIIO[11] regulatory regime is recognised as a world leader, helping to deliver investment, reducing costs to consumers and stimulating innovation. This is resulting in a larger, stronger and more reliable network. National Grid's transmission network is the most reliable network in Europe.[12] For distribution networks, on average, customers now experience 21% less time with power lost than in 2010.[13]

The GB electricity network is over **800,000km** long.[14]

Onshore

For the 2013-21 RIIO-T1 transmission price control, Ofgem has approved up to £21.5 billion (2009-10 prices) of funding for onshore transmission networks, supporting over 8,000 jobs in the sector.[15, 16] Transmission network companies are currently constructing major projects valued at around £4 billion which will deliver about 10 GW of network capacity by mid-2018.[17] For the 2015-23 RIIO-ED1 distribution price control, Ofgem recently approved funding of up to £24.6 billion (2012-13 prices) for the electricity distribution networks.[18]

With a changing climate action has also been needed to ensure the network is more resilient to severe weather. The storms and flooding of 2013-14 demonstrated the need to take further steps to ensure our infrastructure is able to function under pressure and local communities are protected. The storms and flooding of 2013-14 demonstrated the need to take further steps to ensure our infrastructure is able to function under pressure and protects local communities.

Caithness-Moray Transmission Link

In December 2014, Ofgem approved funding for a c. £1 billion transmission link between Caithness and Moray.[19] The new link is needed to transmit around 1,200 MW of electricity from renewable sources in the north of Scotland. Construction work is underway and is expected to be completed in 2018. The project will support over 600 jobs during construction.

Building the resilience of our networks: delivering rapid and effective solutions to the Winter 2013 storms

During the winter of 2013-14 almost 3 million consumers experienced power disruptions as a result of the high winds and severe weather, causing damage to over-head power lines and associated infrastructure.

Government undertook a review of network operator performance to identify lessons that would enable an improved response in future scenarios.[20] Whilst finding that the overall response to the event had been strong by industry (95.3% of disrupted customers had their supplies restored within 24 hours), 24 actions were identified for industry to implement. These covered the following areas:

- Weather forecasting;
- Engagement and information provision to customers;
- Engagement with the media;
- Welfare provision;
- Resource management and deployment; and
- Goodwill payments to disrupted customers.

A key part was the agreement of energy suppliers to provide network operators with customer contact details to facilitate easier communications during disruptive events.

All actions have now been implemented, and a closure report was published in December 2014. The network operators have made improvements to ensure that the response to disruptions this winter will be more effective and efficient.

The Energy Networks Association is leading a programme to implement a three digit national telephone number for use during disruptive events to provide easy and timely access to information – this is expected to commence in April 2016.

Flooding resilience improvements

Following the significant flooding experienced in 2007 in the south Midlands and south Yorkshire, and the subsequent Pitt Review[21], National Grid and the Distribution Network Operators have invested significantly in flood mitigation work on at risk infrastructure. This has included the development by the Energy Networks Association, in 2009, of Engineering Technical Report 138, which sets out the standards of flood mitigation to be applied at substations, taking into account the cost/benefit assessment for each site. Ofgem approved £112 million of investment in distribution network flood mitigation for the 2010-15 price control period. Examples of this investment include a £2 million flood barrier installed around a 132-11KV substation in West Ham by UK Power Networks, completed in May 2013, and £7.3 million invested by Electricity North West in 31 substations to build flood defences, install pumping equipment and to waterproof specific vulnerable equipment. As a result of this additional investment by industry, no significant transmission or distribution network energy infrastructure was flooded during the extreme weather events in 2013-14.

Around **£34 billion** of investment in onshore and offshore networks may be needed to **2020**.[23]

Offshore

Within offshore networks, the innovative and competitive offshore transmission regime that the Government and Ofgem have put in place has secured significant investment[22] in the connections to offshore generation. Eleven offshore links worth £1.9 billion have already been tendered, including the £459 million connection to the world's largest operational offshore wind farm, London Array (Phase 1). A further four projects worth £1 billion are in the tender process. Our competitive approach has already proven highly successful at tapping new sources of finance and driving significant savings for generators and consumers.

Our level of interconnection to other countries has also increased, with projects valued at around £1 billion being delivered since 2010. This brings our current interconnection capacity to 4 GW.

What we need to do

Whilst significant investment has already taken place, much more is needed. Between 2014 and 2020, we estimate a further £34 billion in electricity network investment may be required.[24] Significant infrastructure projects still need to be delivered. The network needs extending further to connect up new locations and types of generation while reinforcement is needed to resolve constraints. This includes strengthening the onshore network between Scotland and the rest of Great Britain whilst offshore we expect further connections to be tendered as Round 3 offshore wind projects reach completion.

This investment will inevitably mean new physical infrastructure needs to be built, but as we do so we are also making design improvements to mitigate the impact on the environment and local communities, such as taking steps to hide lines. Ofgem has allowed £500 million for transmission network companies to mitigate the visual impact of existing lines in specified areas.[25]

CASE STUDY

Innovation in transmission: T-pylon

The T-pylon is the latest addition to UK pylon designs and is expected to be built for the first time in March 2015. The T-pylon was chosen from among 250 entries in an international design competition initiated by DECC and National Grid. The T-pylon's low-height and sleek design provides another way to reduce the visual impact of energy infrastructure. Contracts of around £5 million to supply six structures at National Grid's training centre at Eakring have been awarded to British manufacturers, including Mabey Bridge. Further procurement open to UK and overseas manufacturers will ensure best value for consumers.

Government is working with Ofgem to increase competition, which can help drive down costs and drive up customer service. Ofgem has proposed introducing competition for large discrete onshore transmission projects, which could bring further opportunities.[26] Within distribution connections, more independent providers are entering, increasing competition. In 2010-11, only 14 per cent of connections to distribution networks were carried out by independent connection providers. By 2013-14, this had increased to 32%.[27] Competition in offshore transmission networks has saved £200-£400 million to date.[28]

Action has already been taken to help improve the process of connecting to the network for distributed generation and homes and businesses. All distribution network companies have committed to reducing connection times, driving up customer service and offering smart connection offers that enable customers to connect more quickly at a lower cost. Ofgem is introducing new incentives into the price control process to help reduce times to connect and drive up customer service, in addition to the existing guaranteed standards of performance. Government has also established a community energy grid working group to explore barriers further and recommend solutions, and continues to work with industry and Ofgem more generally, to look at whether more can be done to ensure connections do not act as a barrier to our renewable energy and economic ambitions. Specific areas include looking at extending the scope of the second comer regime, supporting consortia as a means of sharing connection costs and considering whether steps can be taken to increase investment ahead of need in a way that protects consumer bills.

T-Pylon, artists impression. Courtesy of National Grid

Smart Grids bring significant economic benefits, including an estimated **£13 billion** of Gross Value Added between **now** and **2050**.[32]

Smart grids

In addition to conventional reinforcement, we are also making the system smarter. Smart grids will enable us to manage a changing energy system more efficiently at lower cost, providing a more resilient network that enables a much more diverse range of players to enter the market. This will bring innovative ways of balancing supply and demand through increased use of demand side response and energy storage.

Whilst many of the smart grid benefits will not be realised until the 2020s and beyond, it is vital that we act now. Ofgem's new RIIO Price Control model places greater emphasis on supporting network innovation and the commencement of the £500 million Low Carbon Networks Fund in 2010 supports the testing and trialling of new smart grid technologies and solutions. Great Britain has also begun the nationwide rollout of smart meters, which will help improve network management and facilitate demand shifting. We are also investing in energy storage and demand side response. In 2014, Government confirmed that both would be eligible to participate in the Capacity Market. DECC is providing innovation support to reduce storage technology costs to assist wider deployment. Seven research and four large-scale demonstration energy storage projects have benefited with a total budget of about £18 million.

Great Britain has already made significant progress and is now recognised as a European leader in smart grids.[29] Smart grids are already starting to deliver tangible benefits to consumers; through the RIIO-ED1 distribution settlement, the distribution network companies and Ofgem included nearly a billion pounds of savings to consumers through the rollout of smart grids over the coming years.[30] Beyond this, it is estimated that by 2050 smart grids will reduce the cost of additional distribution reinforcement by between £2.5 billion and £12 billion.[31] Increasingly network companies are actively managing generation at the local level, providing smart connection offers that enable generators to connect more quickly and at lower cost. This early start means that the UK is well-placed to lead the world and export its learning and expertise to other markets.

£5 billion of private sector investment in the pipeline to 2020, more than doubling our interconnection capacity and delivering savings to GB consumers of up to **£9 billion**.

Interconnectors

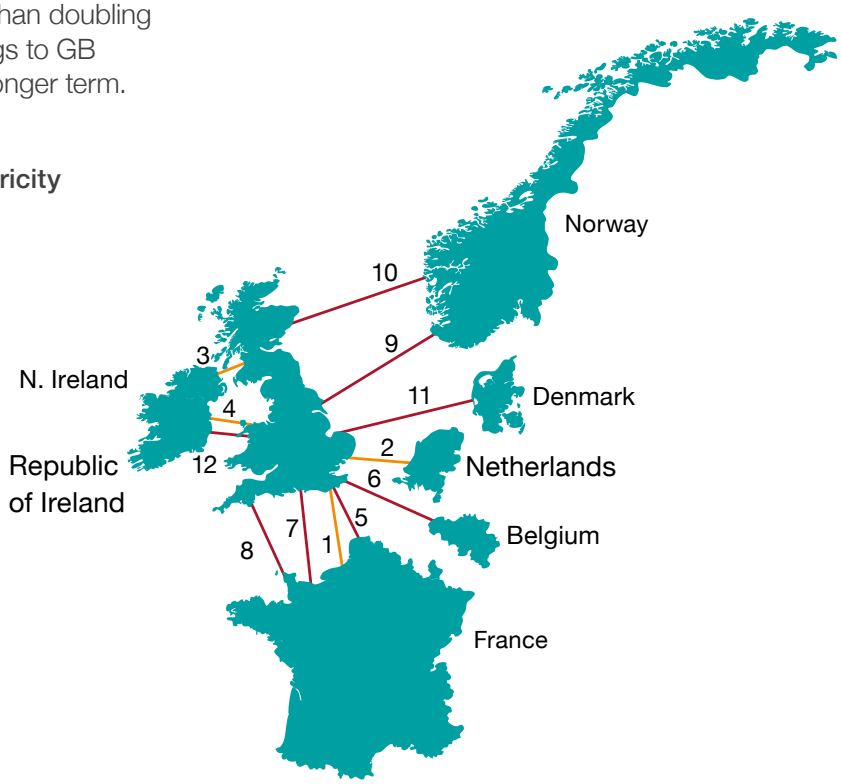
Our network also needs to be more integrated with neighbouring markets. Increased interconnection will support our energy security, affordability and decarbonisation objectives, including through facilitating the single European electricity market. Government has announced that interconnectors will be able to participate in the Capacity Market from 2015[33] and Ofgem has introduced a new regulatory regime to bring forward interconnector investment in the consumer interest. Together these steps send a strong signal to potential investors and have helped deliver a strong pipeline of projects. Government estimates that we could see around £5 billion[34] of private sector investment to 2020, more than doubling our current capacity and delivering savings to GB consumers of up to £9 billion[35] over the longer term.

Three GB interconnection projects were recently granted €40 million of EU funding.[36] This includes NSN linking us to Norwegian hydropower, ElecLink utilising existing Channel Tunnel infrastructure and FAB with the potential to connect to tidal generation off the Alderney coast. Government will continue to work with our international counterparts, developers and regulators to support timely investment decisions. Three projects – NEMO to Belgium, NSN to Norway and Eleclink to France – are due to take Final Investment Decisions in 2015. Behind these there are further projects in earlier stages of development, including a potential link to Icelandic low carbon energy.

Map of existing and proposed GB electricity interconnection projects

Existing Interconnectors
1. IFA – 2GW
2. BritNed – 1GW
3. Moyle – 0.5GW
4. East-West – 0.5GW

Mature proposed interconnector
5. Eleclink – 1GW
6. NEMO – 1GW
7. IFA2 – 1GW
8. FAB – 1.4GW
9. NSN – 1.4GW
10. Northconnect – 1.4GW
11. Viking – 1.4GW
12. Greenlink – 0.5GW



BritNed. Courtesy of National Grid

CASE STUDY

North Sea Network (NSN) Interconnector

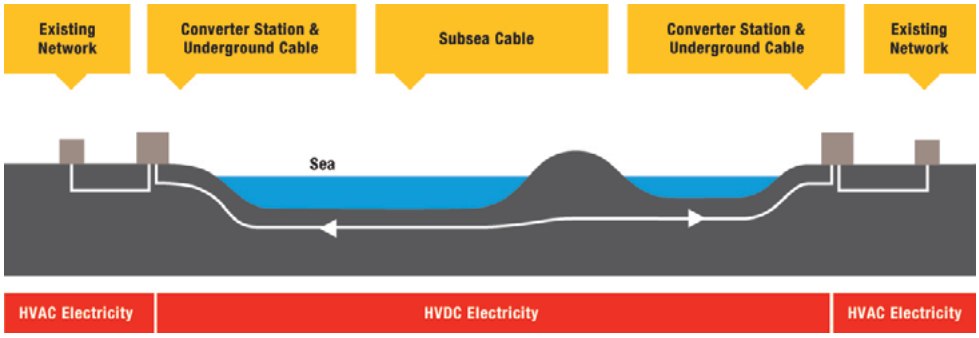
The NSN is a proposed 1.4 GW link to Norway.

In October 2014, the Norwegian authorities granted a licence to the project and Ofgem has now launched a consultation on the project.

It is being developed by National Grid and Statnett and, subject to the regulatory settlement, is expected to reach Final Investment Decision in early 2015.

When completed in 2020, it will be the longest subsea interconnector in the world at 730km.

How does it work?



Why link up?

Connecting the Norwegian and British markets through NSN means electricity can be traded more efficiently. The diversity between GB and Norway's generation portfolio creates mutual benefits which can drive down prices for consumers in both markets.

Norwegian power generation comes predominantly from green hydropower produced from large reservoirs. The levels of these reservoirs change according to the seasons and over time. Hydropower is very flexible and able to respond rapidly to changes in demand.

The link can help optimise the use of renewable resources between GB and Norway: GB can call on flexible Norwegian hydropower when wind generation is low in GB; when demand is low in GB but GB wind generation is high, power can flow to Norway to help Norway manage its reservoir levels.

NSN has the capability to respond within seconds to ensure that it provides the right amount of energy in the right direction at the right time.

Gas

The challenge

Investment in gas infrastructure is required to deliver safe, reliable and affordable gas across Great Britain. This gas is landed from our North Sea resources and from import points from international suppliers. The UK uses this gas in power stations, industry, and for heat in our homes and businesses.

Domestic gas production from the North Sea has been in decline over the last decade and current projections to 2030 expect this trend to continue. As a result, the UK has been a net importer of gas since 2004.

This crucial change required a structural shift in how gas is brought into the country with new developments to compensate for decline in domestic production. Industry brought forward new connectivity to global markets and increased storage.

This shift creates additional challenges for the gas transmission and distribution networks. The transmission network now has to deal with changing gas flows around the country and electricity generation from gas is set to become increasingly variable as renewable generation grows.

We also have the challenge of ageing assets. The UK has a mature gas market with ageing infrastructure. Ensuring gas can still reach consumers safely and reliably means a thorough programme of maintenance and replacement of assets where they are no longer fit for purpose.

As we look to the future, gas will continue to be an important part of the energy mix to 2030 and beyond. Network investment is primarily focused on ensuring an efficient, safe and reliable service; and a sustained lack of investment could lead to inefficient and even unsafe operation. The continued importance of imports and potential growth of gas use in heavy goods transport could present significant opportunities for investors in import infrastructure and storage.

How we have fixed it

The market has responded to the challenge of a growing need for gas imports with the construction over the last ten years of four liquefied natural gas (LNG) terminals, a pipeline from the Netherlands and three pipelines from Norway. The UK has two of the largest LNG facilities in Europe: South Hook and Isle of Grain. Four gas storage sites have come online and two more are currently under construction. Since 2010 alone, around £1 billion has been invested in import and storage infrastructure supporting around 70 jobs.[39]

Between **2010** and **2014** around **11,500 jobs** were supported by investment in **GB gas network** companies.[38]

Storage facts

- The UK already has 4.6 bcm of gas storage capacity and 154 mcm/d of storage deliverability.
- Two more projects are currently under construction. When complete, these will add 0.5 bcm and 45 mcm/d to deliverability.
- There are 11 further gas storage projects with planning permission but where no Final Investment Decision has yet been taken. At the moment, these projects are thought to total 14 bcm of gas storage capacity.[40]

For gas flowing across the UK, National Grid is responsible for the upkeep of the National Transmission System (NTS), which transports large volumes of gas across the country to the distribution networks and major consumers, like power stations. Around £300 million was spent between 2010 and 2014 to ensure the continued safety and reliability of the NTS, supporting on average around 4,000 jobs each year.[41] Ofgem has also approved National Grid's £1.2 billion investment in the NTS between now and 2021, forecast to support 4,500 jobs a year.[42]

CASE STUDY

Improving UK energy security through gas storage investment. Stublach, Cheshire (Storengy).

The gas storage site at Stublach, Cheshire, is a £500 million investment by Storengy, a subsidiary of GDF Suez. The first caverns opened for commercial business in September 2014 and the site will expand sequentially until 2020. The project will ultimately consist of 20 caverns.

By 2020, up to 400 mcm of gas could be stored at Stublach. This will be the largest onshore gas storage site in the country, representing 8% of total UK storage capacity. Stublach will play a valuable role in meeting peaks in gas demand, particularly as the UK electricity mix incorporates more intermittent renewables.

The **GB Gas Transmission Network** has a reliability rating of **100%** and the distribution network has a rating of **99.999%.**[37]

CASE STUDY

Maintaining a reliable gas transmission system. National Grid's replacement works below the River Humber.

An important section of pipeline brings gas from the Easington import terminal, where gas lands from Norway and the North Sea, to the NTS. Some of this pipeline passes under the River Humber and, over time, the tide has eroded the river bed and exposed sections of the pipe.

National Grid has already put in place a short-term solution and encouraged the settlement of sand over the pipeline. However, in the long term, National Grid has decided to replace the pipe with a new tunnel running for 7km. This is expected to be constructed and become operational between 2017-21.

Four regional network operators are responsible for the maintenance and development of the eight capillary-like distribution networks, which take gas from the NTS to our homes and smaller businesses. These companies, operating across the UK, spent around £3.5 billion between 2010 and 2014, supporting on average 7,500 jobs a year.[43]

Ofgem has introduced competition to help drive down costs and improve customer service in gas distribution networks, where independent companies are permitted to connect customers and develop, operate and maintain local networks. Competition in the gas connections market remains strong. Over half of new and modified gas connections are carried out by independent providers, and it is estimated that one million consumers are connected to independent gas networks.

Courtesy of National Grid

US Chamber of Commerce *International Index of Energy Security Risk* (2013) ranks the **UK 4th** among **25** Large Energy using Countries (2012).[45]

What we need to do

Government is committed to the development of UK-based gas reserves through maximising economic recovery of gas from the UK Continental Shelf (UKCS) exploring the potential of unconventional gas sources (e.g. shale gas) and promoting the development of biomethane. Although these sources combined are unlikely to result in UK gas independence, maximising their economic use will reduce our potential exposure to import dependency. Therefore we need to continue to make sure the system is able to make the best use of these sources.

Government is working with the European Commission to take forward the European Energy Security Strategy.[44] This Strategy is designed to reduce Europe's gas reliance on major suppliers and increase resilience to geopolitical shocks.

The needs of the gas and electricity system will be kept under review and are informed by National Grid's annual Future Energy Scenarios[46] and Gas Ten Year Statement[47], which will predict the possible future development of the grid under credible scenarios.

CASE STUDY

Tackling fuel poverty

Wales and West Utilities has connected 2,632 fuel poor consumers to the gas grid this year as part of the Fuel Poor Network Extension Scheme. There is estimated to be an energy saving of £1.3 million a year – and 280,000 tonnes of lifetime carbon saving.

Innovation

Ofgem also incentivises network companies to improve GB's gas networks further in innovative ways. As the case studies show, these often focus on areas that incur the highest consumer costs or benefits.

The Gas Network Innovation Competition (NIC) offers up to £18 million per year for gas network companies to compete for funding for the development and demonstration of new technologies, operating and commercial arrangements. If successful, the companies are obliged to share their learning so that all network users can benefit from the innovation.


Oban

CASE STUDY

Opening up the gas market (NIC 2013)

This project aims to determine whether a different specification of gas to the one currently in use can be safely applied in Great Britain. If successful, this project could open up the gas market to a wider range of gas sources which are currently prohibited by the Gas Safety (Management) Regulations (GS(M)R).

To test the feasibility of applying the wider gas specification to GB, Scotia Gas Networks propose to inject non-GS(M)R gas into a physically separate gas network in Oban. A funding of £2.2 million has been awarded for the project.

CASE STUDY

Low carbon gas preheating (NIC 2013)

Northern Gas Networks is planning to undertake a comprehensive field trial of existing and alternative technologies which are used to preheat gas at pressure reduction stations. This technology is used to avoid freezing the outlet pipework and ensure continuity of supply. Currently, this process is a significant contributor to the carbon footprint of business. The trial will monitor and record energy performance, including overall efficiency, carbon emissions and thermal losses data, under a range of operating conditions. A funding of £4.9 million has been awarded for the project's life.


Hot steam: Courtesy of National Grid

A key challenge will be carefully managing changing resources whilst ensuring value for money for customers.

CASE STUDY

Keyhole technology

National Grid Distribution can now drill a 600mm hole in the road, remove a core and vacuum the debris to expose the gas pipe underneath, all with one vehicle. Works can be completed above ground, reducing the safety risk to employees. This new vehicle was unveiled in September 2013, and can now locate a leak, repair it and reinstate it within a day, as opposed to over a week. Many of these vehicles are now in operation across National Grid, saving time, money, and reducing disruption to customers and communities.

Courtesy of National Grid

Gas networks in the future

The Government's Heat Strategy sees a reduced role for gas in heating in the future, particularly in urban areas, and a key challenge will be to carefully manage changing networks in these areas to minimise the disruption and cost to consumers. However, particular areas of the country could see a strong role for gas networks in the long term, especially in those areas where geographical features make networks a necessary part of future options. This will not be limited to natural gas. For example, future pre-combustion carbon capture and storage plants on the east coast could produce significant volumes of hydrogen overnight when it is not required for electricity production, and this could be fed into local grids to provide low carbon heat. We are working with industry to establish a low carbon production standard to help facilitate this transition. In rural areas, biomethane plants feeding into local grids could be a key part of the solution – and the Renewable Heat Incentive has already helped deliver over 80 GWh[48] of this next-generation fuel source.

Heat

The challenge

Nearly half the UK's energy use is for heating. Space heating and hot water for buildings account for 19% of the UK's carbon emissions.[49] We will need to radically decarbonise building emissions in the next 35 years in order to meet our climate change ambitions.

Whilst individual gas boilers have historically been the most common form of heating and hot water provision in the UK, heat networks have also been supplying UK customers for many years in areas with high levels of heat demand, such as inner cities. Heat networks became popular in the UK during the 1960s and 1970s but have since declined in popularity due to different types of housing stock, and a poor track record for some early schemes. Over the past decade, as gas prices have risen, and Local Authorities have looked to cut carbon emissions and address fuel poverty, the case for heat networks has strengthened. Despite only supplying 2% of heat demand currently[50], there is enormous potential for this to expand. A study by BSRIA in 2013 predicted that the value of the total UK district energy market would rise from about £350 million in 2010 to about £530 million in 2015. This includes an increase in total capital investment from c. £115 million in 2010 to c. £215 million in 2015.[51]

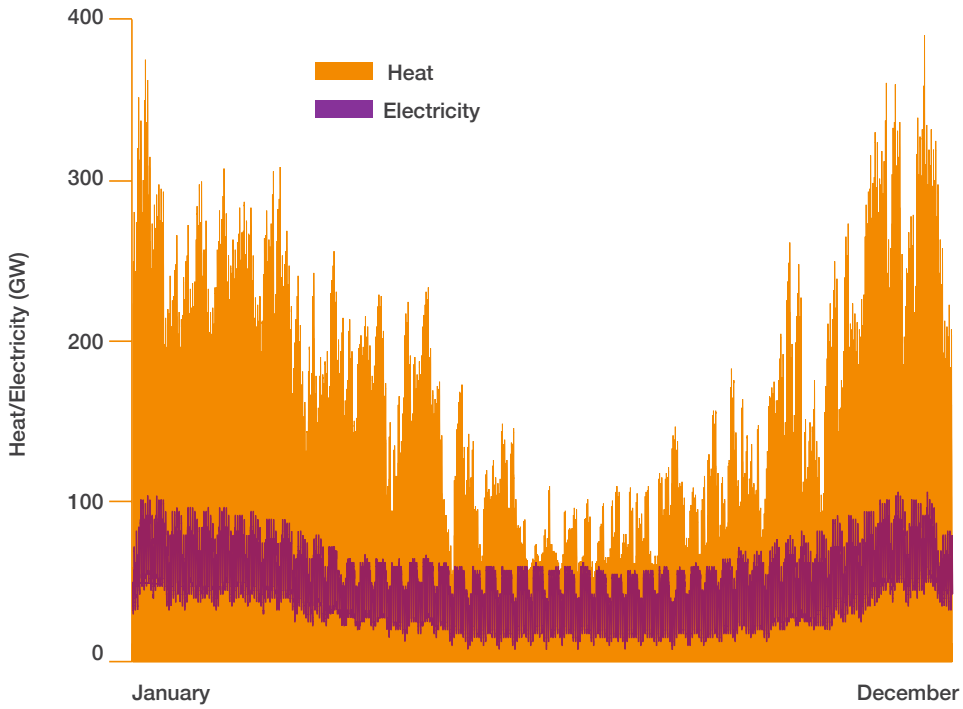
A heat network is a set of insulated pipes that take heat from a central source to supply heating and/or hot water to buildings. Well designed and operated heat networks can be more efficient, reduce carbon emissions and lower costs to consumers than the traditional fossil fuel-based heating systems. A heat network is essentially a distribution infrastructure and as such the system itself can work with any technology. Heat can be taken from different sources including rivers, geothermal, industrial waste heat, sewage works and can also be amplified by a heat pump. Low carbon and renewable fuels such as biogas, biomass and household waste can be used in boilers or by combined heat and power plants if electricity is also needed. Not only can lower temperature, lower cost and lower carbon heat sources be used, but large heat sources, such as energy from waste, can also be accommodated as demand is aggregated through a network. A heat network can also incorporate a heat store to a much larger extent than tanks in individual buildings, which can help manage intermittent supplies of heat until the demand sets in.

Heat store, Bunhill Heat and Power, courtesy of Islington Council

Heat networks can provide a valuable service to the electricity grid, storing and balancing, and improving the resilience of the overall energy system.

On a day by day basis, electricity demand is small and relatively constant compared with heat demand (see graph). With the potential future electrification of our heating and transport system, electricity demand could become increasingly variable, putting a very high premium on storage and network balancing. This is an area where heat networks can provide a valuable service to the electricity grid, storing and balancing, and improving the resilience of the overall energy system. A heat network with combined heat and power can sell electricity to the grid when demand outstrips supply and excess heat generated can be captured in a heat store on the network for later use. Conversely, with an electric heat source on the network, e.g. a heat pump or hybrid boiler, excess electricity on the grid could be converted to heat and stored for when the heat customers require it. This is a system which is already in operation in some Scandinavian countries.

Deployment of heat networks has been slower in the UK than other markets due to a range of barriers that the Government is working hard to address. Until recently, there has been no real assessment of the potential for heat networks and no clear strategic vision for their development.



Courtesy of Imperial College, London

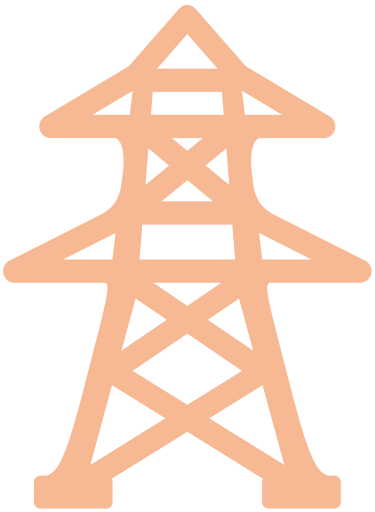
Well-designed heat networks can help to reduce carbon emissions, reduce heating bills and tackle fuel poverty, as well as contributing to energy security.

How we've fixed it

This Government has made a clear statement of support for heat networks, stating in its 2013 document *'The Future of Heating: Meeting the Challenge'* that heat networks have a vital role to play as a cost effective and flexible means of decarbonising heating, especially in towns and cities. Well-designed heat networks can also help to reduce heating bills and tackle fuel poverty, as well as contributing to energy security through an integrated energy system. Heat networks can also play an important role in supporting local jobs and growth. The potential scale of heat network growth is enormous. Some models show technical potential to supply as much as 43% of heat demand for buildings through networks by 2050.[52]

To make that strategic vision a reality, Government is now laying the groundwork for a significant expansion of heat networks. Local Authorities have a key role to play in making heat networks succeed at all stages of their development and final use. Local Authority involvement can help realise the benefits of heat networks and can retain benefits locally, delivering jobs and growth.

Building on the support provided to seven urban areas through the City Deals programme which began in 2012, the Government now offers support to Local Authorities through the Heat Networks Delivery Unit (HNDU) which combines grant funding with expert guidance.



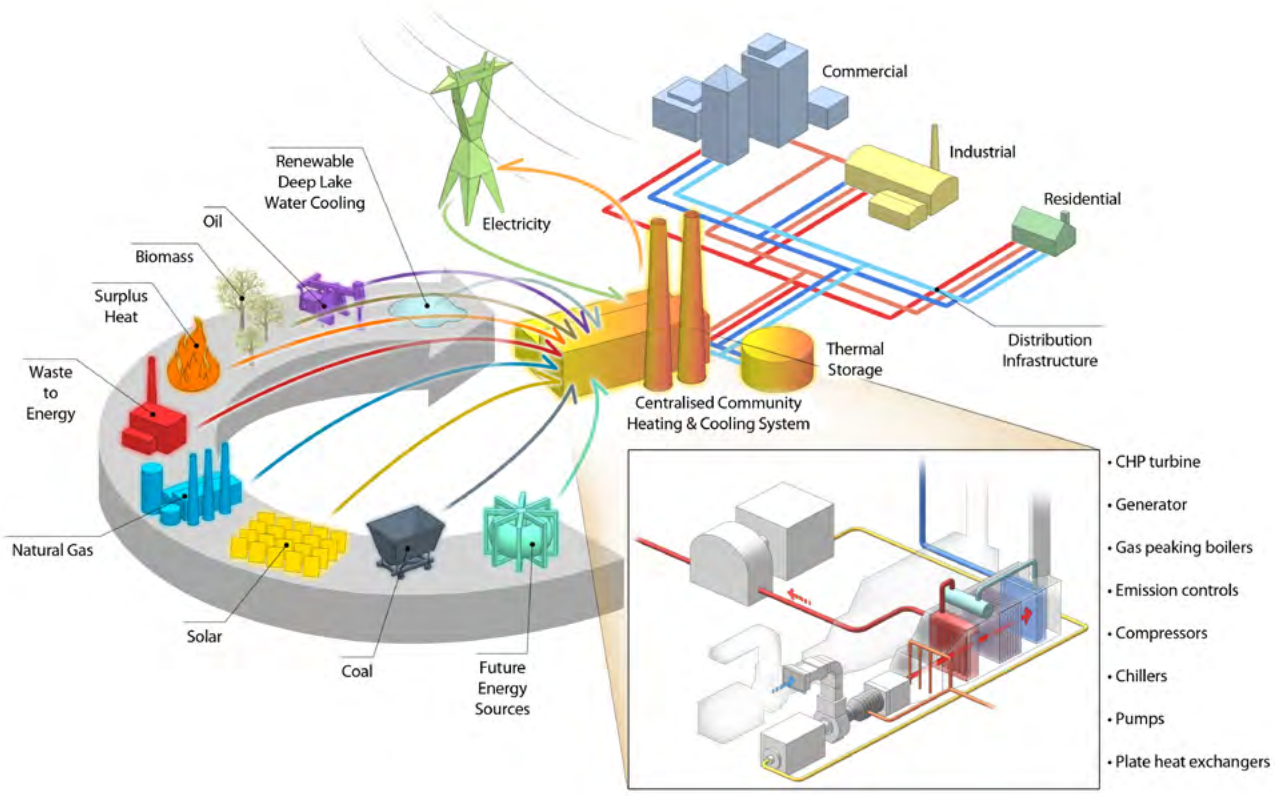


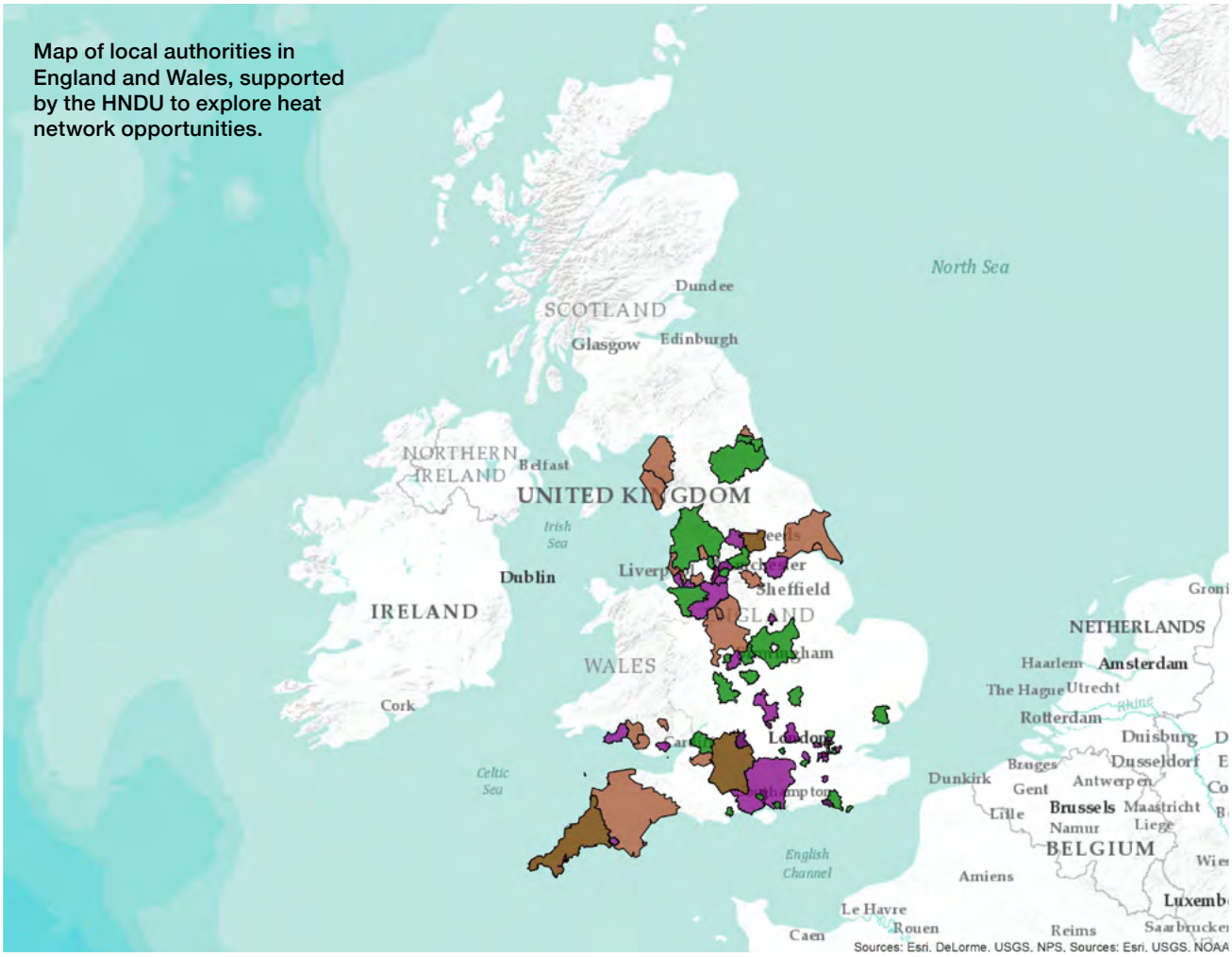
Illustration of a heat network using a variety of energy sources to produce hot/cold water in a centralised energy centre and distributed to a variety of buildings for heating, cooling and/or hot water, courtesy of AEI/Affiliated Engineers, Inc.

Funding of feasibility studies for future network projects

DECC's vision is for heat networks to play a critical role in providing affordable decarbonised heat and improving security of supply. The Heat Networks Delivery Unit (HNDU) was established in 2013 to address the capacity and capability issues faced by Local Authorities in England and Wales when exploring opportunities for heat networks. This innovative support unit combines grant funding with guidance from a dedicated team of commercial and technical specialists with a wealth of experience in developing heat networks, recruited into the department to work as critical partners to Local Authorities.

HNDU is currently supporting 122 projects in 91 Local Authorities (see appendix) with almost £7 million in grant funding awarded, to support £10 million of development studies in the coming year. This number is set to grow as the fourth funding round closed for applications on 27 November 2014. The portfolio of projects supported explore a range of commercial models and technical solutions for delivery of heat including heat sources not suited to individual properties but that require a network to exploit them or to optimise their usage.

Longer term, the ambition is that schemes will join and expand to form a new generation of citywide networks, commercially financeable, which will bring reliable, controllable and low cost low carbon heat to homes and businesses across the country.



Map of local authorities in England and Wales, supported by the HNDU to explore heat network opportunities.

The Heat Networks Delivery Unit is currently assisting **122 projects** in 91 local authorities with almost **£7 million** in grant funding awarded, to support **£10 million** of development studies in the coming year.

What we need to do

Government-commissioned research has confirmed that competing priorities, compounded by a lack of familiarity with the market and its commercial potential, have to date limited the capital available for building heat networks.[53] However, the UK is a particularly attractive market for this heating solution, having a larger number of more densely populated centres than countries such as Denmark, Sweden and Finland which already have far higher heat network penetration. The current technology development stage gives us a commercial opportunity to pioneer more advanced systems bespoke to the UK, leapfrogging other markets.

On the cusp of huge growth in deployment levels, heat networks can become the UK's third piece of significant energy infrastructure, after the gas and electricity grids, which presents an exciting opportunity for investors and supply chain to shape this evolution. Beyond initial development capital, it is likely that significant investment opportunities for financing and project aggregation will follow.

Government support and the willing engagement from Local Authorities are creating a significant investment opportunity for heat networks in the UK. The portfolio of HNDU projects alone could represent between £400 million to £800 million of capital investment opportunity over the next 10 years (on an assumption of 25% to 50% of current projects coming to fruition).[6] This estimation does not include heat networks being developed by other means e.g. the private sector, nor future projects supported by further HNDU funding rounds.

To move towards this future, further initiatives are underway that will increase certainty of heat load and reduce costs and risks for investors, such as industry-led technical standards and the industry-led Independent Heat Customer Protection Scheme, to drive up quality of design and consumer service. In addition, a £7 million heat networks demonstration programme aims to stimulate innovation that will help address cost and performance efficiency challenges related to heat networks.

The Green Investment Bank (GIB) has identified heat networks as a potentially important part of their energy efficiency strategy. GIB could therefore be instrumental in establishing funding models and attracting other investors to participate. Local Authorities might choose to retain part or full ownership of their schemes e.g. using financing from the Public Works Loans Board.

The potential scale of heat network growth is enormous. Some models show technical potential to supply as much as **43%** of heat demand for buildings through networks by **2050**.

Investment opportunity	Central Government investment	Market
HNDU grant funding to Local Authorities	£7 million (to date)	£3 million
Innovation (Heat Networks Demonstration: Small Business Research Institute, SBRI)	£7 million (over 2014-15 to 2015-16)	
Capital investment opportunity for heat network build		25% conversion rate **£0.4 billion** 50% conversion rate **£0.8 billion**

A study by **BSRIA** in **2013** expected the value of the total UK district energy market to rise from about **£350 million in 2010** to about **£530 million in 2015**.[51]

CASE STUDY

Sutton became the first 'One Planet' borough in 2009 when it worked with BioRegional to develop a 'One Planet' plan to give residents a better quality of life and boost the local economy while radically reducing the borough's negative impact on the environment.

The Council has set itself an ambitious target of becoming a zero carbon borough as early as 2025.

As part of this planning, Sutton Council is investigating the feasibility of heating homes and businesses via a heat network using energy generated by the planned Energy Recovery Facility in Hackbridge.

The facility plans to open in 2017. It will take up to 302,000 tonnes of non-recyclable waste from Sutton, Croydon, Merton and Kingston every year. The heat generated could ultimately serve around 19,000 homes (20% of Sutton households) and save 10% of Sutton's CO_2 emissions.

CASE STUDY

London Borough of Islington: Bunhill Heat and Power supplies local residents and businesses

Bunhill Heat and Power is a ground-breaking scheme retrofitting district heating to existing buildings in an inner-city environment. Completed in 2012, the first phase of the network serves over 850 homes, two leisure centres and a new housing development. It provides cheaper, greener heat to residents, helping to provide a buffer for residents against rising fuel prices and delivers CO_2 savings of around 60% for the existing buildings compared to their previous heating systems.

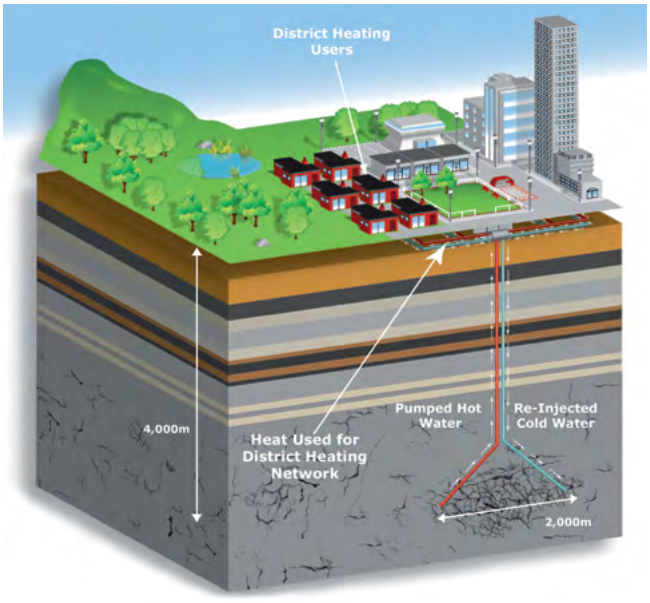
Islington Council is looking to expand the network in 2017 to connect additional homes and capture low carbon and renewable heat from local sources such as the London Underground network. Islington was awarded HNDU grant funding in 2014 to further explore expansion opportunities for Bunhill Heat and Power, and to support the update of the Borough and Bunhill specific heat network masterplans.

CASE STUDY

Stoke-on-Trent District Heat Network to be supplied with deep geothermal energy

The Stoke-on-Trent and Staffordshire City Deal is built around a flagship proposal for the UK's first at-scale, heat network system that takes advantage of local deep geothermal energy. The proposal forms part of the City's Low Carbon Task Force that is driving the transition to increased energy self-sufficiency and sustainability.

With a total expected investment of £52.4 million, of which £20.2 million will be funded from Government through the City Deal, the project will supply 45 GWh per year to a range of consumers. The scheme is expected to lower heating costs by up to 10% and save around 10,000 tonnes of CO_2 per year when it is completed in 2019. Phase 2 of the scheme has wider ambitions for sustainable energy across Stoke-on-Trent including opportunities to use mine water and waste industrial heat.



Geothermal diagram, courtesy of GT Energy Uk Ltd.

Vision for the future

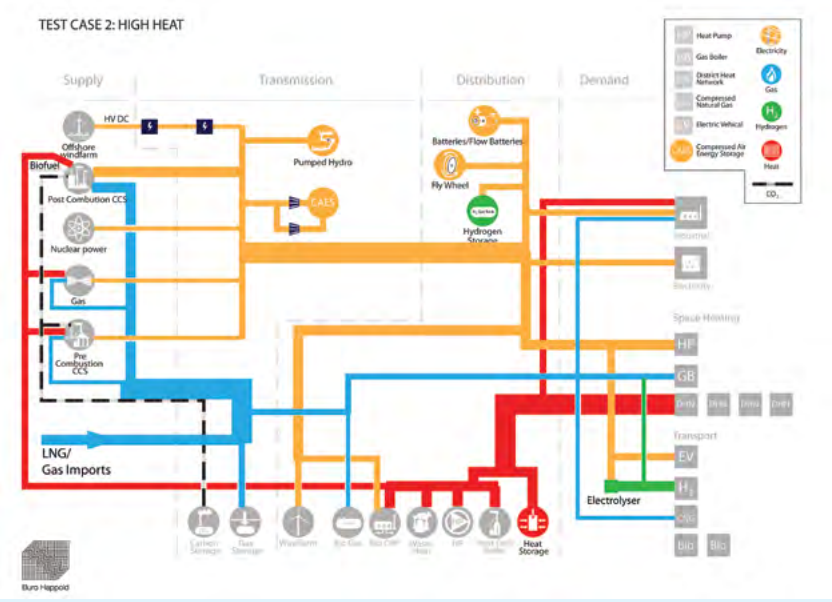
Whilst it is vital to secure the investment needed for our current needs, the Government is also looking to the future – a future with a much more integrated energy system. This will involve changing patterns of energy usage, types and locations of generation and storage capacity, and a strong focus on system efficiency. All of these changes mean potentially very large changes to the way our networks need to be designed and function.

CASE STUDY

The Energy Technologies Institute (ETI) vision of an integrated energy system

The ETI have produced a cost data tool capable of assessing the relative merits of different infrastructure options with different energy generation and demand scenarios. It can identify possible areas where future technology development could significantly influence future cost and performance.

The diagram shows the main implications for wider energy infrastructure where a high use of heat is used. The thickness of the lines indicates the relative importance of each type of infrastructure, with waste heat captured and used demonstrating the potential to be the most efficient use of primary energy in 2050.



Innovative alternatives to **natural gas**, such as **biomethane**, **low carbon hydrogen** and **gas** from anaerobic digestion plants are potential ways of maintaining the existing gas grid while **reducing** our reliance on **fossil fuel gas**.

The energy system of the future will include new and innovative greener low carbon technologies for generating electricity such as wave and tidal generation and deep geothermal. It will involve a great expansion in heat networks to meet our heating needs, allowing for the exploitation of secondary heat sources such as recovered heat from industry, power generation, infrastructure and waste processing, as well as direct renewable heat like deep geothermal, and water-sourced heat pumps. These technologies and methods all exist today but so far are limited to small pilots or vanguard projects. They will need to become mainstream. In addition, innovative alternatives to natural gas, such as biomethane, low carbon hydrogen and gas from anaerobic digestion plants are potential ways of maintaining the existing gas grid while reducing our reliance on fossil fuel gas.

In the future our electricity mix will no longer be dominated by a small number of large generators and we expect to see a growth in the deployment of generation at the local level, where generation and heating can be delivered through a more integrated system which will also deliver storage. Demand-side response will be needed to help with the grid balancing challenges the system will increasingly face. At times of excess generation the system will be able to use storage facilities through heat tanks on the heat network, or through the creation of low carbon hydrogen. There is likely to be a closer link between electricity, heating and transport as all three can no longer rely on the combustion of fossil fuels as their main energy source. Water and waste management may also become part of the same integrated system, as well as the removal of CO_2 from power and industrial plant where fossil fuels continue to be used.

At the same time, the way we use energy will change. Consumer choice and technological advances will mean that consumers are no longer the passive recipients of an energy system which only flows in one direction.

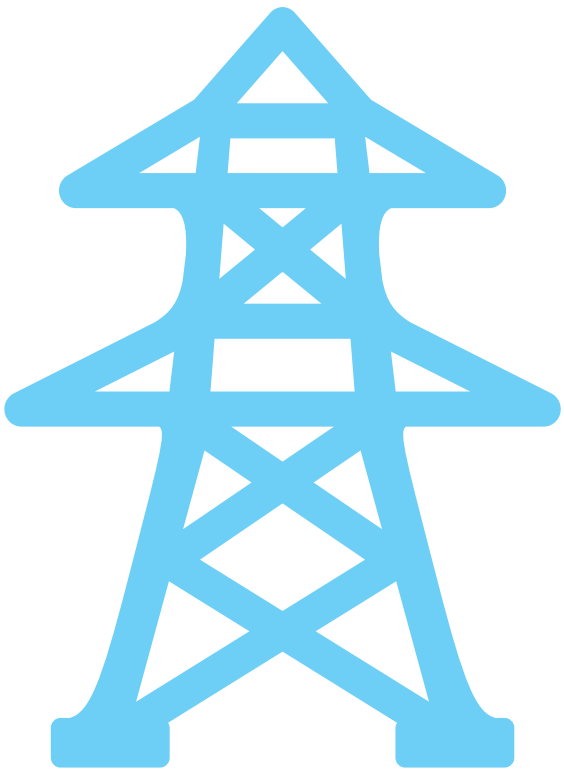
DECC is currently supporting **7** research and **4** large-scale technology demonstration energy storage projects – with a total budget of about **£18 million**.

CASE STUDY

Responding to a more diverse generation mix

The British based company, ITM: Power ltd is currently undertaking trials in Germany converting excess electricity generated by renewables into hydrogen, which can be injected into the mains gas network and 'stored' for release at the point needed. This makes it a highly responsive system that can better manage the integration of intermittent renewable power into networks.

An expansion of the pilot plant is planned from 2016, where the hydrogen will be converted to methane and fed into the gas distribution network.



Energy storage

Energy storage has been identified by Government as one of the UK's current eight 'great technologies' in which the country has world-leading research and which can support UK growth. Alongside other balancing technologies, storage could have an important enabling role in the future energy system, supporting the deployment of low carbon technologies.

The Government is currently providing support to a wide range of energy storage research, development and demonstration projects to help reduce the cost of novel storage technologies and to strengthen investment in energy storage.

In 2013, the Engineering and Physical Sciences Research Council (EPSRC) invested £30 million in five centres to support new science facilities for grid-scale energy storage, to help accelerate the development of national scale electricity storage.

DECC is currently supporting seven research and four large-scale technology demonstration energy storage projects – with a total budget of about £18 million. These projects focus on demonstrating more novel storage technologies which have the potential to lower costs in the longer term.

Through the Low Carbon Network Fund, Ofgem has also funded a number of storage demonstration projects and in December 2012, UK Power Networks was awarded £13.2 million of funding for the Smarter Network Storage project. This 'big battery' project has already led to the installation of a 6 MW/10 MWh device at a substation in Leighton Buzzard and will include a range of trials to improve the economics of electrical energy storage.

Highview pilot plant

With an increasingly diverse energy mix, there will be more opportunities for smaller, non-traditional players to participate in generating, storing, transporting and selling energy.

Consumers will become active players in the energy system. In addition to generating and producing their own energy, through dynamic 'time-of-use' tariffs, consumers will be able to benefit from cheaper energy by using it away from peak times. The smart home of the future will allow consumers to use smart meters and home generation to automatically set smart appliances to use energy at the cheapest time of the day – ensuring convenience and reduced energy bills.

The market will no longer be dominated by a small number of large energy companies and traditional business models. With an increasingly diverse energy mix, there will be more opportunities for smaller, non-traditional players to participate in generating, storing, transporting and selling energy, maximising competition and bringing much needed diversity to the system, helping to reduce cost overall.

Increasingly, communities will come together to manage their energy needs locally, building their own generation, managing their energy use to maximise the use of locally produced electricity and using revenues to invest in energy efficiency and local amenities. This will enable communities and other smaller players in the market to establish local markets where they buy and sell their own energy and become increasingly self-sufficient.

This revolution in the energy system will need a transformation in our energy networks. Smart grids will be at the heart of this, allowing us to manage this changing energy system more efficiently and at lower cost, providing a more resilient network that enables a much more diverse range of players into the market.

The local network operators will take a more active role in managing supply and demand at the local level, as National Grid currently does at the national scale. The smart grid transformation is already underway, but in the future we will need a smart energy system that is able to integrate the use of electricity, heat and gas to maximise efficiency, reliability and reduce costs.

CASE STUDY

A smarter future

The Government, with Ofgem, have set up the Smart Grid Forum. The Forum brings together representatives from electricity network companies, consumer groups, energy suppliers and wider industry to consider the development of smart grids towards supporting GB's transition to a more secure, safe, low carbon, affordable energy system. The Forum has developed a roadmap that aims to make the UK a leader in smart network development and to achieve the following benefits:

- Reduced costs to consumers through the take-up of smart meters and smart appliances and demand side response, giving greater control over energy use.
- Supporting economic growth and jobs with an estimated potential of £13 billion of Gross Value Added, £5 billion of potential exports to 2050 and 8,000 - 9,000 jobs over the 2020s and 2030s associated with smart grids.[54]
- Increased energy security and integration of low carbon technologies through greater monitoring and control of the network, enabling faster response to problems and management of supply and demand locally.

CASE STUDY

Carbon Capture and Storage (CCS)

There is huge potential in the UK for CCS to utilise shared infrastructure to create CCS networks across Europe. Recent estimates suggest that the UK has the potential to store 78 gigatonnes of carbon dioxide offshore, well in excess of required storage of 3 gigatonnes for the UK industry by 2050.

According to the Energy Technology Institute (ETI), the most cost effective way to implement CCS is through shared transport and storage networks, taking carbon from power plants and other carbon rich industries across the UK and Europe to suitable storage locations in the North Sea and East Irish Sea.

The Government is supporting two Front End Engineering Design studies for CCS projects in the UK:

- White Rose proposal to build a large pipeline to transport approximately 17 million tonnes of CO_2 per year. This project will provide the infrastructure for the first CCS Network in the UK, The Humber Hub.
- Peterhead will be storing carbon dioxide in an expended gas reservoir with an estimated storage potential of 30 million tonnes. The wider formation is estimated to have a storage capability of 358 million tonnes.

Appendix: HNDU successful Local Authorities

Allerdale Borough Council	Hampshire County Council	Poole Borough Council
Barnsley Borough Council	Hull (City of Kingston upon Hull)	Portsmouth City Council
Bath & North East Somerset Council	Kent County Council	Reading Borough Council
Birmingham City Council	Kirklees Metropolitan Borough Council	Redcar and Cleveland
Blackburn with Darwen Borough Council	Knowsley Metropolitan Borough Council	Royal Borough of Greenwich
Blaenau Gwent County Borough Council	Lancashire County Council	Royal Borough of Kingston upon Thames
Bolton Metropolitan Borough Council	Leeds City Council	Rugby Borough Council
Bradford Metropolitan Council	Leicestershire County Council	Runnymede Borough Council
Bridgend County Borough Council	Lewes District Council	Salford City Council
Brighton and Hove City Council	Liverpool City Council	Sandwell Metropolitan Borough Council
Bury Metropolitan Borough Council	London Borough of Barking and Dagenham	Sefton Metropolitan Borough Council
Cardiff City Council	London Borough of Camden	Sheffield City Council
Carlisle City Council	London Borough of Ealing	South Gloucestershire District Council
Cherwell District Council	London Borough of Enfield	Southampton City Council
Cheshire East Borough Council	London Borough of Hackney	St Helens Borough Council
Cheshire West and Chester Council	London Borough of Haringey	Staffordshire County Council
City & County of Swansea	London Borough of Islington	Stockport Metropolitan Borough Council
City of Westminster	London Borough of Lambeth	Stockton-on-Tees Borough Council
City of York	London Borough of Lewisham	Stoke-on-Trent City Council
Colchester Borough Council	London Borough of Merton	Sunderland City Council
Copeland Borough Council	London Borough of Sutton	Swindon Borough Council
Cornwall County Council	Manchester City Council	Tameside Metropolitan Borough Council
Crawley Borough Council	Mid Devon District Council	Wakefield City Metropolitan District Council
Devon County Council	Milton Keynes Council	Warrington Borough Council
Doncaster Metropolitan Borough Council	Neath Port Talbot Council	Warwick District Council
Durham County Council	Newcastle City Council	Wiltshire Council
East Riding of Yorkshire Council	North Warwickshire Borough Council	Woking Borough Council
Eastbourne Council	Nottingham City Council	Wychavon District Council
Eastleigh Borough Council	Oldham Metropolitan Borough Council	Wycombe District Council
Gateshead Metropolitan Borough Council	Oxford City Council	
Halton Borough Council	Plymouth City Council	

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2 The electricity network investment estimate has been updated from DECC's Delivering UK Energy Investment Report, July 2014, following Ofgem's Final Determinations for electricity distribution, otherwise figures are consistent with DECC's Delivering UK Energy Investment Report, July 2014, 2012 prices.

3 https://www.ofgem.gov.uk/ofgem-publications/56816/ws3-phase-3-84170-complete-issue-1.1.pdf The figures quoted are in net present value terms discounted using a rate of 3.5% pa, 2012 prices.

4 DECC's Delivering UK Energy Investment Report, July 2014, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/331071/DECC_Energy_Investment_Report.pdf, 2012 prices

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6 DECC analysis of projects supported by HNDU

7 https://www.gov.uk/government/publications/delivering-uk-energy-investment-2014

8 http://www.ey.com/UK/en/Industries/Cleantech/Renewable-Energy-Country-Attractiveness-Index

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10 Based on estimates of RAV additions from Ofgem.

11 Revenue=Incentives+Innovation+Outputs. The RIIO-T1 price control commenced for Transmission in 2013 and RIIO-ED1 will commence for distribution in 2015.

12 National Grid submission (September 2014) to House of Lords Science & Technology Committee inquiry into "The Resilience of Electricity Infrastructure"

13 Ofgem data on Customer Minutes Lost and prior to any weightings. Average Customer minutes lost in GB 68 in 2010/11 compared to 54 in 2013/14 (2013/14 figures not fully finalised).

14 ENA facts and figures publication 2013

15 Ofgem RIIO announcements and Final Proposals, https://www.ofgem.gov.uk/ofgem-publications/76242/20121217-press-release-riio.pdf and https://www.ofgem.gov.uk/ofgem-publications/76230/riio-controls-come-effect.pdf

16 Offshore transmission and interconnection are not covered by the price control process.

17 ENSG Major Projects December Update

18 Ofgem's Final Determinations for distribution networks

19 Ofgem decision document

20 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287012/DECC_-_Festive_disruption_review_-_Final__2_.pdf

21 http://webarchive.nationalarchives.gov.uk/20100807034701/http:/archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html

22 There were 29 expressions of interest for the first 9 offshore transmission tenders for £1.7bn of assets. https://www.ofgem.gov.uk/publications-and-updates/ofgem-grants-%C2%A3308-million-transmission-assets-licence-lincs-wind-farm

23 The electricity network investment estimate has been updated from DECC's Delivering UK Energy Investment Report, July 2014, following Ofgem's Final Determinations for electricity distribution, otherwise figures are consistent with DECC's Delivering UK Energy Investment Report, July 2014, 2012 prices

24 The electricity network investment estimate has been updated from DECC's Delivering UK Energy Investment Report, July 2014, for Ofgem's Final Determinations for electricity distribution, otherwise figures are consistent with DECC's Delivering UK Energy Investment Report, July 2014, 2012 prices.

25 The Visual Impact Provision applies to National Parks, Areas of Outstanding Natural Beauty in England and Wales, and National Scenic Areas in Scotland. To participate in the scheme Transmission Owners are required to develop and submit a policy to Ofgem for approval.

26 https://www.ofgem.gov.uk/ofgem-publications/90475/itprdraftconclusionssept2014.pdf Government is working with Ofgem on what legislative changes may be needed to implement this.

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28 CEPA/BDO evaluation of Offshore Transmission Tender Round 1 benefits Constant prices (£ 2009/10).

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30 RIIO-ED1 Price Control Final Determination. Ofgem assumed £950 million savings associated with the rollout of smart grids between 2015 and 2023. https://www.ofgem.gov.uk/ofgem-publications/91564/riio-ed1finaldeterminationoverview.pdf

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40 The capacity is subject to the projects going ahead and, even if they do happen, the capacities may change.

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