energy Barometer 2016

energy institute

Views from UK energy professionals

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"This year's Barometer highlights doubts about meeting the 2°C global target, and the UK's own emissions targets, reflecting concern that lack of policy continuity leads to under-investment in both UK energy technology and infrastructure. Stopping the CCS pilots was one notable example. I really hope the future will see this improved"

Malcolm Brinded CBE FEI FREng
Vice President, Energy Institute

Presidential remarks

Professor Jim Skea
CBE FRSA FEI

Who better to reflect on future challenges and prospects for the energy industry than the professionals who will deliver change, whether they be engineers, planners, finance staff or regulators? In this year's Energy Barometer report, members of the Energy Institute (EI) College provide their views on a set of familiar energy themes – security, affordability, sustainability – but also reflect on more topical challenges posed by low oil prices, the Paris climate change agreement and the UK's EU referendum.

On perennial themes, EI members have once again flagged energy policy continuity as the biggest challenge facing the industry. Plainly, the Government's energy policy 'reset' in November 2015 has yet to reset confidence among professionals working in the energy sector. Carbon capture and storage stands out as the technology most subject to investment risk due to policy uncertainty, but nuclear and renewable energy are also perceived as high risk. Low oil prices are seen as a further factor discouraging investment, not only in energy efficiency and the low carbon technologies needed for a sustainable energy transition, but also in UK oil and gas supply.

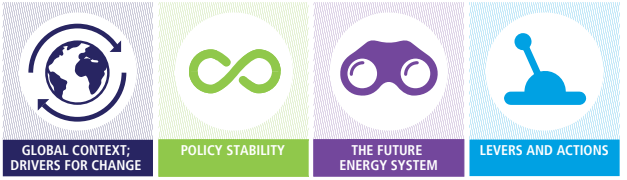
In spite of the euphoria surrounding the Paris climate change agreement, EI College members are sceptical about the likelihood of countries delivering on their commitment to hold global temperature increases to well below 2°C and pursue efforts to limit the temperature increase to 1.5°C. Most members do not expect temperature increases to be held below even 2°C; even fewer believe this is likely than in 2015. Furthermore, a majority of members think the UK will fall significantly short of its goal of reducing emissions by 80% below 1990 levels by 2050.

Finally, an overwhelming majority of contributors to the Barometer foresee negative effects on the UK energy system in the event that the UK were to leave the EU. In terms of securing energy supplies, renewable energy development, climate change and sustainability, and air quality, about four times as many respondents anticipate negative effects. The single exception to this pattern was oil and gas production, where positive and negative views were broadly balanced.

Initiatives such as the Barometer are not possible without a substantial investment of effort. I extend my sincere thanks to the Energy Advisory Panel, chaired by Dr Joanne Wade FEI, Dr Dimitrios Xenias from Cardiff University, and the EI Knowledge Service for their role in designing and executing the survey and preparing this report. Most importantly, I would like to thank the members of the EI College who participated in this important work. The publication of this report would not be possible without their commitment to sharing their views. I commend this report, and the insights it provides, to anyone in the private or public sector with a stake in the future of UK energy.

Professor Jim Skea CBE FEI FRSA
President, Energy Institute

Executive summary



The UK is part of a global energy system subject to geopolitical forces. EI members recognise that there are both short term drivers for change, presently reflected by the low price of crude oil, and longer term drivers such as the climate change goals set under the COP21 agreement. The energy professionals we have surveyed seek stable energy policy to underpin investment for the long term.

In 2016, many of the top ten challenges identified by UK energy professionals are the same as those identified in 2015. Continuity in energy policy remains the top concern with investment a close second. However, the low oil price is now of almost equal concern. International aspects and the need for whole-system thinking and longer term planning have newly emerged as top issues in the past 12 months.

Global context and drivers for change

In the last year, the UK elected a new Government which then undertook an 'energy policy reset'. The UK also signed the Paris Agreement at COP21 setting out longer term aspirations and targets for reducing emissions to mitigate climate change. Based on current policies, EI members are not confident of meeting either the 2°C target set under COP21 or the UK carbon budget targets. This concern is linked to the low price of crude oil, which is perceived to impact not only the oil and gas industry, but also to stifle growth in the low carbon economy and reduce the imperative for energy efficiency. The actions of oil producing nations and geopolitical forces more generally are expected to be the main drivers of the oil price over the next 12 months. There is a concern that these relatively short term challenges may defer attention from underlying long term issues, and EI members urge all parties to maintain focus on the long view.

Stability within a changing policy landscape

EI members continue to prioritise energy security above sustainability and affordability, although all three elements are recognised as important. To achieve energy security in the long term, investment must be sustained to update infrastructure and expand capacity, and this should be enabled through clear policy signals. Over the last 12 months, UK energy policy on new nuclear delivery and energy efficiency was seen to have a positive effect. However, negative effects were perceived for carbon capture and storage (CCS) and renewable electricity deployment. This pattern was repeated for perceived investment risks as a result of policy uncertainty, with low risk for energy efficiency and high risk for CCS and less mature renewable electricity technologies.

Most EI members believe the UK is the best governance level for energy policy and planning decisions, with the exception of climate change and sustainable development policy, for which UN-level decisions are preferred. Overall, if the UK were to leave the EU, about three times as many respondents expect negative energy system effects as expect positive ones. Negative impacts on securing energy supplies, renewable energy development, climate change and sustainability, and air quality were identified by a particularly large numbers of respondents in the event the UK were to leave the EU.

The future energy system

The UK energy system requires significant transformation to meet future demand and emissions targets. Respondents expect gas to form a large component of the primary energy mix for electricity and heat in 2030. Oil is still expected to dominate in the transport sector, but with electricity playing an increasingly significant role. The 'fifth fuel', energy efficiency, has greatest scope for improvement within the built environment, specifically through retrofitting building fabric. Low carbon power generation technologies, along with energy storage, are believed to have the greatest potential to transform the energy system by 2030. Uncertainty in energy policies and lack of investment are considered the largest barriers to this transformation and to the innovation needed to deliver it.

Levers and actions

This Barometer survey makes clear that energy professionals believe the pathway to a secure, decarbonised energy system will require significant investment and a qualified workforce, which will need the assurance of strong policy signals. Increased levels of investment are seen to be necessary in all areas except fossil fuel electricity generation. Specific government measures to reach emissions targets should focus on low carbon electricity generation via nuclear and renewables, supported by financial incentives. Respondents are keen to see skilled workers join and remain in the industry, and recognise the need for better communication with the public to improve acceptance and trust in this essential enabling industry.

How do they compare to last year?

2015 vs 2016 Biggest challenges

Free responses coded and consolidated from two questions: What do you think is the biggest challenge for the energy industry in 2016? N = 393 (N = number of respondents); **Please list any other challenges you think the energy industry will face in 2016.** N = 313

1st	Energy policy continuity	—
2nd	Investment and cost	—
3rd	Low oil price	↑7
4th	Supply security	↓1
5th	Low carbon energy	↓1
6th	Public engagement	↓1
7th	International aspects	New
8th	Sustainability and climate change	↓1
9th	People and skills	↓1
10th	Whole system thinking and long term planning	New

Ten key messages from energy professionals

EI members were asked to identify the biggest challenges facing the energy industry in 2016. Their responses provide the framework for the analysis carried out in this report. The top ten challenges span the energy sector, highlighting the breadth of concerns held by energy professionals.

1

Energy policy continuity

The industry faces unpredictable and frequently changing energy policies which cause a loss of momentum and create an unstable environment for investment. Policy making would benefit from a clear strategy applied across and within all energy policy areas and with a longer time horizon.

Most frequently mentioned with: Whole system thinking and long term planning

"Mounting geopolitical tension and in particular the ongoing face-off between the US, Russia, OPEC and the complex way in which energy production and sales are tied up with the geopolitics"

2

Investment and cost

Members observe investment limitations stemming from two main sources: low investor confidence due to policy uncertainty, and low crude oil prices. The pressure to enable investment is compounded by the urgency and relatively high cost of decarbonisation, the need to secure future supply to meet growing demand and the need to replace ageing infrastructure.

Most frequently mentioned with: Energy policy continuity

"Applying integrated system thinking, to offset perceived technical and investment risk. Sub-sets of the energy system (e.g. electricity and heat) are not joined up in planning and investment decision making"

3

Low oil price

A sustained low oil price is seen to be having a negative impact on investment across both the oil and gas and low carbon sectors. This financial challenge results in job losses, graduates moving to other industries, and deferred development of oil and gas supplies. Members identify a challenge for industry: to ensure security of supply while maintaining support for low carbon and energy efficiency projects in an environment of low oil prices.

Most frequently mentioned with: Investment and cost

"Setting plans for long term sustainable energy use to meet climate change goals, particularly with cheap oil prices delaying any changes"

4

Supply security

Members recognise the complex need to replace ageing infrastructure and meet growing demand, keep costs and emissions down, and provide a diverse energy mix rather than rely on fewer supply sources. Achieving these goals is made more difficult because of continued low investment levels. Responses mainly referenced security of supply in the context of electricity.

Most frequently mentioned with: Investment and cost, Sustainability and climate change

"Reliable supply of energy demands long term thinking. A significant reduction in crude prices leads to redundancies and swathes leaving the industry short of talent upon an upturn"

Ten key messages from energy professionals

5

Low carbon energy

The industry faces the challenge of transitioning to a low carbon energy system, and securing the investment to do so, in the face of low oil prices. Maintaining current momentum towards delivering the new infrastructure needed to meet decarbonisation targets is seen as particularly important.

Most frequently mentioned with: Energy policy continuity

6

Public engagement

Energy professionals want to improve communication with the public and engage in informed debate about the big picture rather than single points in the energy system. They are also eager to improve perceptions of and trust in the industry (e.g. why low wholesale prices do not trickle down to consumer energy bills), which members see as providing essential services.

Most frequently mentioned with: Whole system thinking and long term planning

7

International aspects

Respondents indicate that various international aspects are challenging for policy development and investment planning, particularly for the global oil and gas sector. They specifically cite the impact of oil and gas producing nations (OPEC, Russia, US) on markets, geopolitical instability in the Middle East, overseas investment in the UK, carbon leakage and demand changes in developing countries.

Most frequently mentioned with: Investment and cost

"Meeting a significant shortfall in generation capacity that can meet low carbon targets in a realistic and cost effective way"

"Maintaining sufficient experienced technical people for the cost-effective implementation of changes in the industry. Thousands are faced with redundancy and many may leave the industry"

"The low oil and electricity prices and uncertain government policy means there will be very little investment in energy. This will cause problems going forward with security of supply"

"A robust energy policy for the longer term to instil confidence for investors and encourage research for developers of technologies"

"Building cross-party support in Parliament for a coherent and sustainable vision of the future system, towards which the sector can then work"

"Low oil price bringing down energy costs extending payback times for energy efficiency measures and investment in low carbon generation"

Sustainability and climate change

Members are concerned about the challenge of meeting emissions targets and mitigating climate change against a backdrop of sustained low oil prices, growing demand and unclear policy signals. Some respondents note the risks of rapid future climate change, including unpredictable weather, which will pose additional challenges for the energy system.

Most frequently mentioned with: Energy policy continuity, Supply security

People and skills

The industry as a whole faces a shortage of qualified workers. Low oil prices are currently perceived to contribute to moves of experienced personnel and graduates to other industries, and to redundancies in the oil and gas sector. Experienced people are needed to manage transitions in the energy system, and more will be needed when oil prices stabilise.

Most frequently mentioned with: Low oil price

Whole system thinking and long term planning

Respondents emphasise the need for joined-up thinking across all elements of the energy system and planning over longer time horizons. This includes a long term government strategy for a decarbonised system which works towards the integration of electricity, heat and transportation systems.

Most frequently mentioned with: Energy policy continuity

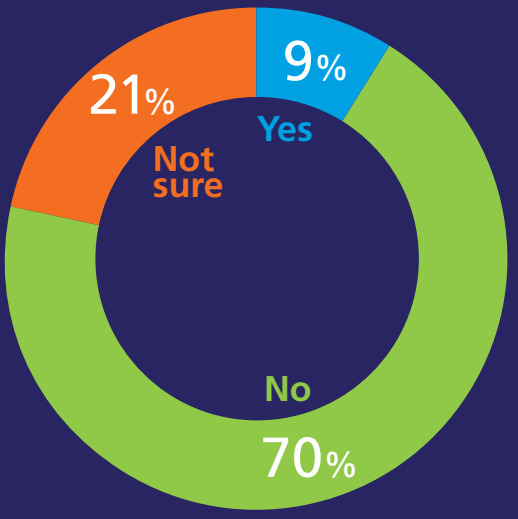
"Setting out a route to 2050 goals that will meet the challenge faced without being over prescriptive and will deliver a complete energy system"

"To be trusted as the essential services provider it is, with a mission to decarbonise the system as efficiently as possible, rather than be perceived as simply big business profiteering from the public"

"Low energy costs lead to apathy over investment in energy saving, and research into new energy applications. Our efforts to promote energy efficiency with our fuel customers are always more difficult at times of falling or stable oil prices"

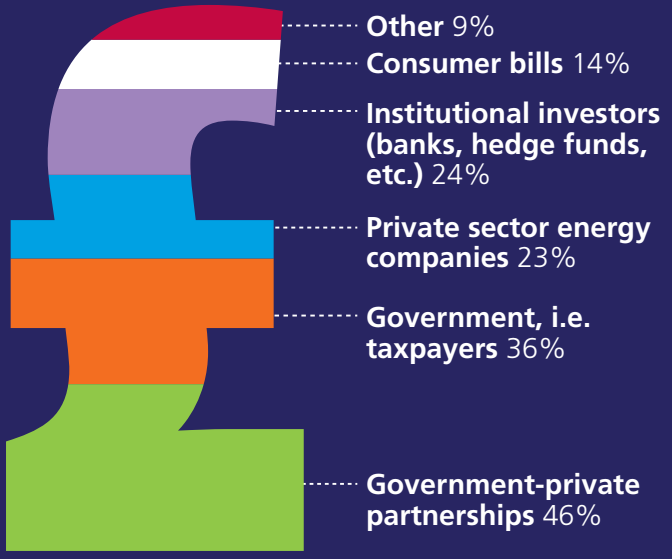
COP21 Agreement preventing a 2°C rise

Do you think the agreement reached at the 2015 Paris Climate Conference will be sufficient to keep global temperature rise below the targeted 2 degree Celsius? N = 438



Climate fund sources

In the agreement, a clause exists for the creation of a $100bn climate fund. How do you think this fund should be paid for? N = 438: Respondents were allowed to choose more than one response. Results are expressed as a percentage of respondents.



GLOBAL CONTEXT; DRIVERS FOR CHANGE

Global context and drivers for change

Setting the scene

This survey was conducted less than a year after the election of a new UK Government, whose approach to energy policy was beginning to emerge. A 'reset' for energy policy had recently been announced, with strong focus on security of supply through nuclear and natural gas development. EI members were asked to provide their views on the current state of the UK energy system, the recent Paris climate agreement, the UK's emission targets, and the direction and drivers of energy prices over the coming 12 months.

Paris agreement

An agreement was reached at the Conference of the Parties (COP) 21 in Paris in December 2015 to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. The agreement comprises emission reduction targets determined by each signatory nation, and $100bn per year of financial support for developing countries, with the UK contributing £5.8 billion over the next five years. Respondents think these contributions should come primarily from government-private partnerships, with the least burden falling on consumer energy bills.

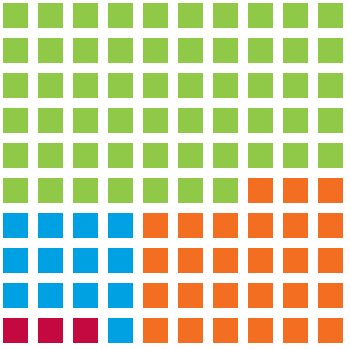
Following COP21 and pledges from 195 nations, a significant majority of EI members do not expect the agreement reached to be sufficient to keep global temperatures from rising by 2°C. This echoes the 2015 findings, but now with fewer respondents claiming to be 'not sure', and opting for a pessimistic view instead.

Emissions targets

Respondents are also doubtful of the UK's ability to meet its domestic emissions targets given the policies currently in place. They increasingly expect to fall short of the third, fourth and fifth carbon budgets, with the most significant shortfall anticipated for the 2050 climate target. This expectation is more pessimistic than that expressed last year, with a higher proportion of EI members stating the UK will 'fall significantly short' of future targets. Despite the Committee on Climate Change outlook that the UK's third carbon budget will be met (2016), due in part to lower energy demand during the economic downturn, members indicate greater policy action will be required to achieve decarbonisation goals in the future. Geopolitical instability in the Middle East and the changing dynamics of oil and gas supply and demand have provided a challenging background to pursuing these targets.

UK 2050 emissions target

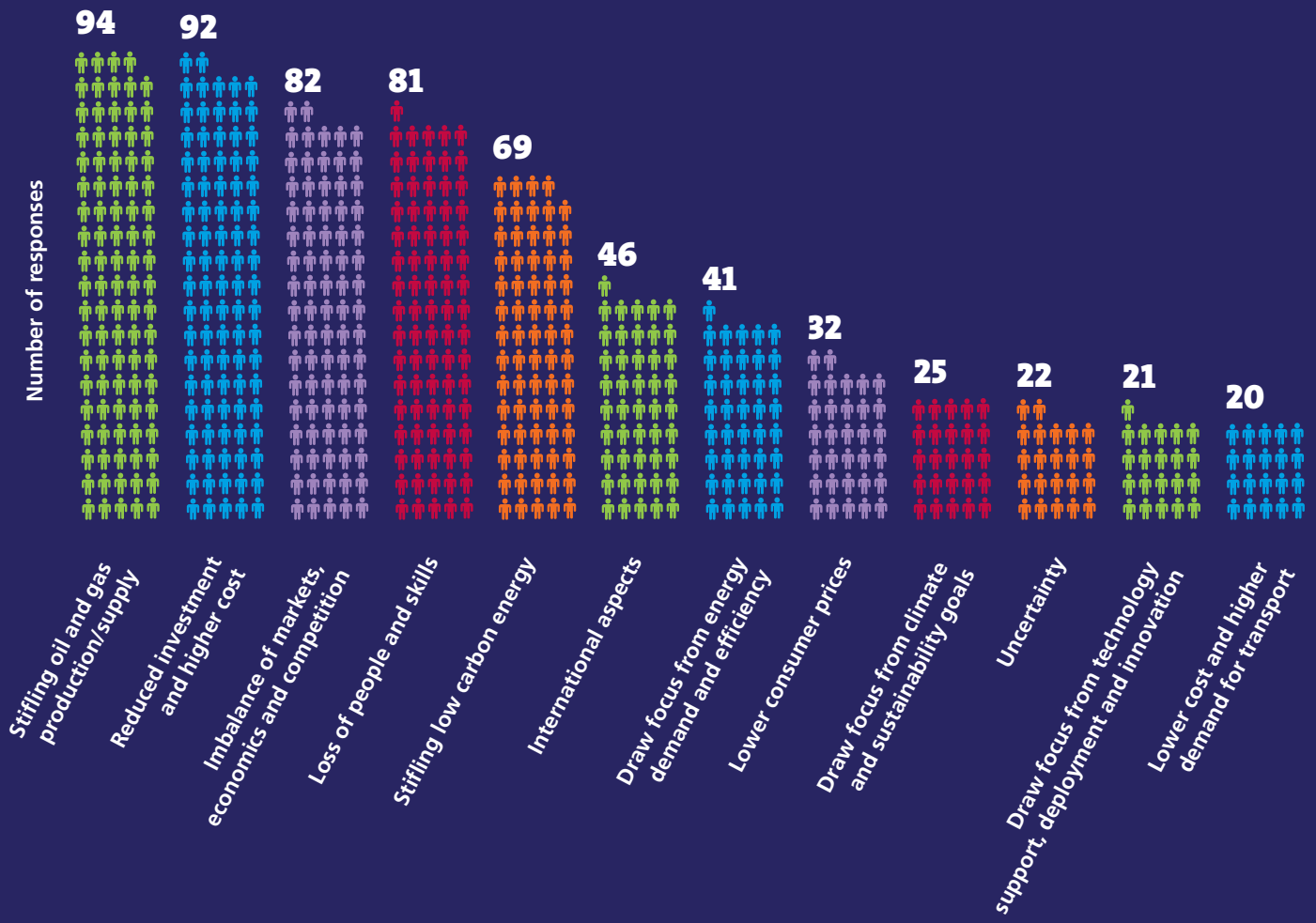
The 2050 UK climate target is to reduce emissions by at least 80% (from 1990 levels). Given current UK emission reduction policies, do you expect emissions reductions to: N = 438: Expressed as a percentage of respondents. Each small box equals one percent.



- **Fall significantly short of the target** 72%or smaller reduction
- **Fall short of the target** 73–77% or smaller reduction
- **Meet the target** 78–82% reduction
- **Exceed the target** 83–87% reduction
- **Significantly exceed the target** 88% or larger reduction

Impact of continued low crude oil price

What is the most significant impact of continued low crude oil prices? N = 370: Expressed as the number of respondents that mentioned each category



Crude oil prices

The effect of the continued lower crude oil price, $35/barrel at the time of the survey, is being felt across the energy system. Impacts on the oil and gas supply industry include reduced investment, imbalanced markets and job losses. Energy professionals also identify significant setbacks to the low carbon economy and to demand reduction and efficiency measures.

The lower cost of oil is seen as a possible barrier to investment in low carbon technologies. Members also note potential opportunities, including lower transport costs in the short term, and a chance for government to reduce fossil fuel subsidies for the longer term.

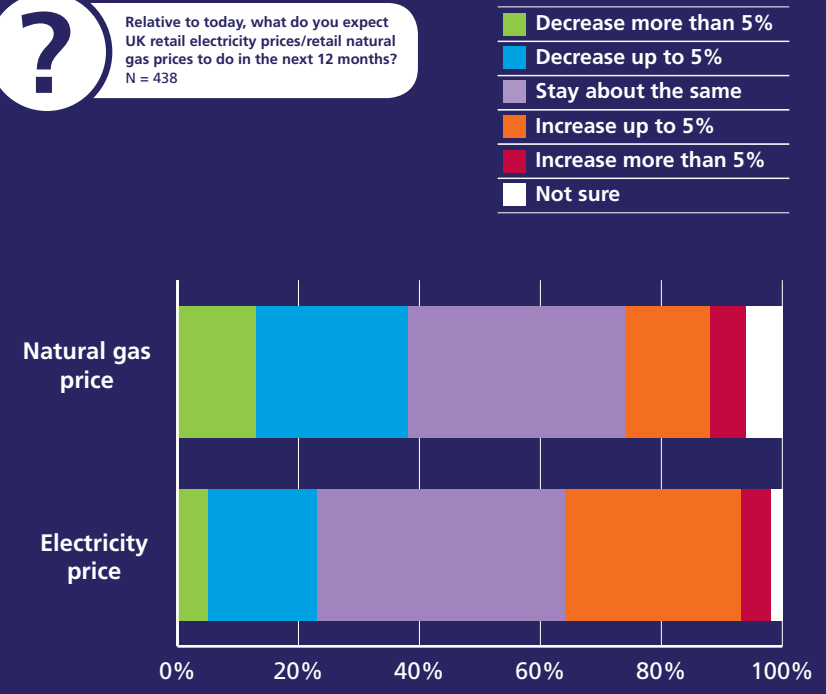
Over the next 12 months, EI members predict crude oil prices will rise slightly. This is similar to their expectation a year ago. Asked what the main driver of the crude oil price will be over this period, EI members cite the actions of oil producing nations as having the greatest impact, followed by geopolitical instability and demand levels in developing countries. Crude oil prices are also expected to have a greater effect on the price of transport fuel than in 2015. The impact on transport fuel demand and taxation is expected to be neutral.

Other energy prices

Over the next 12 months, EI members anticipate that UK retail natural gas prices will decrease, driven primarily by the crude oil price and by natural gas demand from the UK and Europe. Electricity prices, however, are expected to increase slightly, despite the prediction of a lower price for natural gas, which is the main primary fuel for electricity generation. Respondents observe that electricity prices are driven not only by primary fuel costs but also by limits of existing generation capacity and the cost of new-build capacity, which reflects their concerns over security of supply.

Gas and electricity prices

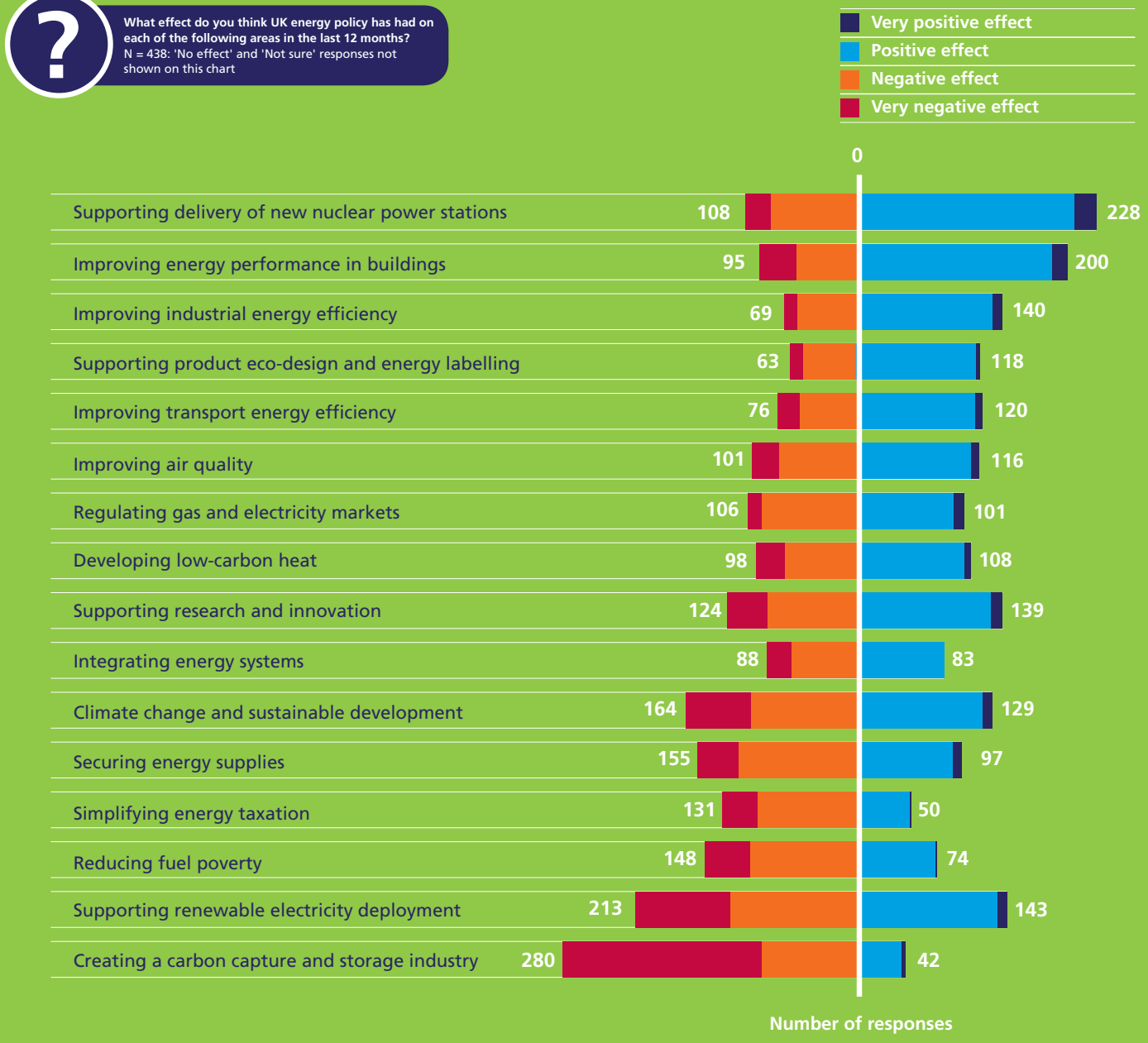
Relative to today, what do you expect UK retail electricity prices/retail natural gas prices to do in the next 12 months?
N = 438



> **Low prices have decimated the supply structure and halted essential development. OPEC policy has worked, forcing many shale-based operators to relinquish their positions, aligning supply closer to demand and pushing the price to $50. The $100+ enjoyed earlier was unrealistic and OPEC was warned that such levels would lead to demand destruction, fuel efficiency and encourage alternative energy sources"**
>
> **John Hall FEI** Chairman, Alfa Energy

UK energy policy effects

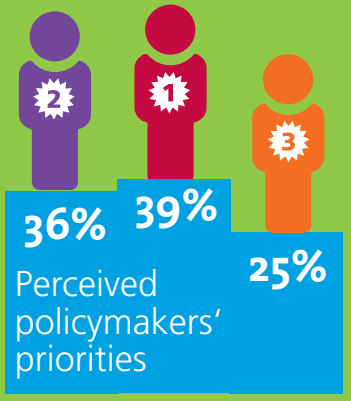
What effect do you think UK energy policy has had on each of the following areas in the last 12 months?
N = 438: 'No effect' and 'Not sure' responses not shown on this chart



Priorities vs perceived priorities

In what order would you prioritise the three elements of the Energy Trilemma? How do you expect UK policymakers to prioritise the three elements of the Energy Trilemma during the next 3 years?
N = 438: Answers ranked by priority and shown as a percentage

- Sustainability
- Security
- Affordability



POLICY STABILITY

Stability within a changing policy landscape

Security of supply, sustainability, and affordability are the ultimate objectives of energy policy in the UK, and the focus of measures and messages from policymakers. While each factor is undeniably important, the balance between the three constantly shifts as the energy system develops. Policymakers and industry stakeholders are challenged to balance these factors and follow a stable trajectory as they enact individual measures within an overall strategy.

Implementing policies that achieve their specific aims is a further challenge. EI members report varying success for the suite of energy policies currently in place in the UK. These policies directly affect investor confidence in specific technologies and across the energy sector.

Competing priorities: Security, sustainability and affordability

EI members continue to place security of supply as their top priority, while perceiving that policy makers place affordability as theirs. Graduate members however hold sustainability as their top priority, to a greater extent than in 2015. Overall these results are consistent with those reported last year. Respondents continue to perceive a disconnect between their own priorities and those of policymakers.

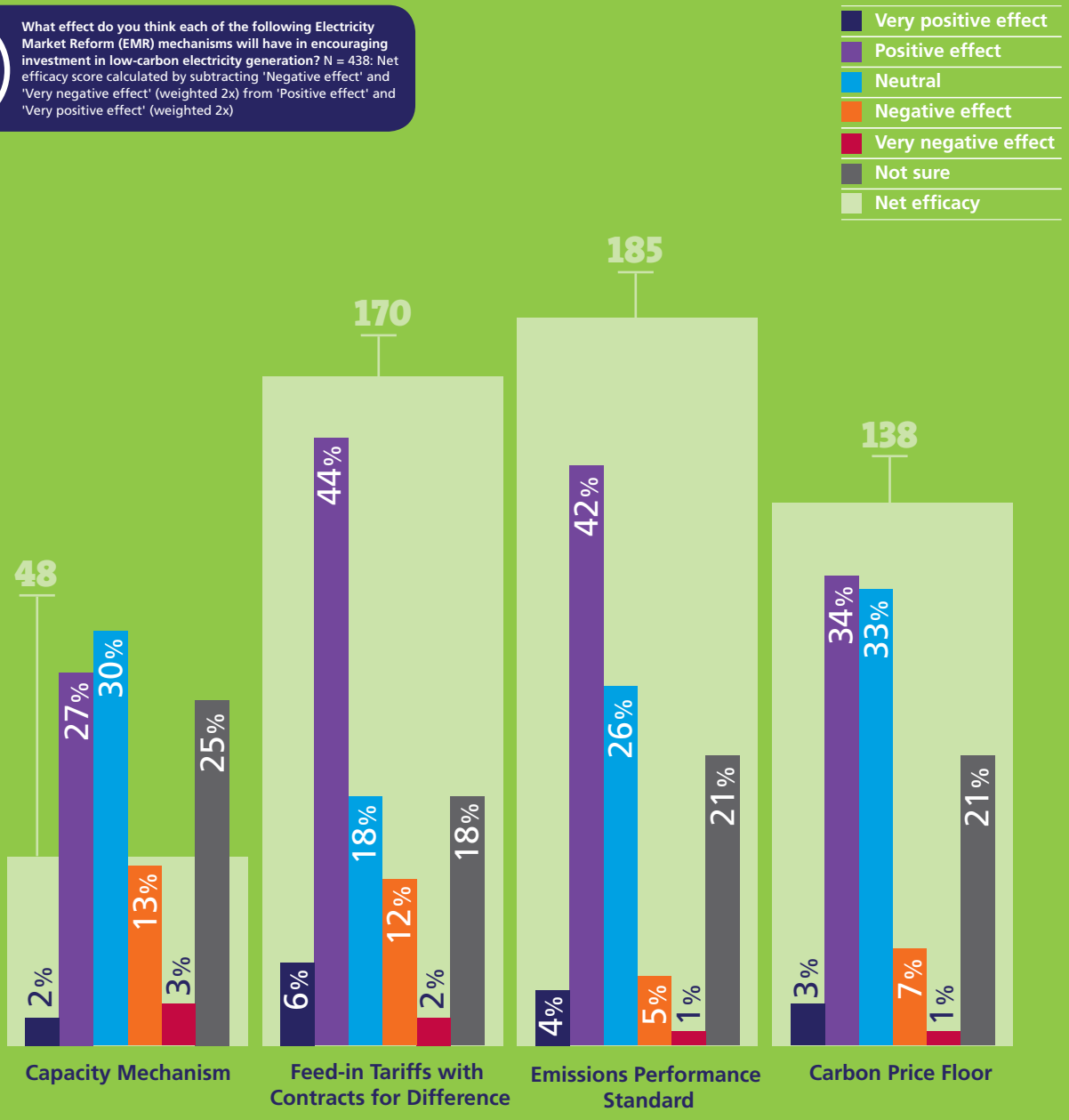
UK energy policy effects

The effects of policy on the energy system over the past 12 months have been gauged by EI members. A number of changes to energy policy were announced or implemented by the Government during this period. These included the commitment to close unabated coal-fired power plants by 2025, support for offshore wind and natural gas power generation, ending the £1bn carbon capture and storage (CCS) competition, changes to renewables subsidies and ending the Green Deal energy efficiency programme.

Energy professionals view policy relating to CCS as having a particularly negative impact on industry. Net negative effects from recent policies are also reported for renewable electricity deployment, reducing fuel poverty, and simplifying energy taxation. Policies aimed at the delivery of new nuclear power stations, along with energy efficiency and energy performance in buildings, are seen to have had a net positive impact over the same period. Notably, professionals working in the energy management sector are less positive than professionals in other areas of the industry about UK policy effects on energy efficiency; they indicate that policy has had a neutral effect on efficiency (in buildings, industry, and transport).

Electricity Market Reform

What effect do you think each of the following Electricity Market Reform (EMR) mechanisms will have in encouraging investment in low-carbon electricity generation? N = 438: Net efficacy score calculated by subtracting 'Negative effect' and 'Very negative effect' (weighted 2x) from 'Positive effect' and 'Very positive effect' (weighted 2x)



Enabling investment through policy signals

Electricity Market Reform

The measures included in the Electricity Market Reform (EMR) were evaluated by respondents for their influence in encouraging investment in low-carbon electricity generation. Compared with last year, EI members are more certain of the effect these are having, and overall the measures are perceived more positively. The drop in 'Not sure' responses since 2015 is not surprising, as EMR policies have had one more year to take effect.

The increased approval of EMR measures does not translate into positive perceptions of progress towards the underlying policy objectives of EMR: climate change mitigation, sustainable development, supporting renewable electricity deployment and securing energy supplies. All are perceived to have been negatively affected by wider UK energy policy over the same period (see p14).

Investment risk due to policy uncertainty

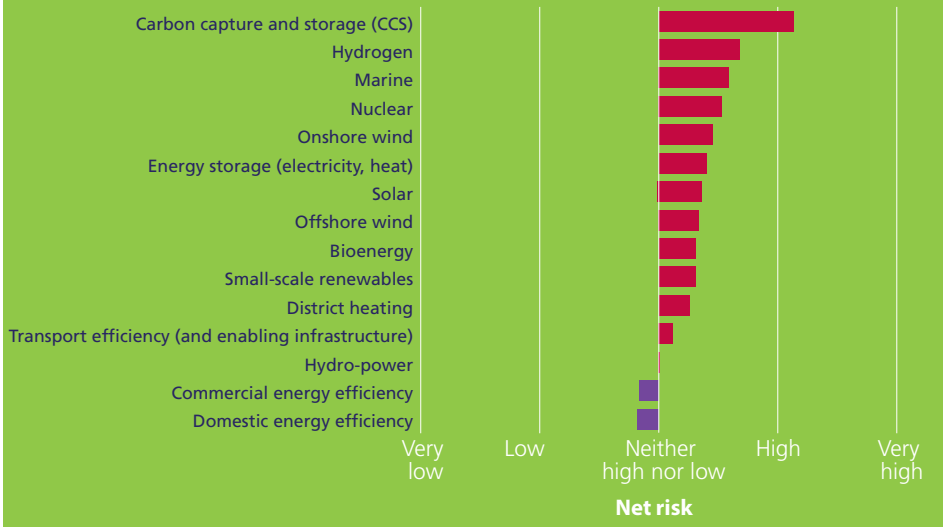
EI members were asked to assess the extent to which policy uncertainty contributed to investment risk for a number of low carbon technologies. For the technologies and sectors included, investment risk due to policy uncertainty is almost universally seen to be high.

CCS is again singled out as having been impacted most significantly by policy uncertainty. Hydrogen, marine and nuclear are also perceived among the highest-risk technologies for investment. This reinforces the theme emerging from respondents that CCS and renewable electricity deployment have been negatively affected by policy signals over the previous year. Despite policy being seen to have a positive impact on the delivery of new nuclear power stations, nuclear technology on the whole is still perceived as carrying high investment risk.

> "It is concerning that investment risk due to policy uncertainty is almost universally seen as high. This should be of significant concern as perception of high risks leads to low investment and innovation which, in turn, stores up problems for the future"
>
> **Ian Marchant FEI** Chairman, Wood Group and Former President, Energy Institute

UK investment risk

In the UK, what is the level of investment risk due to policy uncertainty for the following low-carbon technologies?
N = 438: Net risk score calculated by subtracting 'Low' and 'Very low' (weighted 2x) from 'High' and 'Very high' (weighted 2x)



Levels of governance

Policy and planning decisions

EI members were asked at what level policy decisions should be made for six broad aspects of the energy system. The UK emerged as the most common response, followed by the EU, across five of the six areas. For the sixth area, climate change and sustainable development, UN-level policy decisions are most frequently selected.

Interestingly, for all areas EI members prefer policy decisions at national and supranational levels, as opposed to devolved administrations or local councils. With regards to planning, UK-level decisions were again preferred over sub-national levels across the board. Onshore wind is the one area where devolved administrations and local councils were cited nearly as often as the UK.

EU Referendum

To further explore the role of the EU in the UK energy system, Energy Barometer respondents were sent a follow-up questionnaire on the energy-related impacts of the EU referendum. Respondents to these questions (N=223) were asked to gauge the effect that leaving the EU, but remaining in the single energy market, would have on several areas of the UK energy system. In terms of securing energy supplies, renewable energy development, climate change and sustainability, and air quality, about four times as many EI members see "Brexit" as having a negative or very negative impact as those who see positive effects. The single area of the energy system seen to benefit slightly in this Brexit scenario is oil and gas production.

EI members were also asked to identify potential risks and opportunities of three scenarios: remaining in both the EU and the single energy market; leaving both the EU and the single energy market; and leaving the EU, but remaining in the single energy market. The key impacts highlighted in response to all three scenarios, both as risks and as opportunities, were: energy security, business development, investment and market influence, and environment and climate change.

Across the scenarios, energy security was the topic of most concern. Reduced energy security was the most-cited risk for both of the 'leave' scenarios, but was also cited as a risk of staying in the EU. Conversely, improving energy security was also mentioned in all three scenarios as an opportunity. Despite this ambivalence, EI members indicate that the greatest risk to energy security is posed by the scenario in which the UK leaves both the EU and the single energy market. This concern about energy security is further supported by responses indicating the negative effect a Brexit would have on support for new nuclear and renewable power generation.

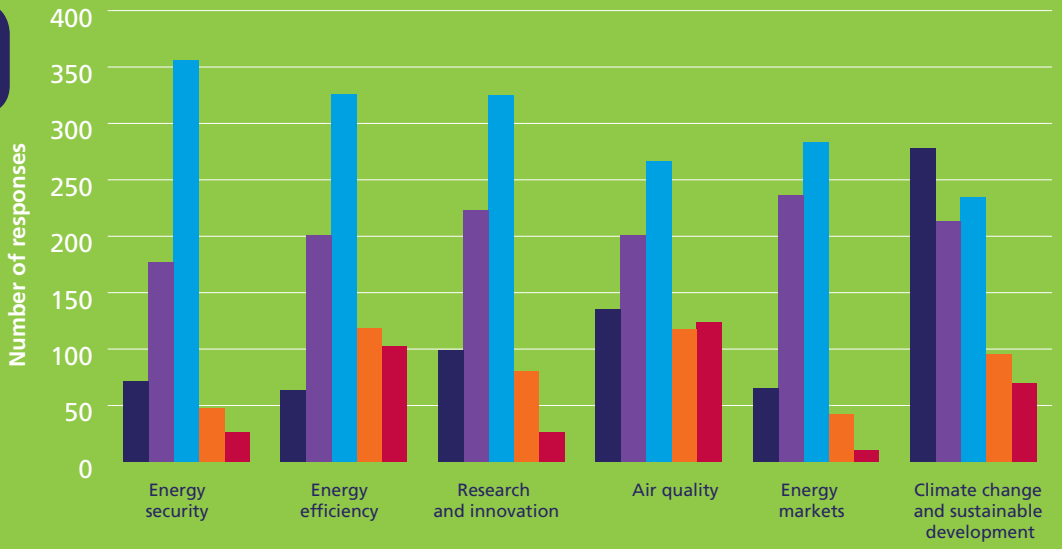
The economic impacts on businesses and investors, such as price volatility, and the UK's level of autonomy and market influence (or lack thereof) emerged as both risks and opportunities across scenarios. An opportunity for increased market intervention is perceived outside of the single energy market, but so are increased price volatility and business risk. Leaving the EU, but remaining in the single energy market is seen as a double-edged sword; it raises the opportunity for greater policy self-determination as well as the potential of regulation without representation. Overall, EI members see regulating energy markets as being negatively affected by this scenario.

The area most negatively impacted by an exit from the EU is 'addressing climate change and sustainability'. This is reflected again in the comments on the two leave scenarios, with mentions of risks significantly outnumbering mentions of opportunities. This also correlates with the policy results, where EI members show a preference for climate policy decisions to be made at the UN level, reflecting the role for climate change policies that cross national boundaries.

Level of policy decisions

At what level should policy decisions be made for the following areas? N = 438
Respondents were allowed to choose more than one response

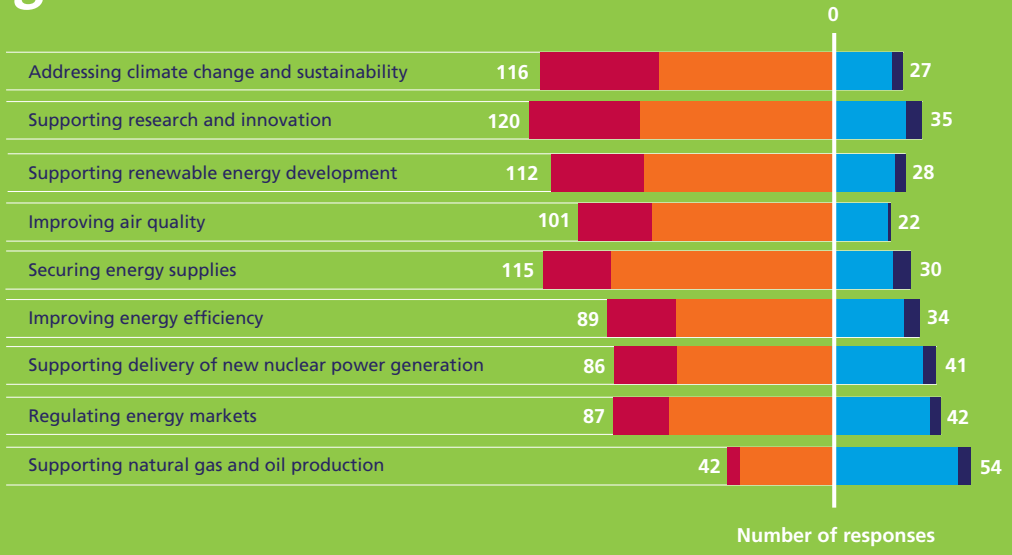
- United Nations
- European Union
- United Kingdom
- Devolved administrations
- Local councils



Effects of leaving the EU

If the UK were to leave the EU but remain in the EU single energy market, what effect would this have on the following areas of the UK energy system? N = 223: 'No effect' and 'Not sure' responses not shown on this chart

- Very positive effect
- Positive effect
- Negative effect
- Very negative effect



The future energy system

Where will we be in 2030?

To ensure security of supply and meet 2050 climate change targets, significant transformation of the UK's energy system should be well underway by 2030. It will include replacing ageing infrastructure to maintain sufficient capacity, as well as adjusting the balance of primary energy supplies and updating technologies to decarbonise the energy system. Energy efficiency improvements and reduced demand will help to jump start this transformation.

Respondents' expectations of the constituent sources for heat, transport and electricity in 2030 are not drastically different from the current supply mix, but align relatively well with decarbonisation scenarios given in recent UK Government and Committee on Climate Change (CCC) reports. EI members expect gas to be the greatest primary energy source for heating, with electricity, bioenergy and solar thermal making significant contributions. This aligns with the heating decarbonisation scenario given in the Government's report, The Future of Heating (2013), which indicates that gas will still be the largest fuel source in 2030, with air- and ground-source heat pumps supplying most of the balance of demand.

For transport, respondents expect oil to still constitute the bulk of the 2030 supply mix. They also predict that electricity will play a significant role in the transport system. This aligns with the scenarios presented in the National Grid Future Energy Scenarios report (2015), where fossil fuels are predicted to remain the largest transport energy source in 2030. A significant number of electric and hybrid road vehicles are also indicated in three out of the four scenarios.

Respondents anticipate an electricity mix of high levels of gas and nuclear, alongside sizeable contributions from offshore wind, bioenergy, onshore wind and solar PV. This matches quite closely the 'high nuclear' mix given in the emissions scenarios for the sub-100g/kWh power sector from the CCC power sector scenarios for the Fifth Carbon Budget (2015). Our respondents generally weight gas generation and bioenergy higher than the CCC scenarios do, and weight offshore wind slightly lower.

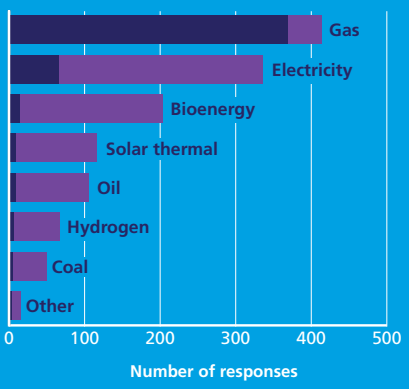
> **"An even higher proportion of energy professionals than last year doubt that the UK will meet it's third, fourth and fifth carbon budgets with current policies. Failure is not inevitable, but the government must act without delay to raise its game in the wake of the historic Paris agreement which cemented the global consensus on the need to do much more to tackle climate change"**
>
> **Joan MacNaughton CB HonFEI**
> Former President, Energy Institute

Future energy sources

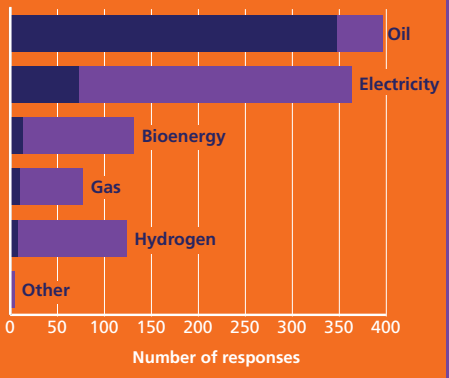
In 2030, which primary energy source will contribute most to the UK heat/transport/electricity mix? What other sources will make a significant contribution?
N = 438

Greatest contribution
Other sources

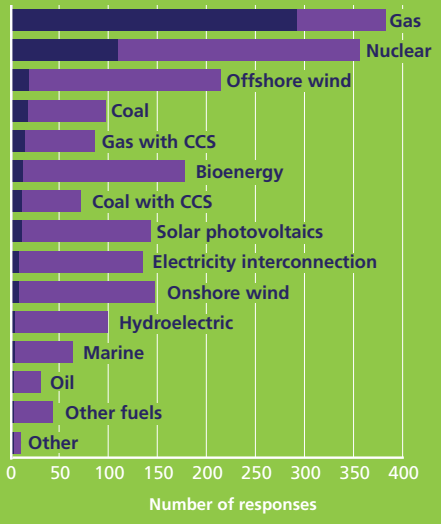
Heat



Transport

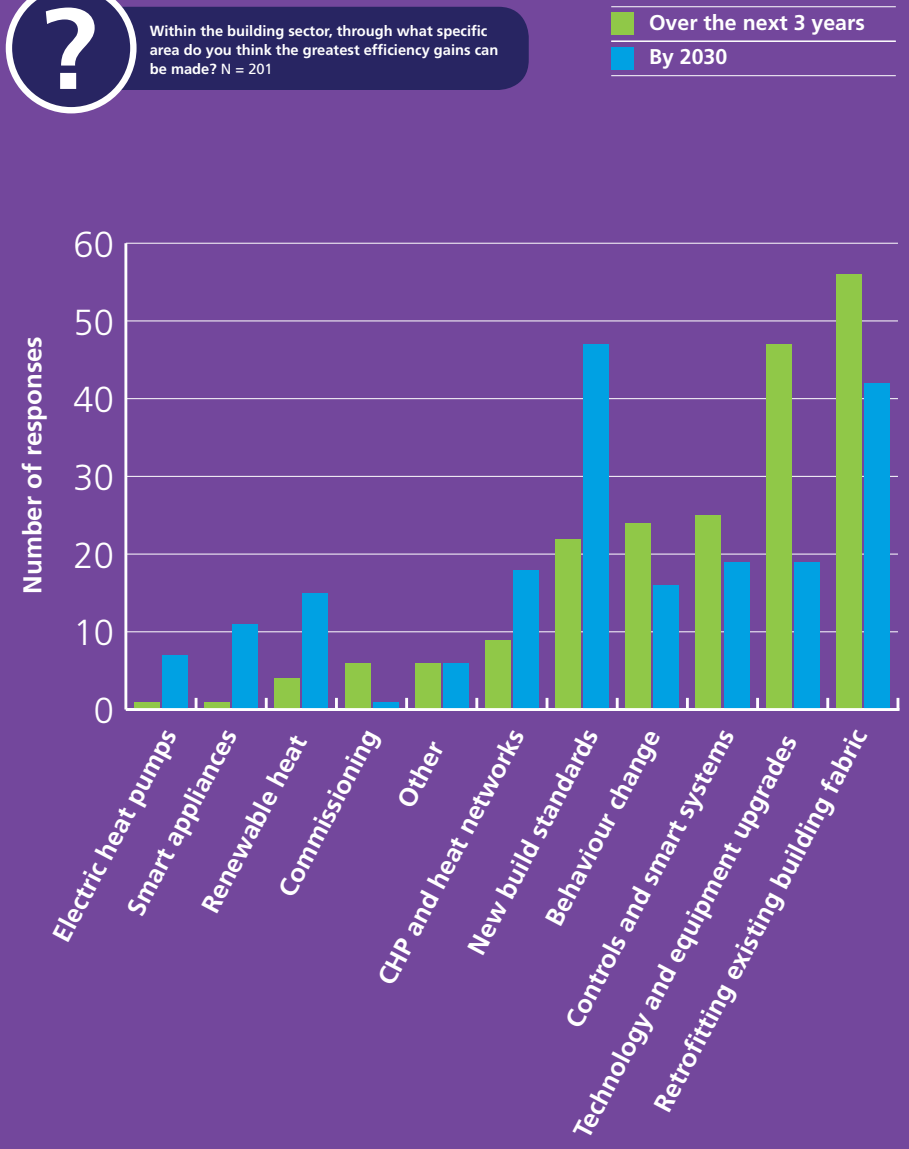


Electricity



Efficiency opportunities in buildings

Within the building sector, through what specific area do you think the greatest efficiency gains can be made? N = 201



Energy efficiency potential

Energy efficiency has the potential to address all aspects of the energy trilemma. Firstly, it can reduce energy use and consequently lower energy-related emissions and costs. Efficiency improvements made since 1990 have saved over 6,000 million tons oil equivalent (Mtoe) globally (the equivalent of 30 years of UK primary energy demand at 2014 levels [DUKES 2015]) and avoided over 10 gigatons of CO_2 emissions (almost one third of global annual emissions [IPCC Fifth Assessment Report 2014]). Efficiency also has the potential to significantly improve energy security; 190 Mtoe of primary energy imports were avoided in IEA countries through demand reduction in 2014 alone (IEA 2015). The UK could save £1.6bn by 2030 from energy efficiency schemes implemented by large organisations (Environment Agency 2016).

Nearly half of EI members think the greatest energy efficiency improvements over the next three years can be made in buildings. The remaining respondents are split evenly between transport and industrial processes. The greatest near-term potential gains within the built environment are expected through retrofitting building fabric and technology and equipment upgrades. In the medium term, to 2030, retrofits are still seen to have strong potential, though new build standards are expected to result in the greatest energy efficiency gains.

Within transport efficiency, areas contributing the greatest short-term efficiency improvements include hybrid and electric vehicles, changes to travel habits and infrastructure to enable those changes, and general road vehicle efficiency. Through 2030, respondents see continued potential

for changes to travel habits and enabling infrastructure, and for electrification of road vehicles, with emerging impact from hydrogen fuel cells.

Industrial processes were cited by a quarter of respondents as the area where greatest efficiency gains can be made over the next three years. During that period, these respondents expect gains to be made through technology and equipment upgrades, controls and smart systems, behaviour change, and heat process improvements. Through 2030, these same areas are expected to continue to drive efficiency gains, with less of a role for behaviour change.

For both transport and industry, behaviour change is seen to have potential for achieving short term gains, whereas technological or infrastructure upgrades have longer lead times. For each of these sectors, respondents who felt behaviour change had the most scope to increase efficiency were asked to identify specific, highly-impactful behaviour changes. Within the transport sector, the behaviour changes most frequently identified include reduced road vehicle use, through increased use of public transport and modal shift in transport types. For industrial processes, improving knowledge and attitudes and integrating energy into business activity were identified as the main behavioural opportunities to impact energy efficiency.

> **Energy efficiency in buildings can deliver results in both the short and longer term, if Government acts now to set a policy framework that drives investor confidence, consumer demand for energy efficiency, and energy use behaviour change"**
>
> **Dr Joanne Wade FEI**
> Chair, EI Energy Advisory Panel

Greatest scope for energy efficiency improvements

In which sector do you think the GREATEST energy efficiency improvements can be made over the next 3 years? N = 438

Transformative technologies and innovation

By 2030, the UK energy system should be on the road to its security of supply and decarbonisation goals. Progress towards these goals will be driven by innovation and diffusion of new technologies, as well as improved use of existing technologies. EI members were asked to comment on which technologies have the greatest potential to transform the energy system and where innovation is needed most.

Transformative technology

EI members identify nuclear and renewable technologies as having the greatest potential to transform the energy system by 2030. Energy storage is also frequently mentioned. Those who identify nuclear sometimes mention small modular reactors, thorium reactors, and nuclear fusion. Renewable energy responses include wind, solar and marine (both tidal and wave) sources. Energy storage is often mentioned as a supportive technology alongside renewables.

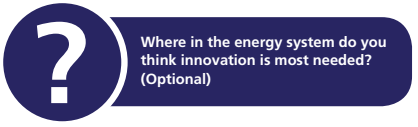
There is a tendency among respondents to mention electricity-related technologies as being those with the greatest potential to transform the energy system, whereas heat- and transport-specific technologies received fewer than 40 mentions combined. This focus on a relatively narrow sector of the energy system may reflect members' expectations that electricity will make a significant contribution to the supply of transport and heat by 2030. Of note, a number of respondents name 'technologies' which are intangible, including improved system and technology efficiency or demand management and reduction.

Innovation

When asked where in the energy system innovation is most needed, energy storage is singled out as the clear leader. This was also the case in 2015. Renewables, smart grid technology and energy efficiency are also frequently mentioned. There is an emphasis on integration between technologies, again identifying energy storage and the smart grid to support the expansion of renewable generation capacity. System-wide innovation in energy efficiency is called for to reduce demand and improve security of supply.

Dynamics

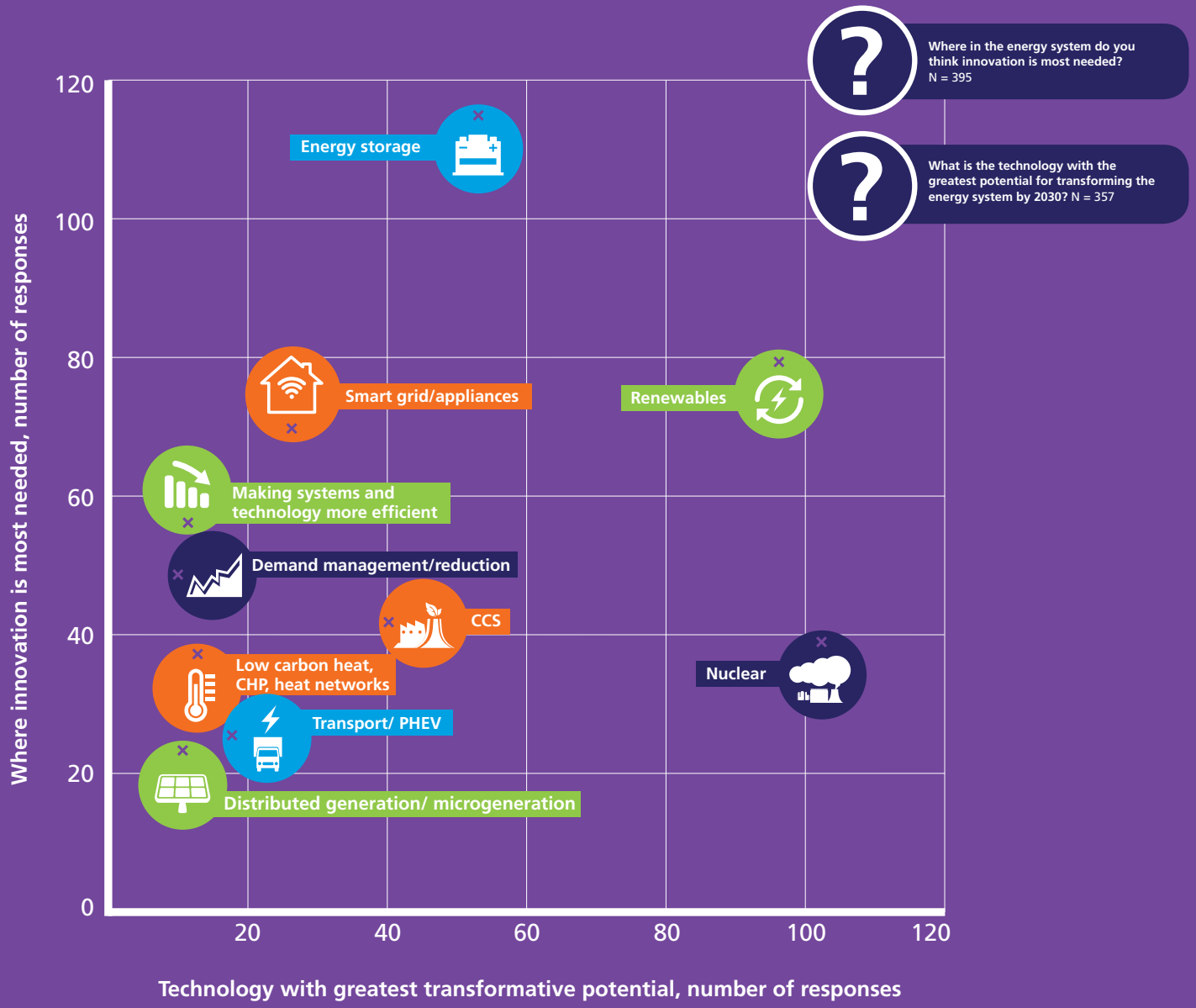
Viewed in tandem, responses about the transformative potential of, and need for, innovation highlight those areas which may require additional support to be fully exploited. Renewables, energy storage and the smart grid are all identified as playing potentially important roles in transforming the energy system, but also top the list for needing innovation. Facilitating this innovation and unlocking the potential of these technologies might involve a combination of additional support and the removal of barriers.



"Integration of renewables into smarter infrastructure"

"Energy Storage – building/vehicle scale and utility scale for reducing peak demands and making use of low carbon sources which can be variable (solar, wind)"

Innovation need and technology potential



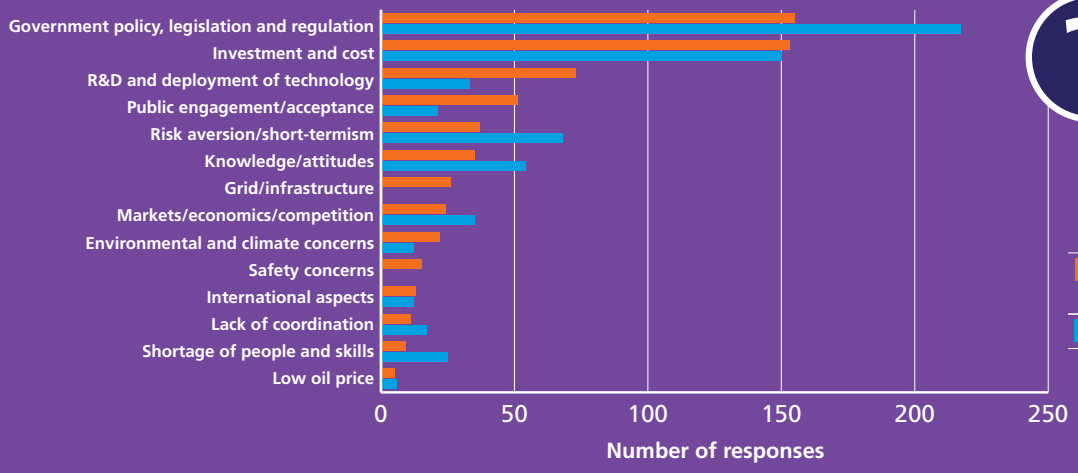
Barriers to transformative technology

What are the biggest barriers to the uptake of the transformative technology you have identified? N = 353: Free responses coded and summed

1 Investment and cost

2 Government policy, legislation and regulation

3 R&D and deployment of technology



What do you see as the largest barrier preventing innovation in the UK? N = 397: Free responses coded and summed

Barriers to transformative technology

Barriers preventing innovation

Enabling and inhibiting factors

EI members say that the UK's greatest innovation strengths are in research and academia (universities in particular), the people and skills within the energy industry, and the expertise and R&D of private companies. These responses emphasise the strength embodied by the people working in the sector and institutions enabling collaboration, as opposed to material, technological or natural resources.

Alongside members' assertion that attracting and retaining skilled workers is a challenge in 2016, these results emphasise the importance of supporting the development of people. The energy industry's human resources are integral to its ability to innovate and achieve its energy goals.

Barriers

EI members send a strong message about which factors they see as preventing innovation with these technologies. Respondents identify 'government policy, legislation and regulation', and 'investment and costs' as the top barriers to both transformative technologies and to innovation. This echoes the key challenges to the whole energy system identified by members, and reiterates the call for clear policy signals that enable investment to move the energy system toward future goals. Apart from the overarching policy stability and investment messages, respondents cite risk aversion as a common barrier to innovation, and deployment to market as a hurdle for transformative technologies.

"To respond to the challenges of climate change and growing energy demands, it is crucial that we rapidly electrify our energy needs and decarbonise the electricity sector. More than ever, we must innovate the generation, distribution, storage and management of consumption of electricity. This can only be achieved with strong collaboration and coordination of industry and academia and a supportive and consistent policy framework"

Jonathan Cole
Managing Director, Iberdrola Renewables

What do you see as the UK's greatest strength in terms of innovation? (Optional)

"Fantastic research and development institutions, both academic and in industry with a very motivated, passionate, young cohort of students wanting to innovate and respond to the energy crisis"

"The depth of knowledge in all aspects of energy generation and utilisation in industry and higher education institutions"

Energy storage

The 2015 findings drew attention to energy storage as an area of outstanding potential for transforming the energy system. As a result the 2016 survey looked in more detail at the scale at which storage could make the greatest impact, and which storage technologies are appropriate in various applications. The aim is to develop a picture of the role respondents expect energy storage to play across the energy system out to 2030, and what barriers stand in the way.

Potential for energy storage is seen by EI members at all scales of the energy system. However, distribution network-level (local or regional) was most frequently cited, followed by transmission network-level (national).

Respondents also specified which storage technology they believe has the most potential to provide cost-effective capacity by 2030, given the fact that most existing storage comes in the form of pumped storage at hydroelectric stations. Batteries were the preferred technology at all scales, increasingly so at smaller scale. At transmission scale, increased pumped hydroelectric storage was the next most cited technology.

It should be noted that when asked at which scale energy storage has the most potential, 16% of respondents indicated that 'energy storage will not be a significant part of the UK energy system in 2030'. This may be a reflection of concerns around barriers to innovation and transformative technologies as they relate to energy storage.

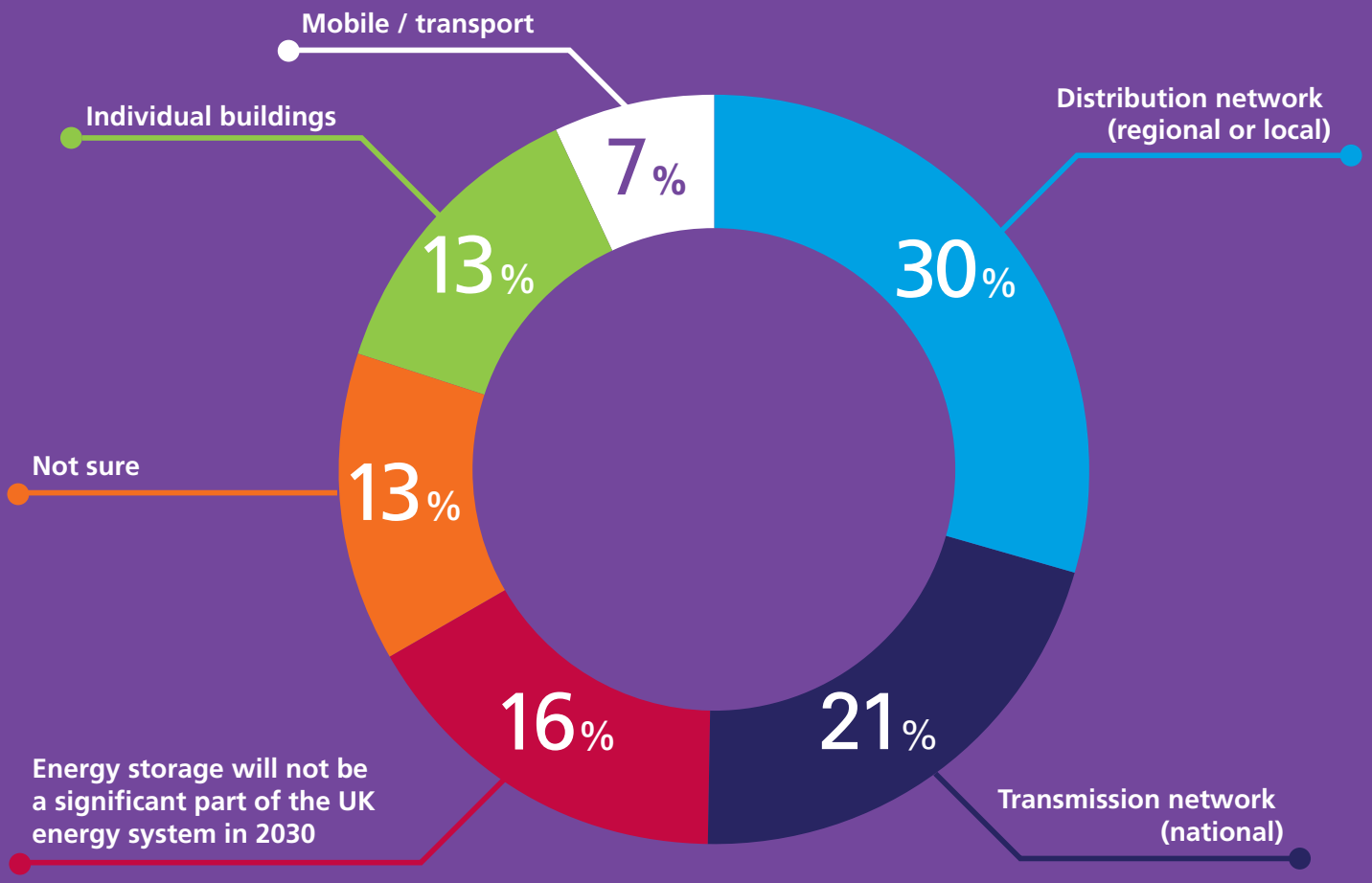
As expressed in other contexts, EI members perceive the main barriers to deployment of energy storage to be investment and cost. 'Limitations of existing technology' is the next most popular response, followed by 'energy policy, legislation and regulation'. These findings reinforce the message that energy storage is in great need of innovation and has the potential to transform the energy system by 2030, but investment to develop and deploy these technologies will require stable energy policy.

What is the largest barrier to deployment of energy storage capacity? N = 315: Free responses coded and summed

Barrier	Responses
Investment and cost	153
Limitations of available technology	89
Energy policy, legislation and regulation	48
Markets, economics and pricing structure	34
Technology support, deployment and innovation	27
Lack of incentives	26
Knowledge, attitudes and leadership	25
Grid infrastructure	18
Planning and land use	17
Public engagement/resistance to change	14

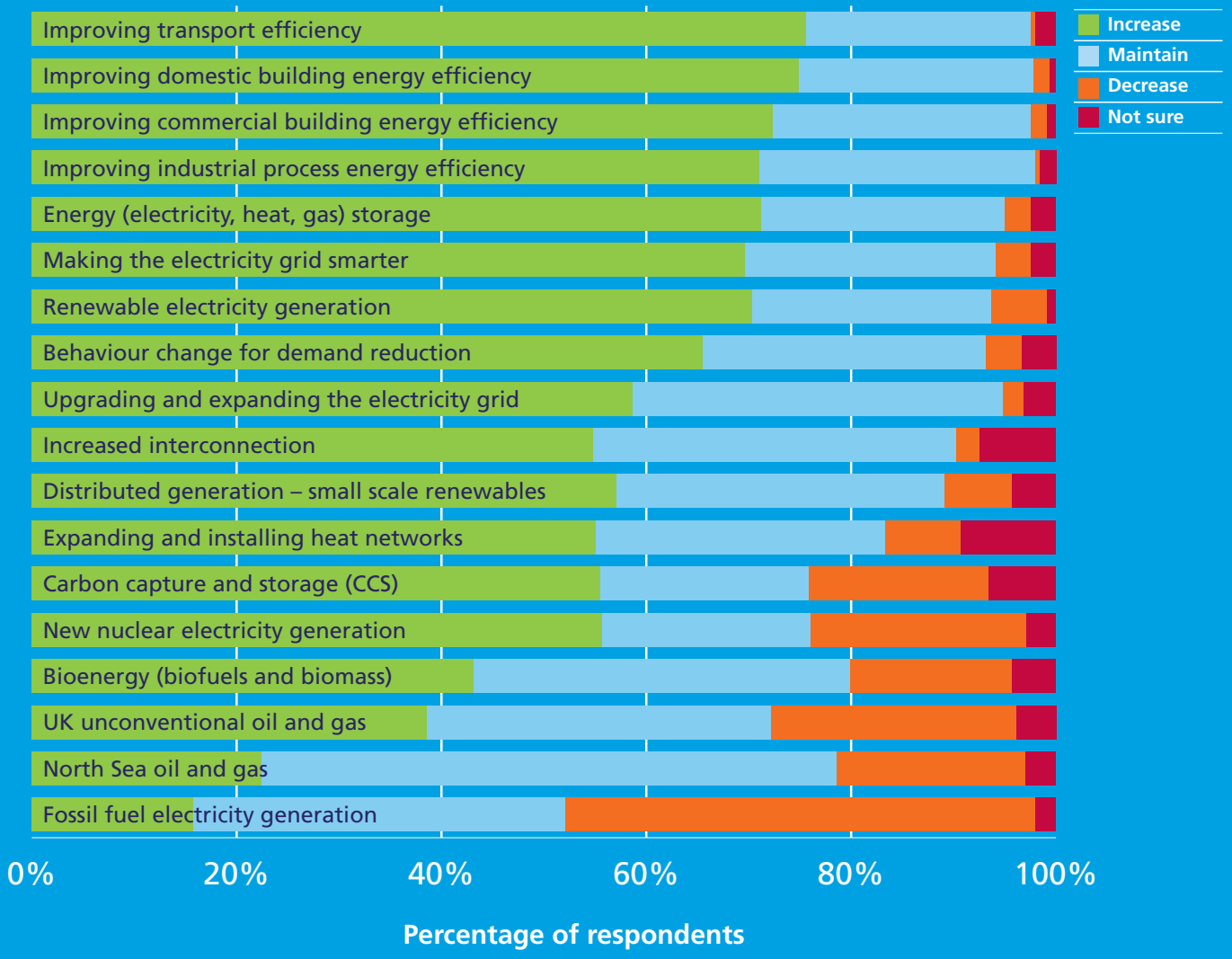
Greatest potential for future energy storage

Where is the greatest potential for future energy storage technologies in the UK in 2030? N = 438



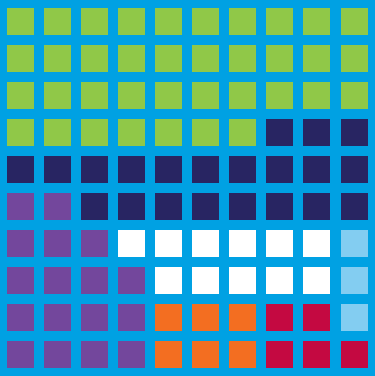
Changes in investment levels

In order to maintain security of supply and meet environmental goals affordably, what do you think should happen to UK investment levels (from all sources) for the following areas over the next 3 years? N = 438



Preferred sources for infrastructure funding

Where should the majority of funding for large-scale energy infrastructure come from? N = 438: Expressed as a percentage of respondents. Each small box equals one percent.



- Government-Private partnerships
- UK Government and devolved administrations i.e. taxpayers
- Private sector energy companies
- Institutional investors (banks, hedge funds)
- International (e.g. EU funding)
- Consumer bills
- Other

LEVERS AND ACTIONS

Levers and actions

Having provided their perspectives of the current state and future direction of the UK energy system, members were asked about actions needed to meet their stated challenges. Sustained investment is seen as an imperative across the entire energy system, and is contingent upon stable policy signals and smooth policy transitions. More specific measures for meeting emissions targets are identified by respondents as they assess what is effective on the ground. A strong emphasis is again placed on people: both those that apply their skills and expertise to providing essential services, and the public relying on those essential services. Energy professionals stress the importance of connecting with people in new ways to attract and retain talent in the industry and to gain the acceptance and trust of customers and communities.

Investment

As they did in 2015, energy professionals call for increased investment across the energy value chain to maintain security of supply and meet environmental goals affordably. The strongest increases are recommended across energy efficiency in transport, buildings and industrial processes. The next largest increases are suggested for energy storage, smart grid, and renewable electricity generation, which were similarly identified as areas that have the potential to transform the energy system but are in need of innovation. Compared to last year, renewable electricity generation has seen the greatest rise in responses for increased investment.

Electricity generation from fossil fuels has again been singled out as the only area where investment should not be increased. This message is more exaggerated than in 2015, while North Sea and UK unconventional oil and gas are also seen to need less investment compared to other sectors and to last year. This move away from investment in fossil fuels reflects the challenge identified by EI members to transition to a low carbon energy system in a drive to meet ambitious emissions targets.

Large scale infrastructure

For the first time, EI members were asked where funding for large scale infrastructure should come from. The most common response was for government-private partnerships to fund these kinds of projects, followed by UK government and devolved administrations. There is least support for drawing funding from consumer bills. Overall this echoes the preferences for sources of the $100bn climate fund for developing nations, which also leaned towards government-private partnerships and away from consumer bills.

> **"Once again, members have strongly signalled the need for policy stability on renewable energy projects as the key priority for meeting both long and shorter term targets. And they see this happening through Government-Private partnerships. To me, policy stability does not mean freezing subsidies, but rather giving clear indications of how support will change over time. All investors want is confidence in what the Government will do. And they do, after all, have choices about where to invest"**
>
> **Dr Bernard J Bulkin FEI**
> Member of Council of the Energy Institute, Chairman, K3Solar and Chairman, Ludgate Investments Limited

Policy measures

EI members express scepticism over the UK's ability to meet approaching carbon budgets and the 2050 emissions target. When asked which single measure would best be taken by the UK Government to reach emissions targets, support for renewable and nuclear power generation are the leading responses. These also come out on top as the technologies with the greatest potential to transform the energy system by 2030, and are expected to make strong contributions to the UK's electricity mix in 2030, alongside gas.

Increased investment levels and stable policy signals are imperative for the technologies that energy professionals see as playing a big role in energy security and decarbonisation through 2030. There will also be a need for skilled professionals to deliver these infrastructure changes and the transformation of the energy system.

What single measure would be best taken by the current government to reach these UK emissions targets? N = 368: Free responses coded and summed

Measure	Responses
Renewable energy	77
Nuclear	70
Policy stability	58
Financial incentive	43
Energy efficiency	43
Technology support, deployment and innovation	40
Carbon pricing/tax/trading	35
CCS	33
Focus on transport	31
Demand management/reduction	21

"To create a long term strategy on generation and more focus on encouraging renewable technologies through incentives. To boost confidence in this policy, do not change the conditions"

Respondent's 'Greatest challenge'

Supply of qualified workers: 2016 vs 2021

Can you identify any existing surplus or shortage in qualified workers in any of the following energy sectors: N = 438: Net perceived supply calculated by subtracting 'shortage' responses from 'surplus.' 'Neutral' and 'Not sure' responses not included.

In the next 5 years, do you foresee surplus or shortage of qualified workers in each of the following energy sectors: N = 438

"Demography, ageing workforce and in oil and gas a huge flow of competency and knowledge from the industry"

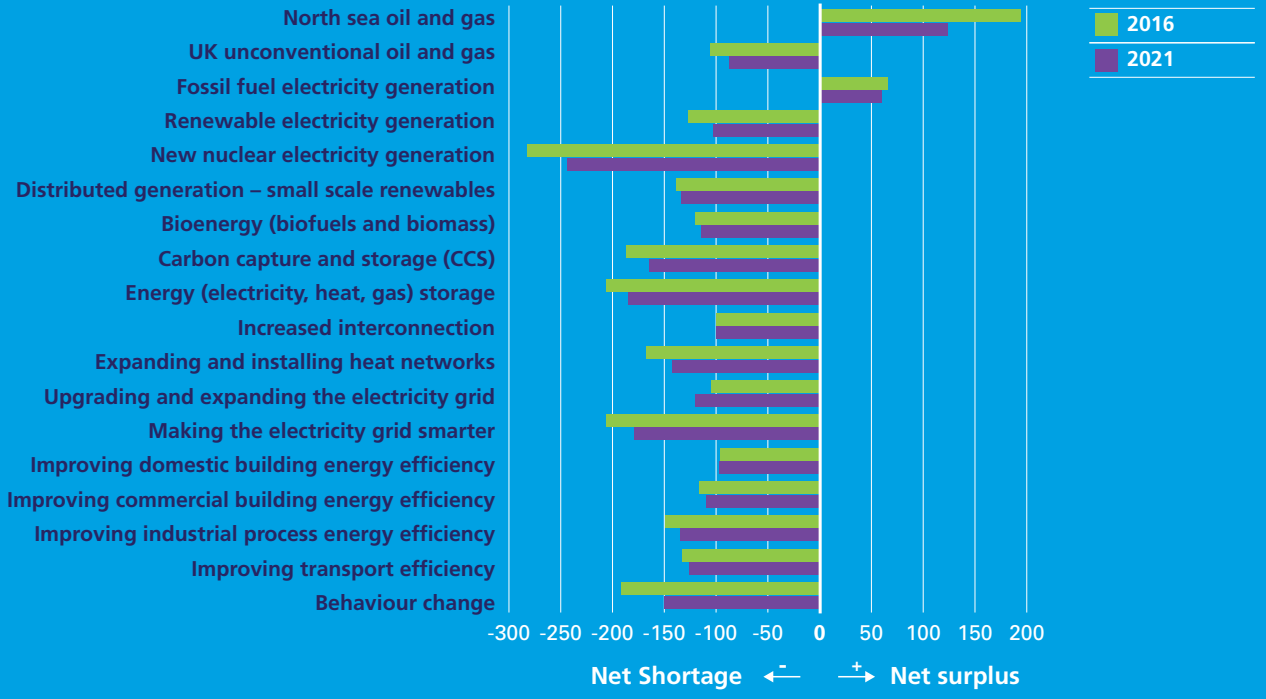
Respondent's 'Greatest challenge'

Skilled workforce

As with investment levels, energy professionals identify a shortage of skilled workers across all sectors except North Sea oil and gas and fossil fuel electricity generation. New nuclear capacity, identified as vital to meeting security and decarbonisation goals, is seen to have the greatest shortage in skilled workers, both today and in five years' time. This is felt more acutely than in 2015 over both timescales.

Energy storage and making the grid smarter are seen to have the next most pronounced skills shortages, with renewables aligning closer to the average. Overall the message is similar to last year's Barometer report, although shortages are seen to have decreased in UK unconventional oil and gas, and increased for energy storage and making the grid smarter.

> **Finding bankable talent in an emerging sector is always going to be a challenge. Energy storage is hugely multidisciplinary; which forces us to get a little more creative in recruitment. We have to look further afield towards other technologies and industries to identify skilled, passionate and adaptable people who we can develop in house"**
>
> **Andy Hadland** Chief Development Officer, ARENKO Cleantech



Public communication by sector

How do you think your area of the energy industry communicates with the public? N = 438: Results displayed as a percentage of the respondents within each sector.

Acceptance and trust

- There is little or no effort made with this type of engagement
- This is not considered a priority area
- This is done as a matter of course
- This is prioritised and is part of key strategies for my sector
- My sector leads the way with this type of engagement

Active involvement

Outgoing communication

Incoming communication

Public engagement was identified as a top challenge for 2016 by EI members. There is a strong desire from energy professionals to communicate better with the public and foster greater understanding, acceptance and trust. Respondents were asked about their own sector of the energy industry, and which types of communication are prioritised – outgoing (informing, explaining activities and plans), incoming (asking for and listening to information, ideas and concerns), and active involvement (enabling the public to make an impact on decisions and strategies).

Respondents across sectors generally see outgoing and incoming communication undertaken as a matter of course, though the perception is less positive for those in the demand management and buildings sector. Active involvement, however, is seen as less of a priority across all sectors, and in many cases is given little or no effort. Those working in demand management and buildings perceive least priority given to this type of 2-way communication, followed by those working in natural gas and oil. The most positive view of involvement comes from academia and research, and heat and power generation including renewables, where just under half of respondents in these sectors believe they involve the public as a matter of course or as a priority.

EI members were also asked to provide an example of a programme, campaign or initiative from the energy industry that successfully engaged the public, and state why it was successful. It is perhaps telling that members had to reach back 30 years to find campaigns that had caught the public's imagination. The transition from town gas to natural gas and the public sale of British Gas (the 'Tell Sid' campaign) were frequently cited by senior members of the College, alongside major development projects which involved local communities. Those campaigns are seen to have succeeded primarily because they involved some financial incentive or engaged with communities on a local level. Programmes identified by members that would have benefitted from public engagement include unconventional oil and gas along with energy efficiency and demand reduction. Recapturing the public's imagination is perhaps the biggest hurdle to communicating effectively with the public.

> **"Once public trust has been lost, it takes an awfully long time to regain. Crucially it's not just communication with the public that needs to improve – it's the consistent behaviour of some firms themselves. The industry is in a difficult place and it won't see any substantial change in public mood for a while, especially when politicians' statements on energy are in such disarray"**
>
> **Roger Harrabin**
> Energy and Environment Analyst, BBC

> **"Trust has to be earnt and we all have a role to play here. Companies by doing the right thing and acting responsibly. Policymakers by working consistently from a good evidence base. Others like the EI and the media by improving understanding and the quality of the debate. Like the development of the energy system itself, it's a long term commitment to get it right"**
>
> **Louise Kingham OBE FEI**
> Chief Executive, Energy Institute

The role of the EI

Louise Kingham
OBE FEI

The Energy Institute (EI) has developed and shared knowledge, skills and good practice for a safe, secure, affordable and sustainable energy system throughout the 20th century and into the 21st. As the professional membership body for the energy sector, we support over 23,000 individuals working in or studying energy across the world.

These individuals hold a wealth of insight and experience, and the EI has a responsibility to apply this knowledge to drive progress in the energy system. To fulfil this responsibility for public benefit, the EI annually conducts the Energy Barometer survey which gives a voice to energy professionals, enabling them to inform the energy debate. It also demonstrates the value of their knowledge and expertise to governments, influencers, the industry, and the public.

Members of the EI College have been asked for their thoughts on the UK energy system and their perception of the challenges and opportunities facing their industry. By capturing these views, this report provides a conduit to the knowledge of those at the heart of the industry, energy professionals. Work doesn't stop with the publication of this report, in fact it signals the start of new work to respond to some of the challenges identified.

By fostering the expertise of energy professionals we can work towards solutions to the concerns they have raised. There are a number of areas where we plan to conduct further research and contribute to finding solutions, including: incentivising new infrastructure investment; decarbonisation of heat; energy system scenarios for 2030; market signals for long term certainty; and future skills.

There is also a need to improve the quality of the energy debate and bring all voices together to learn from each other and find answers together. We will do this across our networks, from Fellows' Debates to Young Professionals events, regionally and nationally. We will continue to build our activities around improving understanding for people who influence the energy system, to encourage a system-based approach to its future development. We will also continue to seek partnerships and collaborations to improve the consumers' understanding of energy to increase its value and relevance to us all.

It is my sincere hope that the Energy Barometer report is a useful tool for all those involved in shaping our energy system. I invite all those with a responsibility for, and interest in, energy to consider these expert insights and talk to us about how together, we can make the most of this resource.

Louise Kingham OBE FEI
Chief Executive, Energy Institute

Method

The 2016 Energy Barometer is the second in a series of annual surveys of the EI College, a group representative of EI professional and pre-professional members. The survey was sent to 729 College members, of which 517 were respondents to the 2015 survey and 212 were new this year. Together they form the 2016 EI College. This includes the professional member grades of Fellow (FEI, N = 258), Member (MEI, N = 273), and pre-professional Graduates (GradEI, N = 216). This process was designed to ensure a diverse range of sectors, disciplines, and seniority levels were included in the sample.

The survey questions were established by the EI Knowledge Service (EIKS), under the guidance of the EI's Energy Advisory Panel (EAP) and industry-wide experts. The questions within the survey were both quantitative and qualitative. Some questions are repeated annually to form trends over time; others cover topical subjects which change year-to-year.

The survey focuses on the UK's energy system, and encompasses a wide range of topics including energy policy, investment and innovation, emissions targets, skills and knowledge retention, communication and engagement and energy prices. The questions were refined with the help of Dr Dimitrios Xenias at Cardiff University before being disseminated to the EI College.

A total of 438 participants fully completed the survey online in February 2016. The responses were analysed by EIKS to assess key findings and interpret themes from the results. The findings represent the views of the EI's professional and pre-professional members. In some cases, the views of subsets of respondents (where $N \geq 100$) have been included. This report, which compiles the headline results of this research, represents a step towards creating an informative, useful picture of the energy industry based on the views of those working within it.

The complete set of data used in this Energy Barometer report is available online at **www.energyinst.org/energy-barometer** Additional research covering solutions to challenges identified (e.g. decarbonising heat, 2030 energy system scenarios) will be conducted by the EI later this year.

Notes

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