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Review of Energy Policy 2019

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Summary of recommendations

Jim Watson

Climate change is higher on the agenda than ever this year. The UK government has raised the level of ambition, legislating for a net-zero target for all greenhouse gas emissions by 2050. Whilst it may be possible to achieve this goal before 2050, the political debate about the target year risks distracting attention from a crucial question: what actions will the next government take to significantly reduce emissions?

This year's Review of Energy Policy focuses on seven themes that form the backbone of UKERC's research programme for the next five years. The Review sets out some of the challenges the next government will face – and makes specific recommendations about future policy priorities. Our key recommendations are:

1. The transition to net-zero will affect the whole economy. Investment and policy decisions by all government departments need to be compatible with this transition.
2. Policies to support renewable electricity generation should be more ambitious, building on deployment and cost reduction successes. Action is also needed to ensure electricity market rules are fit for a fully decarbonised power sector.
3. Decisions by the energy regulator, Ofgem, should also be compatible with net-zero. This includes enabling investment in local electricity networks to facilitate heat and transport decarbonisation, and ensuring more active use of existing networks.
4. Local energy systems could play a significant role in achieving net-zero, particularly in the integration of electricity, heat and transport. More resources and greater powers for Local Authorities will help to ensure the potential for local action is realised.
5. A clear plan is required for upgrading the UK housing stock. A heat and energy efficiency White Paper must include policies for widespread deployment of low carbon heat (including demonstrating hydrogen at scale) and for prioritising low income households.
6. Whilst the decarbonisation of industry is receiving more attention, policy initiatives are not joined up. Funding for specific projects and industrial clusters should be complemented by market creation policies, including for carbon capture and storage.
7. Our analysis shows that achieving net-zero requires the phase out of fossil-fuelled vehicles to be brought forward to 2030. Immediate action is also required to counter the rapid increase in sales of larger cars (including SUVs).
8. Plans to meet net-zero should maximise environmental co-benefits. Potential negative impacts on ecosystems should be assessed and mitigated.
9. Continuing uncertainty about the UK's changing relationship with the European Union has already affected decarbonisation plans. Whatever the outcome, close co-operation with the EU is likely to make it easier to achieve net-zero.
10. The transition to net-zero should not compromise energy security. In light of the events on August 9th, responsibilities for ensuring system resilience need to be clarified and applied in a more rigorous way.

Securing our energy future: Brexit and net-zero

Michael Bradshaw, Antony Froggat, Caroline Kuzemko

Today the UK imports about half of the energy that it consumes, largely from within the EU's Internal Energy Market (IEM), which includes Norway. Any future Government must now square the dual challenges of energy security – ensuring secure and affordable energy services, and decarbonisation – putting the energy system on the path to net-zero by 2050. Within the context of Brexit, key policy issues include:

- Negotiating a new relationship with the EU'S Internal Energy Market (IEM);
- Retaining the Single Electricity Market (SEM) on the Island of Ireland;
- Implementing a carbon pricing regime to replace the EU's Emissions Trading System (ETS);
- Securing the substantial amounts of investment needed to create a zero-carbon energy system.

The Brexit Interregnum

Since the 2016 referendum, the UK Government has failed to agree on Brexit. This continuing 'Brexit Interregnum' has resulted in a loss of time and policy momentum, the most recent casualty being the Energy White Paper. The political parties have been rather vague on their plans for the UK's energy future as uncertainty over Brexit continues to make it difficult to plan. At the same time, the wider global energy system is experiencing a period of 'radical uncertainty' as the consequences of climate change are increasingly apparent and the low carbon energy transition is gaining momentum[1].

Beyond Brexit

Placing the UK's energy transition in global context alongside the continuing uncertainty of Brexit raises a set of challenges that future energy policy must address. The exact nature of those challenges is dependent on the UK's subsequent relationship with the EU which could still include: 'No Deal Brexit'; 'Hard Brexit'; 'Softer Brexit; and 'Remain'.

> "Brexit Interregnum' has resulted in a loss of time and policy momentum, the most recent casualty being the Energy White Paper."

Our initial research has highlighted four areas where the scale of the challenge and final outcome will be determined by the outcome of Brexit.

Interconnection and market coupling: as the EU's electricity and gas markets have become increasingly integrated, this has improved efficiency and security and delivered savings to consumers. In the future, the more distanced the UK is from the EU's IEM the greater the cost to consumers, a situation that will be aggravated by any further devaluation of Sterling. Furthermore, as decarbonisation continues the cost of balancing the UK's power system and securing gas when needed may increase[2].

Ireland and the SEM: a single regulatory body operates across the whole of Ireland. In the event of 'No Deal', market problems would be significant across the island of Ireland. The importance of the SEM is recognised in the Protocol on Ireland/Northern Ireland included in the Withdrawal Agreement, which would enable the SEM to continue with current EU market trading, including the Emissions Trading System (ETS) continuing to apply across the whole of the SEM[3].

[1] Van de Graaf and Bradshaw. (2018) dx.doi.org/10.2139/ssrn.3291655

[2] UKERC. The Cost of Bilaterally Uncoupling British-EU Electricity Trade. 18 Dec 2018. See: http://bit.ly/2RGKylX

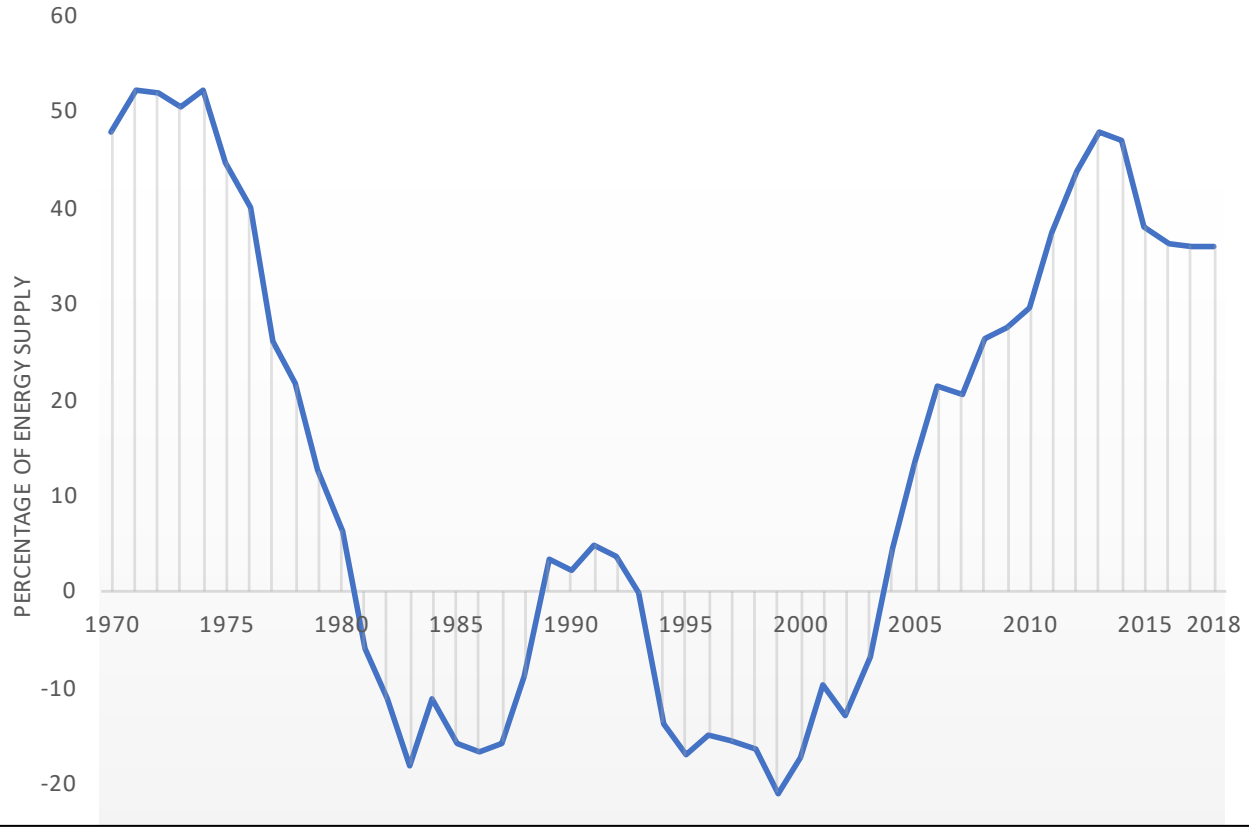
ETS: As the UK leaves the EU, it will no longer be part of the Union's ETS but the October Political Declaration states that in the longer term the UK will seek to have its own trading system that is linked to the ETS. In the event of 'No Deal' the UK Government will introduce a Carbon Emissions Tax, at £16 per tonne. The new tax will cover the majority of the sectors covered by the ETS, but excludes aviation[4].

Investment: The EU has been a source of considerable grants and loans for the energy sector over the last decades, in particular grants from the EU's structural programmes and the loans from the European Investment Bank (EIB). The Brexit process has already affected these and the value of EIB loans to the energy sector decreased tenfold between 2015 and 2018. Building a net-zero energy system requires an acceleration of investment and new domestic funds are needed, as Brexit uncertainty has already put-off some foreign investors and slowed economic growth.

> "Fully decarbonising the UK economy by 2050 will be a monumental challenge, but one which will be made easier with close co-operation with the EU."

Meanwhile, the EU is accelerating its plans to decarbonise. The incoming President of the European Commission has said: "At the heart" of the new Commission "is our commitment to becoming the world's first climate-neutral continent."[5] Fully decarbonising the UK economy by 2050 will be a monumental challenge, but one which will be made easier with close co-operation with the EU.

Figure 1: UK Energy Import Dependency 1970-2018



[3] UK Government. (2019) Revised Protocol to the Withdrawal Agreement, on Ireland/Northern Ireland, 17 Oct 2019. See: http://bit.ly/2OzvcqB

[4] UK Government. (2019a) Guidance Meeting climate change requirements if there's no Brexit deal, 5 Nov 2019. See: http://bit.ly/2DEATNH

[5] Euractiv. Green Deal branded as 'hallmark' of new European Commission. 11 Sept 2019. See: http://bit.ly/34zt8o2

Net-zero for local and regional energy systems

Janette Webb

Reaching net-zero is expected to include a greater emphasis on locally integrated systems for heat, power, transport and energy storage. In theory this improves 'whole system' economics of clean energy by helping to balance supply and demand on a network with high levels of intermittency. Localised systems are expected to optimise use of local generation and heat sources (and surplus electricity) for district heating with thermal storage. Alongside this, Government expects new local business structures to retain value and improve productivity, welfare and energy justice in local economies. These government ambitions are surprising, given past UK emphasis on economies of scale from centralised generation and markets.

For network operators, a key technical issue is the increasing renewable electricity generation being fed into distribution networks[1] not designed to balance two-way supply and demand. Growth of micro renewables and storage 'behind the meter', and expected electrification of transport and some heat, are adding further uncertainties over local network planning, costs and operator services[2]. There is particular interest in reducing capital investment by monetising local flexibility services to optimise use of network capacity, with 'flexibility marketplace' pilots[3] designed around local aggregators and storage. For the regulator, there are questions about standards for distribution services, flexibility procurement and market platforms, while avoiding perverse incentives.

The challenge of devolved decision making

Technical change is however only part of the mix. Some have argued for more devolved, democratic decision making about energy, partly as a result of UK devolution and Brexit. Debate over renewable heat has also highlighted potential for locally differentiated solutions, requiring local authority (LA) planning. Many LAs have ambitious plans, but investment varies[4]; projects are prone to stalling, over money for feasibility and investable business plans; political uncertainty; and a perceived maze of government departments, financial sources and procurement rules. UK central and devolved governments are exploring new frameworks, albeit investment is limited.

> "Many Local Authorities have ambitious plans, but investment varies and projects are prone to stalling."

The £1.6 million BEIS Local Energy Programme funded development of strategies by (English) Local Enterprise Partnerships in 2017, and £4.8 million has established five pilot Local Energy Hubs in England. Scottish and Welsh governments also propose LA engagement, but local and regional governance is constrained by powers reserved to Westminster. The Scottish government has the only proposal for new LA statutory powers for heat and energy efficiency strategies and district heating regulation[5], but there are political tensions over resourcing.

1 Estimated capacity of GB distributed generation is 23GW, relative to peak demand of 61GW (Future Energy Scenarios, National Grid, 2017).

2 Bell and Gill (2018). doi.org/10.1016/j.enpol.2017.11.039

3 See for example http://bit.ly/2Y5Lpa4

4 Webb, Tingey and Hawkey (2017); UK100; District Energy Vanguards.

Technical and societal agendas are inextricably interconnected, as exemplified in the 2011-2019 Smart Systems and Heat (SSH) programme led by ETI/ Energy Systems Catapult. SSH envisages local heat planning, informed by cost-optimised modelling tools and coordinated by LAs, to support markets for heat services. Three pilots revealed the gulf between engineering models and LA approaches to energy and spatial planning, highlighting a lack of LA resources, and the mis-alignment of LAs, Distribution network operators (DNOs) and developers[6]. Different roles for local governments were also implied by SSH scenarios: local energy planning entailed a significant LA role, but 'heat as a service' envisaged market choices by individual owner occupiers. In the latter, local democratic participation in a workable consensus over renewable heat is marginalised.

Addressing uncertainties

Overall there are questions about whether localised energy systems, which serve local goals and help to meet net-zero in a 'whole system' way, can be realised in UK liberalised, centralised markets. Contested assertions about finance, technology, types of provision, regulation and ownership create new demands on governance for potentially different local, regional and national priorities, with differential risks, costs and benefits. New developments are addressing some uncertainties. Examples include first the £102.5 million UK Industrial Strategy Challenge 'Prospering from the Energy Revolution' for local energy system demonstrators, designs and research. Second the National Infrastructure Commission 2019 Report proposes greater devolution of regulatory processes for infrastructure investment, including local scale where planning interacts with network regulation (p.11).

Answers cannot emerge from data, engineering models and technical innovation alone. If local energy systems are going to play a larger role, democratic political leadership for policy is urgent. This will require the devolution of energy powers and budgets to Scottish and Welsh governments and Local/Combined Authorities. This devolution could also support stronger devolved and local policies such as comprehensive support for thermal retrofit of buildings to reduce system costs; incentives for net-zero integrated local systems, including socio-technical demonstrators; a transparent framework for investing using socio-economic metrics (not simply the fastest payback); and a local engagement with citizens to so that decision-making is more inclusive.

> **"If local energy systems are going to play a larger role, democratic political leadership for policy is urgent, which will require the devolution of powers and budgets."**

Local renewable energy scheme. Solar lighting along path in housing estate.

[5] http://bit.ly/33rOGRT

[6] Cowell and Webb (2019). http://bit.ly/2OYXKZz

Ensuring net-zero is a win-win for the climate and the environment

Nicola Beaumont, Alona Armstrong, Paolo Agnolucci, Astley Hastings, Rob Holland, Brett Day, Gemma Delafield, Felix Eigenbrod, Gail Taylor, Andrew Lovett, Anita Shepard, Tara Hooper

The path to net-zero will require an immense institutional, societal and environmental transition with both positive and negative secondary consequences. In the urgency to meet net-zero caution must be exercised to avoid exchanging one environmental crisis for another. The implications for other policy drivers, including the recent 25 year Environment Plan, the forthcoming Environment Bill, and agricultural policy reform cannot be neglected. The implementation of these policies must be harmonised and trade-offs evaluated, with negative impacts minimised and co-benefits maximised. Cross-government working needs to be a priority, with relations between the environment and energy communities strengthened. The use of spatially resolved land and marine systems approaches is essential to enable a holistic perspective and to ensure optimal solutions that maximise wider environmental co-benefits.

> "In the urgency to meet net-zero, caution my be exercised to avoid exchanging one environmental crisis for another."

Swapping global scale climate change for local scale ecosystem degradation?

A key action on the path to net-zero is the growth in renewable energy, necessitating expansive land and marine use change. Given land and sea use change is one of the greatest drivers of environmental degradation[1] there is a real risk that solving the carbon problem will be at the expense of creating a host of other environmental problems, including biodiversity loss. Current net-zero deliberations, have considered which energy types can be implemented, but there has been very little focus on where installations and crops will be sited and what their environmental implications will be[2,3].

A win-win solution

It is evident that if the transition to net-zero is not prudently managed there is a danger of triggering a range of negative unintended environmental consequences[4], both within the UK and abroad. Taking a global perspective this could include a net increase of the UK's carbon emissions, via for example, increasing carbon intensive imports. Equally, the UK based environmental trade-offs of net-zero policies should be balanced against the avoided global environmental impacts elsewhere. Judicious management of the transition could however enable win-win outcomes, maximising ecological co-benefits of energy system decarbonisation and alleviating pressures on natural resources[5]. To achieve these positive outcomes discussions must be held in the same space[6]. At a policy level this will necessitate stronger partnerships between BEIS, Defra and other governmental departments including MHCLG, and the bringing together of academics, industry, user groups and stakeholders from different disciplines.

1 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.
2 Holland et al. (2018). doi.org/10.1016/j.apenergy.2018.04.022
3 Hooper et al. (2018). doi.org/10.1016/j.enpol.2018.01.028
4 Hooper, et al. (2017). doi.org/10.1016/j.rser.2016.11.248

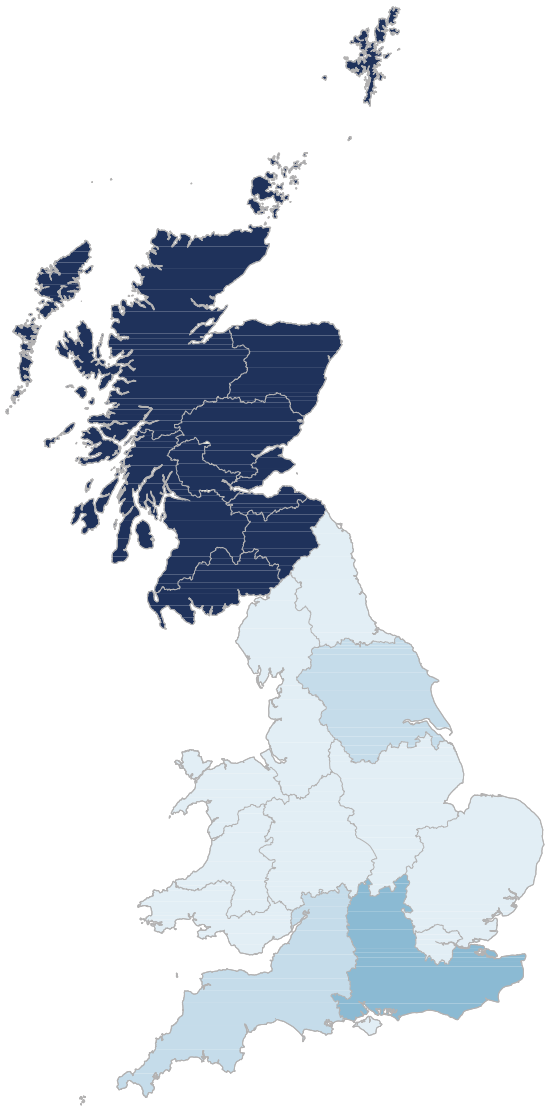
A holistic systems approach

Any net-zero pathway is likely to result in significant competition for land and marine space, as space needed for energy production will directly compete with needs for food production, including shifts in diet, and Greenhouse Gas Removal, including afforestation. Spatially resolved systems approaches will be essential to enable informed decision making[7]. Figure 2 shows the land use change required to meet a UKERC scenario for the previous 80% emissions reduction target, without the use of CCS. It illustrates the changes associated with generating electricity from solar farms, wind farms and bioenergy power stations fuelled by locally grown miscanthus and short rotation coppice. The results show that approximately 29% of Great Britain's arable & temperate grassland would need to be utilised for energy purposes, almost all of which would be converted to bioenergy crops. This figure does not include associated environmental implications, such as changes in biodiversity and flood risk, and given the extent of land use changes they are likely to be substantial. Whilst this scenario is not representative of a net-zero pathway it is currently the closest proxy available. Scenarios for achieving net-zero are currently under development and once completed their wider implications can be explored, providing key evidence to underpin the choice of an optimum pathway.

To avoid further environmental degradation, and maximise co-benefits, the overarching policy priority must be to embed environmental research and policy into the UK energy system transition and net-zero pathway.

> "To meet an 80% emissions reduction target without CCS, 29% of arable and temperate grassland would need to be used for energy purposes."

Figure 1: Regional % loss of arable and temperate grassland required to achieve the future energy scenario of Low Carbon with no CCS[7].



Analysis assumes no restrictions on the location of energy infrastructure, and therefore includes National Parks and AONBS.

[5] Hooper, et al. (2018). doi.org/10.4324/9781315666877

[6] Holland et al. (2016). doi.org/10.1016/j.enpol.2016.01.037

[7] Delafield G., Smith G., Lovett A., Day B., plus input from the ADVENT team. Model resolution in the spatial optimisation of complex decentralised energy futures. In development.

Heat: urgent policy action is needed

Jianzhong Wu, Richard Lowes, Meysam Qadrdan

The UK Government has emphasised the importance of decarbonising heating to achieve its industrial strategy, clean growth and net-zero objectives. The need for rapid and transformative change to the heating system is also recognised in the CCC's net-zero analysis. However, existing policy and regulatory frameworks are not compatible with the required transformation, and the governance of space and hot water heating needs to be overhauled.

Heat constitutes the single biggest use of energy in the UK, and accounts for over a third of the UK's greenhouse gas emissions. Despite uncertainty over the optimal low carbon heat technologies (e.g. hydrogen, electric or hybrid), especially for those connected to the gas grid, there are areas where policy and regulation can act now, including areas such as energy efficiency, off-gas grid consumers and dense urban areas. We also suggest that the timescales needed for heat decarbonisation by 2050 requires policy makers to embrace uncertainty and deploy low carbon heat technologies in areas where a gas grid is present, as it is possible that low carbon gas options may fail to materialise.

Low-carbon heat technologies

Ten years after the Climate Change Act was passed, there is still no plan or governance for decarbonising UK heating. Many of the fundamentals of the heat challenge remain the same as they were a decade ago. Energy efficiency measures, heat pumps and district heating in dense urban areas all need to be deployed rapidly at scale and this view is supported by the recent net-zero review by the CCC[1]. The Government's clean growth strategy also suggested significant growth of heat networks across all scenarios, even those with high levels of hydrogen.

Heat pumps, district heating systems, and heat recovery technologies are widely deployed in other countries (whereas hydrogen is not). Deployment of these technologies in the UK is limited and the upcoming heat pump and hydrogen trials should provide valuable UK data, particularly hydrogen for heating which appears internationally novel. There is a need to improve knowledge about whether and where low-carbon heat technologies will work in the UK, and what the costs and other impacts might be. This can support further decision-making and create room for energy system integration and optimisation. However, the delivery of trials should not detract from the rapid deployment of other low carbon heat technologies.

> "Despite uncertainty, there are areas where policy and regulation can act now, areas such as energy efficiency, off-gas grid consumers and dense urban areas."

Policy and governance focus

It is encouraging to see the Government's commitment to banning fossil fuel heating in new homes in the 'Future Homes Standard' although this is not yet a live policy.
The Government should undertake an urgent review of the future of the Renewable Heat Incentive, the Heat Networks Investment Project, and other initiatives that are due to close in the early 2020s. These polices should be redesigned to deliver low carbon heat technologies with a focus on heat pumps, biomethane and hydrogen, and district heating at a rate commensurate with the 2050 net-zero target. Policy needs to take an integrated approach that supports whole building

1 ICCC. (May 2019) Net-zero – The UK's Contribution to Stopping Global Warming.
2 UK Government BEIS. (Dec 2018) Clean Growth – Transforming Heating: Overview of Current Evidence.

Hand turning dial on a digital thermostat

> **"We hope that the 'heat policy roadmap' expected in 2020 will lay out a clear policy and governance framework to drive heat decarbonisation and protect consumers."**

upgrades including efficiency and low carbon heating. A lack of continuing policy support in these areas represents a major risk for UK energy policy goals.

With significant costs associated with heat decarbonisation, the Treasury's review of the costs of net-zero should specifically consider how decarbonisation can be funded fairly across government spending and energy bills. We would also support consideration of the wider macro-economic costs and benefits associated with heat decarbonisation and links to gas security and imports.

The geographic scale of heat governance is an important challenge that Government must address. As this Review has already argued, it is likely that heat technologies and markets will need to be delivered at local level with involvement of Local Authorities, particularly for the deployment of district heating and building energy efficiency.

Government must also take a whole-system approach to heat (including its regulation of networks through Ofgem) to deliver:

- Effective regulation to support the growth and consumer protection in heat networks;
- The potential expansion of capacity, and advanced monitoring and control solutions of electricity networks;
- Low carbon gas networks, if shown to be possible and sensible;
- Sector coupling and multi-energy system integration to improve the efficiency and flexibility of the energy system as well as its reliability and adequacy with reduced costs;
- Training a large cohort of skilled professionals that can actually deliver all this, to a high standard.

We hope that the 'heat policy roadmap' expected in 2020 will lay out a clear policy and governance framework to drive heat decarbonisation and protect consumers.

Transport: taming of the SUV?

Jillian Anable, Christian Brand, Caroline Mullen

Over the past twelve months, the UK transport sector has maintained its onerous accolade of being the only sector to have increased its energy demand and CO_2 emissions compared to 1990 levels. The technical challenge of decarbonising heavy goods vehicles, ships and aircraft renders this unsurprising, at least in part. The shock comes in the revelation that the average tailpipe CO_2 emissions from new passenger cars has been increasing for the past three years.

Only a minor part of this trend can be attributed to a rapid downturn in the adoption of new diesel cars, down to 31.7% of market share in 2018 from 41.7% in 2009. This makes less of an impact on CO_2 than might be expected because of the increasing availability of petrol-hybrid vehicles and the introduction of higher tech-turbocharging systems which have allowed the efficiency of petrol engines to catch up to diesel.

The rise of sports utility vehicles

It is tempting to attribute these figures to the stalled growth in the adoption of pure battery electric vehicles (BEVs), remaining at less than 1% of new car sales in 2019. While attention has been directed towards the somewhat mis-labelled 'EV revolution', we have failed to see what has been happening right in front of our eyes: the immense rise in sales of larger cars, particularly dual-purpose vehicles, known as Sport Utility Vehicles (SUVs).

In 2018, SUVs accounted for 21.2% of new car sales, three times their share a decade earlier and up from 13.5% just three years earlier (see Figure 3). SUV sales over the past four years totalled almost 1.8 million compared to a cumulative total of 47 thousand BEVs, a 37:1 ratio. SUVs emit about a quarter more CO_2 than a medium-size car[1] and nearly four times more than a medium sized BEV[2]. Assuming the majority of these will be on our roads for at least a decade, we estimate the extra cumulative emissions to total around 8.2 million tons of CO_2[3].

The trend is not unique to the UK. The International Energy Agency has estimated growth in SUVs accounts for 60% of the increase in the global car fleet since 2010, concluding that *"SUVs were the second-largest contributor to the increase in global CO_2 emissions since 2010 after the power sector, but ahead of heavy industry (including iron & steel, cement, aluminium), as well as trucks and aviation."*

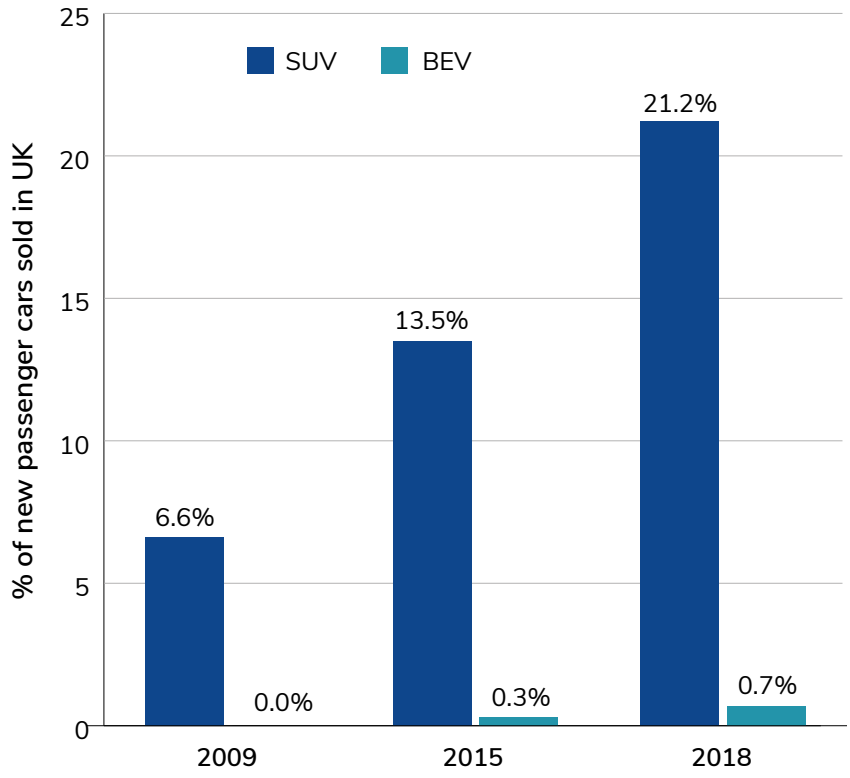
The potential for large cars sales to jeopardise the UK transport sector's ability to meet EU targets for tailpipe CO_2 emissions was foreseen back in 2005 in UKERC's first publication on transport[4]. However, the extraordinary leap in the past four years has been unprecedented. Its cause is yet to be empirically researched, but can be reasoned to be a product of attractive car financing packages which divert attention from running costs, the ongoing freeze in fuel duty, and the wider information environment in which consumers are immersed. In 2018, over 90% of all private new car registrations in the UK were financed using finance products (e.g. Personal Contract Purchase (PCP))[5]. PCP deals wrap the first year of Vehicle Excise Duty into the monthly cost, rendering the only clear policy signal to discourage high-carbon vehicles somewhat useless.

1 IEA (2019) World Energy Outlook 2019.

2 This is based on test-cycle tailpipe emissions factors, well-to-tank emissions (from production, generation and transmission of either fossil fuels or electricity) and average UK carbon content of electricity of 316 gCO_2/kWh. Final estimates: medium sized petrol car (e.g. VW Golf) = 138 gCO_2/km; medium sized BEV (e.g. Tesla Model 3): 47 gCO_2/km; medium sized SUV = 171 gCO_2/km (e.g. Ford Kuga).

3 Based on UKERC 'TEAM-UK' fleet turnover modelling of large Euro6 ICE cars, assuming that larger, younger cars travel further than the average, average annual car mileage = 16,358km; difference between average CO_2 of a medium sized SUV and medium car = 27.3 gCO_2/km (includes tailpipe emissions only); adjusted for scrappage over the period of 13.1% on average.

Figure 3: Proportion of new SUV and BEV passenger car sales (private + corporate)



Source: Compiled from SMMT (2019) Motor Industry Facts 2019, p24-26. London: SMMT and DfT (2019) Vehicle Licensing Statistics Table VEH023. Note that data for 2009 BEVs is for GB only.

EU regulations may have been expected to prevent this failure. Unsuccessful voluntary arrangements with manufacturers in the late 20th and early 21st century turned into binding regulation. This included the threat of fines for manufacturers who fail to meet their targets of a fleet average of 95g carbon/km in 2020/2021, and a further target of a 37% decrease relative to 2021 by 2030[5]. However, the regulations have been structured to prioritise principles of 'fair competition', allowing manufacturers of larger, heavier cars to have higher levels of emissions per kilometre. Yet, despite its flaws, there are dangers of Britain choosing not to align with the EU vehicle regulations post Brexit.

The phase out of conventional ICEs

Whilst there is talk of bringing forward the phase out of conventional internal combustion engines (ICEs) in England and Wales to at least 2035 (it is already 2032 in Scotland), this ignores the potential to transform the whole market towards more efficient vehicles in the interim period. The recent DfT announcement of a transport decarbonisation plan to be completed in 2020 states it "will consider how UK technology and innovation can be implemented to encourage major changes to the way people and goods move across the UK". It is too early to say what will be included in the plan, but this announcement might suggest continued attention to new technology, rather than a more rapid phase out of the most polluting ICE cars.

[4] Anable and Boardman. (2005) Transport and CO_2. UKERC Working Paper.

[5] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles. See: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019R0631&from=EN

Electricity: cost reduction windfalls and system concerns

Keith Bell

Major investments in low carbon electricity generation have been made in recent years. This needs to continue and accelerate. The low prices in the recent Contract for Difference (CfD) auction for offshore and island wind are excellent news provided the projects can be delivered, despite the bad publicity attracted by network company profits. Such concerns should not detract from the need to make best use of existing network capacity, build enough new capacity at the right time to enable net-zero greenhouse gas emissions, and share the costs equitably. The electricity system disturbance on August 9th reminds us of the need to ensure sufficient system resilience.

What happened to the White Paper?

The target of net-zero greenhouse gas emissions is likely to drive a significantly increased demand for electricity. Meeting it depends both on massively increased renewable generation capacity and on meeting demand when wind speeds and solar irradiance are low. The net-zero report by the Committee on Climate Change (CCC) points to a role for schedulable 'mid-merit' generation capable of being ramped up and down at appropriate times. However, this must, by 2050, use fuels with minimal emissions such as hydrogen or abated methane.

The Energy White Paper, which was due to set out a new policy framework for low carbon electricity, has not emerged during 2019. Nevertheless, the new government will have some pressing questions to address:

- How will appropriate new generation and network capacity be developed that keep us on the road towards net-zero?
- How can we make a decarbonised electricity system sufficiently resilient?
- How can the total costs of new facilities be minimised and how will the bill for them be split?

Electricity production and cross-border trading

The spectacular falls in the auction prices for offshore wind capacity are very good news[1]. The days of significant subsidies to renewables are over for the more established technologies. There are slow movements towards 'merchant' onshore wind and the government has been taking steps towards a 'smart export guarantee' for small scale 'behind the meter' generation. However, risks to investors remain. Continuation of a CfD arrangement for renewables would help to address financial uncertainty and reduce the cost of capital. Wholesale markets increasingly dominated by low short-run marginal cost plant will present cost recovery challenges to all participants. The enduring market mechanisms to ensure that enough low carbon and flexible generation is built are not yet clear.

> "The target of net-zero greenhouse gas emissions is likely to drive a significantly increased demand for electricity."

There will be increasingly important roles for flexible demand and interconnectors. The construction of 4.8 GW of new interconnectors is already under way[2]. However, the French regulator and the Norwegian energy ministry want to see what happens after Brexit before giving firm backing to others. While there is no reason to suppose that Brexit will stop electricity trading over interconnectors, this Review has already noted the potential impact on electricity price from any uncoupling from the integrated European electricity market.

1 https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-3-results

2 ElecLink, IFA2 North Sea Link and Viking Link.

A more active retail sector

Competition has increased in the electricity retail sector over the last few years, with 30% of the domestic market taken by the 'challenger' Suppliers[3]. However, eight Suppliers have gone bust in 2019[4] and others have pointed towards tightly squeezed margins. Ofgem's default tariff cap ended the year at a higher level than at the start of 2019.

The newer supply companies have tended to be those that are offering new types of tariff such as those for electric vehicle (EV) charging and tariffs that reward flexibility[5]. However, greater uptake of the latter will depend on the completion of the smart meter roll out, a process that has been subject to significant delays.

Meeting the cost of networks

Recent public discourse on the cost of electricity has largely moved away from Suppliers to concerns about the profits made by network owners, driven in large part by costs being lower than those assumed when their price controls were set. The CCC has been clear that new electricity network capacity will be needed over the longer term but how much of it will be needed in the period up to 2028 – which upgrades can be viewed as 'low regret' and how investment will be funded will be key considerations for Ofgem and the network owners in the upcoming price controls.

There are correct concerns about the impact on the least wealthy energy users of meeting the cost of new facilities. Ofgem's Significant Code Review addressing network access and charging[6] faces the important but difficult challenge of articulating price signals that encourage network users to make best use of what's already there, ensuring that costs of network upgrades are shared among those who benefit from them and avoiding negative impacts on existing consumers. The effective utilisation of distribution network capacity also depends on more 'active' operation of distribution networks, though progress towards that is relatively slow and the DNOs' readiness to become distribution system operators (DSOs) was not shown in a good light by what happened on August 9th.

> **"Institutional arrangements will become critical as technologies continue to change. Responsibilities for ensuring system resilience need to be clarified and applied in a more rigorous way."**

Is our electricity system resilient?

Decarbonisation of the electricity system needs to be achieved while keeping the lights on. On August 9th a lightning strike on a transmission line triggered a chain of events that led to around 1.1 million electricity users losing supply for up to 40 minutes though some train services took much longer to be restored[7].

The August 9th event itself was largely the effect of an unfortunate coincidence of factors and was, on an international scale of major electricity system disturbances, minor[8]. However, it reveals some weaknesses in institutional arrangements that will become critical as the technologies used to generate, transmit and distribute electricity continue to change. In particular, responsibilities for ensuring system resilience – preventing, containing and recovering from interruptions to supply arising from disturbances – need to be clarified and applied in a more rigorous way.

3 Cornwall Insight, Domestic Market Share Survey.

4 https://www.energyscanner.com/which-energy-suppliers-have-gone-bust/

5 http://www.ukerc.ac.uk/publications/disrupting-uk-energy-system.html

6 https://www.ofgem.gov.uk/electricity/transmission-networks/charging/reform-network-access-and-forward-looking-charges

7 https://www.ofgem.gov.uk/publications-and-updates/investigation-9-august-2019-power-outage

8 http://www.ukerc.ac.uk/news/what-happened-electricity-system-fri-aug-9-2019.html

Industrial decarbonisation: money is nice, but where are the policies?

Peter Taylor, Stephen Allen

Over the last year Government has announced a raft of funding aimed at promoting long-term reductions in greenhouse gas emissions from UK industry, fulfilling promises made in the Clean Growth and Industrial Strategies. However, there is still much to do if industry is to play its part in delivering net-zero, notably in demonstrating and deploying electrification, hydrogen and carbon capture and storage (CCS) technologies, creating demand for low carbon products and capitalising on the opportunities offered by resource efficiency.

Significant funding is on the table

Government aims to reduce the carbon footprint of industrial activities, while maximising advantages for UK industry from the global shift to clean growth. The centrepiece of this strategy is a plan to establish the world's first net-zero carbon industrial cluster by 2040, with at least one low carbon cluster by 2030. This is backed by £170 m of government funding under the Industrial Strategy Challenge Fund, with industry expected to contribute a further £260 m[1]. In addition, the Government has consulted on the design of a £315 m Industrial Energy Transformation Fund, which will target capital investment in energy efficiency and deep decarbonisation projects.

Smaller amounts of innovation funding have also been announced, including an Industrial Fuel Switching Competition, Carbon Capture and Usage Demonstration, a CCUS Innovation Competition and a Clean Steel Fund. This funding has been complemented by revisions to some existing policies, including significant increases in the Climate Change Levy from April 2019 and a review of the Climate Change Agreements Scheme.

> "Despite significant investment there is a lack of co-ordination between funds and policy frameworks."

But further concrete policies and accelerated ambition are needed

Despite these welcome announcements, industrial decarbonisation still lacks an overarching strategy with the level of ambition and urgency commensurate with the net-zero target. Currently, there is a lack of co-ordination among the various funding pots and emerging policy frameworks (e.g. on CCUS business models).

1 CCC (2019a) Reducing UK emissions – 2019 Progress Report to Parliament. Committee on Climate Change.

2 CCC (2019b) net-zero – Technical Report. Committee on Climate Change.

3 BEIS (2019) What is the industrial cluster mission? https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/803086/industrial-clusters-mission-infographic-2019.pdf

4 Scott, K., Giesekam, J., Barrett, J. & Owen, A. (2019). Bridging the climate mitigation gap with economy-wide material productivity. Journal of Industrial Ecology, 2018: 1–14. doi: 10.1111/jiec.12831

Under a net-zero pathway, industrial emissions will need to reduce from 105 $MtCO_2$ to around 10 $MtCO_2$ by 2050, in a way that does not drive emissions overseas[2]. For comparison, the UK's six largest industrial clusters have emissions of just over 33 $MtCO_2$[3]. Therefore even if all these clusters were to reach zero-emissions by 2050, industry as a whole would still be a long-way from its net-zero goal. This clearly illustrates the need for policies covering the whole value chain and that tackle a much broader range of industrial sectors and locations. This will require policy action in three areas:

1. Research, development and demonstration support for breakthrough technologies and wider low-carbon infrastructure;
2. Market creation for products made via low carbon production processes; and
3. Promotion of resource efficiency and circular economy approaches.

Further RD&D of electrification, hydrogen and CCS technologies are all urgently needed. Electrification of low-temperature industrial heating and some higher-temperature combustion technologies have significant potential to reduce emissions across a wide-range of sectors. CCS is the most promising technology for deep decarbonisation in a number of energy intensive industries as it can deal with large volumes of both combustion and process related emissions. It has already been demonstrated in several countries, and is ready for full scale deployment. However, there is still a lack of policy support for deployment in the UK.

In principle, hydrogen could be used to replace natural gas in many remaining industrial applications. Unless the costs of hydrogen production from low carbon electricity falls significantly, this would require a massive roll-out of both CCS and hydrogen technologies and networks. Such a roll out would need to start in the next few years, and be co-ordinated with the natural cycle of plant replacement and refurbishment. Future UKERC research will explore how the availability of hydrogen networks and CCS pipelines could impact the cost of emissions reduction pathways for key industrial sectors.

> **"CCS is the most promising technology for deep decarbonisation in a number of energy intensive industries. However there is a lack of policy support for UK deployment."**

The decarbonisation of industrial production needs to be accompanied by policies that create markets for low carbon products by allowing for a price premium. Such policies could include certification, public procurement, carbon taxation of materials and regulation of end-uses. These approaches would also help at least partially to address the problem of carbon leakage by guaranteeing demand for low carbon production.

Given the capital expenditure and long lead-times associated with low carbon supply infrastructure, the Government should also prioritise short-term actions to promote resource efficiency and the circular economy. This would encompass a range of production and consumption changes, e.g. waste reduction, lightweighting of products, material substitution and increased product longevity, which together could offer savings of up to 21 MtCO2 by 2030[4]), while also reducing the need for new supply-side infrastructure. Often these strategies require no breakthrough in technology and limited capital investment, but do need Government intervention in the form of support for innovation and skills development, green procurement policies and mandatory labelling of whole-life environmental impacts.

Securing our energy future: Brexit and net-zero

2 http://www.ukerc.ac.uk/news/elecxit-could-cost-270-million-a-year.html

3 https://www.gov.uk/government/publications/new-protocol-on-irelandnorthern-ireland-and-political-declaration

4 https://www.gov.uk/government/publications/meeting-climate-change-requirements-if-theres-no-brexit-deal/meeting-climate-change-requirements-if-theres-no-brexit-deal

5 https://www.euractiv.com/section/energy-environment/news/green-deal-branded-as-hallmark

Net-zero for local and regional energy systems

3 https://www.centrica.com/innovation/cornwall-local-energy-market/

5 https://www.gov.scot/publications/energy-efficient-scotland-route-map/

6 https://heatandthecity.org.uk/resource/local-area-energy-planning-a-scoping-study-final-report/

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