

## UK Energy System in Transition: Technology, Infrastructure and Investment

Edinburgh Centre for Carbon Innovation, University of Edinburgh

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Note: speaker slides are available from the UKERC website. This note focuses mostly on the panel discussions and Q&A.

### SESSION 1

#### Introduction to ClimateXChange (Ragne Low) and the UK Energy Research Centre (Mark Winskel)

See slides. UKERC conducts independent, interdisciplinary and whole systems research into future sustainable energy. It is funded by Research Councils' Energy Programme. UKERC is now at the end of its second 5-year phase. A third 5-year phase will start in May. UKERC and CXC aim to strengthen their links on the Scottish research-policy interface in this next phase.

#### Electricity generation technology costs (Phil Heptonstall, Imperial College)

See slides. The presentation is based on one of several 'Technology and Policy Assessment' projects undertaken by Phase 2 UKERC. Each of these offers independent, policy-relevant assessments addressing key issues and controversies in energy policy. This project considered how past estimates and expectations of future costs of electricity generation technology compared with experience to date, and the implications of these differences for energy innovation research and policy.

Q&A:

Q. Is it possible to compare the future costs of technologies in terms of their different exposures to commodity costs? Can commodity-price fluctuations be represented more explicitly?

A. Yes, it's possible to separate-out capex from opex costs, and cost uncertainties – this would make fuel cost uncertainties more visible. Levelised cost is very much a single aggregate measure.

Q. What is the message in this research for policymakers? Does the fact that the costs of *all* technologies have been rising – even established ones – provide some comfort for policymakers trying to understand and manage the costs of emerging technologies?

A. Possibly – there has been a general pattern of cost escalation, but within this there are some important technology-specific differences. One key message for policymakers is to recognise that cost increases often happen in technology development programmes, and policy needs to be able to withstand short term pressures to abandon innovation programmes in these circumstances.

#### UK Gas Security (Mike Bradshaw, Warwick Business School)

See slides. The presentation was based on a UKERC 2-year research project. The project developed a whole system supply-chain framing of UK gas security, to serve as an 'antidote' to more limited geopolitical discussions of energy security

Q&A:

Q. In Japan (Tokyo Gas) there has been a real focus on demand side response to decrease gas import dependency; why haven't we seen a similar response in the UK?

A. Japan pays very high prices for LNG imports, around 3x those in the US and around 50% higher than in the UK, and these are a major factor in balance-of-payments problems in Japan. For an equivalent response in the UK to gas import dependency, a belief in sustained high gas prices is

probably necessary, but it is possible to imagine scenarios for the UK and Europe where prices fall, e.g. if Russia floods the European market.

Q. Is there a strong business case to keep the UK's LNG import terminals open?

A. They're relatively inexpensive to keep open, but each of their (private) owners have different business options. National Grid's Isle of Grain terminal offers capacity on a take-or-pay basis. Private owners may prefer to run at low capacity, for their own business reasons.

### **Green Finance and Green Jobs (Will Blyth, independent consultant)**

See slides. Will presented two pieces of recent UKERC research: one on the availability of investment finance for electricity undertaken as part of the UKERC *Uncertainties* project (a working paper is available), and one carried out as a systematic assessment of the evidence on 'green jobs' – a review of green job estimates from the research literature.

Q&A:

Q. Isn't investment risk in electricity generation already being addressed by re-regulation, through Electricity Market Reform?

A. Not fully. Contracts for Difference (CfDs) are a half-way house: they don't provide the guaranteed returns often required by pension funds. That's why pension funds are investing in gas pipeline infrastructure in Europe – it's fully regulated, so it offers a low risk rate of return.

### **Session 1 Respondents' Panel**

#### **Dermot Rhatigan, Scottish Government**

- Much uncertainty stems from UK government policy. In electricity, we seem to be drifting towards national planning on technology deployment and pricing, but is this the right way forwards, and is it proving effective? Does the energy market need a 'strategic architect', with National Grid, DECC and Ofgem working closer together?
- The public are increasingly worried about rising energy prices. Bills for dual fuel have doubled. What would be the political impact of another 50% rise?
- Even regulated assets are coming under investment pressure, with the transmission owners facing issues in raising finance as their share prices are under pressure.
- The policy focus has been on supply. EMR has scope to enhance demand side measures, but the potential to manage demand in smarter ways is still largely untapped.
- On costs: the research could be made more interesting to policymakers if the different components could be separated-out. What would the pattern look like if fuel costs could be stripped-out? What is the effect of network costs on top of levelised costs?

#### **Keith Bell, Strathclyde University**

- Utilities' health is poor, but that is relative to what they've told their investors to expect. They're under pressure to deliver high returns to the city, and in trying to achieve that they're having to cut their investment programmes.
- A key issue is the high cost of capital for investment in the UK compared to our European neighbours (not just for energy). Costs of offshore wind are higher in the UK than elsewhere: anecdotal reasons for this are high UK construction costs, reflecting its piecemeal organisation and difficult physical terrain.
- Gas price uncertainty and low profit margins ('spark spread') has reduced its attractiveness versus coal.
- There is a fundamental tension between decarbonisation and consumer prices: are we willing, as a society, to pay the price to decarbonise?

### Jenny Hogan, Scottish Renewables

- Industry bodies are not necessarily aware of UKERC research, and how to access it. How does UKERC ensure that its work goes on to inform policy and strategy?

### Speaker Responses

Will Blyth: It's possible to invent a strategic architect for energy / electricity, but it depends on your view of the role of the market. Until recently the UK's approach was 'let the market decide'. We're now in a half-way house between central decisionmaking and market decisionmaking.

The UK is unusual in the degree to which it embraced free market principles for energy. This effectively means privatising risk, and you'd expect the cost of capital to be higher in liberal market economies. If you nationalise the risk, the cost of capital declines, but the taxpayer is then more exposed. It's largely about risk allocation and moving money around.

Q. But is the risk really being privatised? Look at banks: are the utilities similarly too-big-to-fail?

A. Compared to the UK banks, most utility companies are diversified across technologies and countries, so it's unlikely they would 'fail' in the same way, although individual projects may fail, so there are similarities. Arguably utilities have taken on too much debt to support a recent round of mergers, and they haven't managed their risks well.

### Mike Bradshaw

- In thinking about society's willingness-to-pay, we should include security as well as decarbonisation. The UK gas market works : we have the lowest gas prices in Europe, the highest levels of liquidity and the highest number of market actors. When short-term supply security emergencies occur, the market responds – e.g. by increasing imports through interconnectors.
- Policymakers need to think carefully about intervening in that, in terms of the motivations and the risks of coming up with something less effective. For example, Ofgem is considering requiring gas suppliers to ensure security, but then the costs involved would be passed on to consumers.
- The UK approach to gas market security is to play the market, trading in spot markets rather than signing long term contracts, so we take that risk. We might have to pay higher prices in future, but that's a symptom of the market working.
- Mandating security is difficult: EMR's capacity mechanism may lead to gas stations being built, but only operating infrequently. That's likely to undermine the market, and investors are voting with their feet – they're not investing.
- Parts of UK energy debate seem to be calling for a 'Dad's Army' energy policy in response to geopolitical risk – opening a home front on fracking.
- On policy relevance and impact: there's an important role for UKERC to provide an independent contribution to improve public debate. That said, UKERC's (and wider academia's) relationship with DECC is not simple, because the policy world is something we study – it's part of our research.
- On consumer sensitivity to prices: current UK public energy debate is too focused on fossil fuel price volatility. European concerns about cheap US energy costs may lead to back-tracking here. We need a different understanding of affordability, with inclusion of climate change and security issues – the debate should be on the affordability of secure and low carbon energy, and why prices have risen and may rise in the future.

### Phil Heptonstall

- It's worth thinking about the replacement cost for the UK electricity system – the impact on bills if we had to rebuild the UK's power generation portfolio from scratch: even with cheapest power stations, bills it would go up dramatically – costs have gone up for everything. We're in a rebuilding phase, and costs are likely to go up in any scenario.
- There's a raging debate in the research literature on including system balancing and back-up costs in levelised costs; different positions generally reflect technology preferences.
- On the future of utilities: it's worth distinguishing between asset failure and company failure; there's a lot of experience in the energy sector of assets continuing to be operated after company failures – that's different to the banks.

## SESSION 2

### **Decarbonising heat: networks, pumps or pipes? (Robert Sansom, Imperial College)**

See slides.

Heat is a big part of the decarbonisation and energy policy challenge – contributing almost 50% of entire Scottish carbon dioxide emissions – but it is less well understood: e.g. gas is not metered at the same level of accuracy as electricity. Better information is needed in order to understand the investment and infrastructure challenges.

Heat demand differs from electricity demand in important ways: it's much more variable: annually, weekly and daily, with big daily and seasonal swings. UK gas demand is very temperature sensitive. Normalising weather (seasonal normal temperature) disguises this 'peakiness'.

Scottish Government's draft Heat Generation Policy Statement features aggressive energy efficiency measures, significant electrification, modest development of district heating – but no storage heating. Modern storage heaters are well suited to low energy consumption houses and can be an attractive option. By comparison high heat pump adoption has massive implications for electricity infrastructure investment.

Comparing low carbon heating technologies:

- Heat pumps: running costs are around average, buildings need retrofitting, performance generally low, no optionality (i.e. electricity only) and investment costs are high (with infrastructure costs included – distribution network would require considerable upgrading).
- District heating: low running costs (if well designed), lower total investment cost than heat pumps, flexible (heat storage), but high network-building costs.
- Storage heaters are preferred for their easy deployability, low network impact and low costs.

Although there are no clear winners, heat pumps are not favoured on any dimension.

Consumer engagement is important, as ultimately consumers will make the decisions.

We need to get better at 'digging holes' – both for heat networks and electricity upgrades.

### **The role of bioenergy in Britain (Pete Smith Aberdeen University and CXC Science Director)**

See slides.

- Bioenergy suffers from a polarised debate between evangelists and opponents concerned about land use competition. UKERC commissioned a multi-partner, multidisciplinary project to examine where and when bioenergy would make sense in the UK.
- Unsuitable areas were excluded, in terms of slope, existing use, cultural heritage, social, geographical, agricultural areas, etc.

- Crop yield models were then used to develop scenarios of the spatial distribution of biomass, including projections of future climate, with consideration to which crop is best suited, spatially.
- UKERC then commissioned spatially disaggregated demand scenarios, including forecasting out to 2050 consistent with wider UKERC energy system scenarios.
- This allowed for a spatially disaggregated matching of supply and demand for bioenergy CHP plants. Places where bioenergy makes techno-economic sense vary very considerably by region. However, from farmer's perspective, there is a relatively small area in which it makes sense to supply biocrops– and this can explain the low levels of planting seen in the UK.
- In practice, a more distributed power generation will be needed for biomass CHP to take off. The current policy focus on co-firing is not the best use of the UK biomass resource in the longer term.

### **UK Energy Strategy under Uncertainties (Jim Watson, UKERC Research Director)**

(Note: Jim's slides will be made available after UKERC's London event on 30<sup>th</sup> April.)

- The Uncertainty project is one of two UKERC Phase 2 synthesising projects (the other is on global energy uncertainties and their implications for the UK). The aim of the project is to expose uncertainties and explore responses.
- The UK Committee on Climate Change revised 4th carbon budget is being used as a point of reference for thinking about uncertainties.
- Natural resources, public attitudes and ecosystem services are seen as systemic drivers and impacts. UK policy uncertainties and Scottish (referendum).
- The project includes engagement with 'alternative' higher carbon pathway, to question the suggestion that a 'plan B' offers an easy alternative.
- A meta-uncertainty is the growing political battle over policy priorities.

Power sector decarbonisation uncertainties include:

- Lack of capital and the 'wrong type' of capital i.e. the conditions under which capital will flow into assets.
- Technology costs and lack of technology progress
- Policy and political uncertainty, and its impact on capital and technology
- Public attitudes. UKERC research suggests that people look for particular values in energy systems (sustainability, efficiency, etc.). Continued use of fossil fuels is more acceptable if part of a changing system.
- Ecosystem services
- Bioenergy resources
- Heat pump effectiveness
- Electric vehicle effectiveness

Electrification of heat uncertainties include: Grid constraints; Heat pump performance; Electricity decarbonisation and the development of non-electric low carbon vectors; energy efficiency and district heating business models

One major uncertainty is residential heating demand – with scenarios from under 30TWh to over 70TWh by 2050, related to the extent of electrification and impact of energy efficiency programmes. Some alternatives to electrification for heat and transport decarbonisation are often not well represented – delayed decarbonisation of electricity is not a show-stopper for decarbonising heat. Learning through demonstrations is needed in some areas – e.g. around business models for district heating, it's not just about technology learning.

DECC talk about a low carbon technology race, but in practice it will be increasingly difficult to keep all technologies in the race under financial and political constraints.

The suggested alternative (plan B) gas-based future still means having to pay for new power stations, and with additional exposure to fuel security and price risks.

Looking ahead, the research agenda for UKERC has shifted from: what does a decarbonised system look like in 2050? (Phase 1: 2004-09); to how can decarbonisation be achieved? (Phase 2: 2009-14); to energy transitions in an uncertain world – covering a wider range of potential pathways and trade-offs (Phase 3: 2014-19)

## Session 2 Respondents' Panel

### Chris Stark, Scottish Government

- From a policymakers' perspective, energy is strikingly difficult compared to other policy areas, because it is genuinely a system – any policy intervention will tend have impacts across the whole system.
- These are the dying days of policymaking in silos. We still think in terms of pulling a policy lever and seeing a direct effect.
- The next frontier is developing system-wide policy making and understanding. This is a rich vein for UKERC to look at, and Scottish Government are building models to help develop a system-level view.
- The 'trilemma' is useful, but there are far more than three things in tension – for example, industrial development policy.
- The future holds the promise of more distributed energy, community energy, integration of energy waste and transport infrastructures. However, that does require big changes to the current regulated model, and EMR is obviously not the end-point.

### Jackie Horne, Scottish Government

- Scottish Government are keen to see UKERC's response to mitigating uncertainties – it's important to go beyond diagnosing problems.
- Research/policy interface is not linear; rather, it should be seen as being about opportunities to share knowledge and ask questions e.g. the Heat Generation Policy Statement consultation process, which is open until June.

### Jan Webb, Edinburgh University

- The presentations offered accessible solutions to the problems.
- Public values broadly speaking are more supportive than headlines often suggest, and confirm the need for a coherent system-level approach to policymaking.
- The issue that seems to be missing is analysis of the political processes laying behind policy failures – we need to look more systematically at this. We already know a lot of the solutions, so why aren't they being implemented?.
- The trilemma discourse may be disabling, if it presents problems rather than exploring pathways and futures.
- For example, district heating is developing in a piecemeal fragmented basis, not as an integrated part of (distributed) energy system development.

### Q&A:

- Hydrogen can be a viable low carbon heat vector, and would allow re-using of existing assets i.e. the gas distribution network. We need to look at the complementarities of the old and new.

- We need to look at the historical underinvestment in the UK energy system. Ofgem's remit was to keep costs down and this restricted investment. At some point we have to replace the assets built under nationalisation, and that should be a bigger part of the public debate.
- How wide-ranging will UKERC's pathways analysis be? Will it go beyond official UK policy pathways?
- Is there a problem about being in the 'messy middle' between markets and state intervention – does this need some clearer resolution, as some are now suggesting?
- There's a thin line between presenting the evidence and advocacy – UKERC can analyse the options and present the evidence, but it shouldn't tell policymakers which levers to pull.

### **Speaker Responses**

#### Robert Sansom

UK energy policy isn't very integrated – heat and transport weren't included in the recent Energy Bill – even though heat and electricity networks work well together, as other UKERC research has shown. Heat lends itself to local solutions, but UK policy has gone largely for a national solution: heat pumps.

#### Will Blyth

There have been periods of rapid investment in the UK privatised energy industries, although at other times downward price pressures have led to lack of capital investment.

#### Jim Watson

- UKERC engages with policy in a number of ways – there is a lot of informal interaction at workshops and events like this, as well as more formal advisory groups and boards.
- The 'messy middle' between markets and the state is inevitable – it's where the UK has been since privatisation. Giving-up on markets altogether, with a more dirigiste approach, would mean a loss of transparency and hiding costs and risks in taxes, rather than allocating them through contracts and bills. This is in some ways shuffling the risks around, but some approaches are more transparent than others.
- UKERC Phase 3 will take a wide and diverse approach to its pathways analysis, and it will strive to be interdisciplinary and holistic by including issues such as political processes and ecosystem services into its scenarios; this is a core mission of UKERC.