RPI-X@20 Working Group Report on Innovation in Energy Networks

Executive Summary

Energy networks are facing new challenges, particularly with regard to delivery of a low carbon economy as set out in the Government's Energy White Paper. Delivering a low carbon economy implies not only 'low carbon' per se, but also a sustainable economy; that in turn means ensuring:

- decarbonisation of the energy sector where economically sustainable;
- security of energy supplies;
- affordability of energy; and
- the development of exportable intellectual energy-related expertise.

Given that innovation will be key to achieving these objectives, the RPI-X@20 Innovation working group has explored the following fundamental questions:

- What is innovation in the context of energy networks?
- Is more innovation in energy networks needed?
- How have the existing initiatives performed?
- Are there other models that could facilitate more innovation?

The group concluded that the greatest opportunity for innovation lies with the technological development and future management of 'low carbon' networks. The group identified four discrete areas where it believes that significant innovation will be required; these are:

- Financial Affordability;
- Market / Regulatory Structure;
- Commercial Innovation; and
- Intellectual Capacity

Each of these areas is the subject of a dedicated section of this report. The group also recognised that the introduction of change in the above areas could give rise to potential operational issues; a further section of the report explores these issues and outlines appropriate safeguards.

The overall conclusion of the report is that while significant innovation is required in each of the above four areas, the majority of the proposals put forward do not require fundamental changes to the regulatory framework; rather they represented a need for significant evolution of the current RPI-X regime.

The key conclusions of the group, which are captured in the concluding section of this report, can be summarised as follows:

- The dominant incentive towards cost-efficiency currently embedded within the RPI-X regime needs to be balanced by specific incentives towards innovation.

- The IFI mechanism for electricity and gas networks has been successful in resurrecting an innovation culture within the energy networks industries, but its scope now needs to be expanded to support demonstrators, commercialisation and deployment.

- Greater flexibility within the current market structures and commercial (regulated and unregulated) frameworks will be necessary if innovation is not to be unduly constrained, with the result that opportunities for synergies in delivering the Energy White Paper objectives could remain unexploited.

- An inevitable consequence of innovation (more specifically deployment of innovation) is that some additional risk must be accepted. While it will be important to mitigate such risk (especially safety-related risk) some controlled relaxation of (or derogation from) regulatory (and statutory) obligations would be helpful in allowing pilot trials of technological and commercial innovations to be more thoroughly tested.

- Regulators will need to fully discount any incremental short-term costs associated with the introduction of new innovative technologies and commercial products in their efficiency benchmarking of companies.

- While innovation is expected to deliver long-term customer and societal benefits, customers may have to accept that some changes, including energy-related lifestyle changes, might be inevitable if the Energy White Paper objectives are to be achieved. Achieving 'buy-in' from the general public will therefore be an essential up-front cost of innovation.

- The creation of Intellectual Property is an important incentive for companies operating in a free-market environment. While it is in the general interests of UK plc that the results of innovation are shared (and replicated) this must not preclude companies (for example manufacturers and their research partners) from gaining competitive advantage from successful innovation. To do so would create a disincentive for such companies to invest, with the result that energy network companies might then have difficulty in leveraging regulatory funding (such as IFI) through collaborative partnerships.

- Innovation and Intellectual capacity are synonymous, but sustaining intellectual capacity requires experience as well as intellect. It is therefore imperative that the RPI-X framework, which has hitherto rewarded efficiency but has also resulted in minimalist succession planning and knowledge transfer strategies, in future addresses the emerging 'skills gap' by encouraging sustainable staffing levels.

- Energy companies in turn will need to be innovative in developing effective recruitment strategies; in engaging with other non-energy related sectors of industry to exploit transferable skills; and in marketing the energy industry as a career option both within UK and overseas. In turn, the regulatory regime must support the necessary complementary investment in marketing, post-recruitment training and career development.

1. Overview

Energy networks are facing new challenges, particularly with regard to the delivery of a low carbon economy and related environmental targets, as set out in the Government's Energy White Paper. This is discussed in further detail in the Background/Context section.

The energy networks should play a full role in delivering secure, sustainable and affordable supplies of energy, incorporating security of supply, environmental and social requirements for a transition to a low carbon economy. The RPI-X@20 review will be considering how more innovation can be achieved to meet these challenges, since the industry regulator needs to consider how future innovation can best be delivered by the regulated businesses to achieve this goal.

To facilitate this, Ofgem established a small working group of stakeholders from various interested industry parties to jointly develop an advisory report of how innovation could be further developed within the industry. This report will be submitted to Ofgem for their consideration as part of their RPI-X@20 review.

The aim of the group was to clarify the role of innovation in energy networks, what forms of innovation are required, and how best to encourage such innovation through the regulatory regime. Loose terms of reference were provided, a key aspect of which was that the working group should not be a decision making group, rather a forum for providing guidance / recommendations to Ofgem.

As technical innovation has evolved over time the working group needed to consider the following key points in its approach to the report.

- Does the existing regime work?
- What is innovation in the context of the energy networks?
- Is more innovation in the energy networks needed?
- How have the existing initiatives performed?
- Are there models that could facilitate more innovation?

Incentives will be a major factor in determining the level of innovation that energy network companies will undertake and the degree of risk they will be prepared to accept. However, the need for further innovation is being driven by many factors including:

- Climate change;
- Energy efficiency;
- Cost effectiveness;
- Quality of supply;
- Uncertainty around supply/demand, volume and locations;
- UK plc competitiveness in the wider global market.

These factors are set out within the Low Carbon Transition Plan and the Renewable Energy Strategy which outline the UK's transition plan for becoming a low carbon nation. Based on this transition plan and strategy, it was apparent to the group that more innovation would be required over and above current levels if the objectives of the Energy White Paper were to be achieved.

Some important principles in considering the role of innovation in energy networks include:

- The need for appropriate balance in terms of how risk should be shared between energy network companies and stakeholders;
- In terms of balancing opex / capex incentives, the underpinning principle should be whole-life cost (though this balance should be factored according to relative risk);
- The need for a clear common UK goal which encourages large-scale and co-ordinated innovation;
- Flexibility within the regulatory regime is necessary to enable innovation to progress;
- Apart from technical innovation, other important areas for innovation include: financial, regulatory / market, commercial, operational / process, and skills.

Ofgem has published a number of RPI-X@20 'Working Papers'.

Working Paper 1 addresses the question: "what should a future regulatory framework for energy networks deliver?", the main focus areas being:

- What outcomes do we want energy networks to deliver?
- What are desirable network behaviours?
- What are desirable characteristics of the regulatory process and frameworks of the future?

Working Paper 2 specifically addresses the question: "is more innovation in energy networks needed and how can this be stimulated?" and identifies three specific areas where change may be required:

- Products and Equipment (for example to enable smart grids);
- Communications and Commercial Interactions (enabled by smart technology); and
- Culture (i.e. moving from a 'low risk' to a less risk-averse culture that would support innovative and riskier projects).

While the group found the 'latest thinking' as described in these papers useful, this was not allowed to unduly influence the group's direction. The group also looked at the approach in other parts of the world, for example the USA. It is clear that incentives will be a major factor in determining the level of innovation that energy network companies will undertake, and the degree of risk they will be prepared to accept. In drawing comparisons with the USA the group noted the following:

- in the USA, the average historic level of innovation for utilities is 0.75% of sales (cf. 15% for pharmaceuticals and 1.8% for all industries);
- the Ofgem Innovation Funding Incentive (IFI) is more advanced than any current regulatory incentive in the USA; however
- The new "Obama" Stimulus Package is substantial and a component is ring-fenced for smart grid development;
- The Obama package perhaps sends a key message about the role of government in providing a major stimulus where the required speed of development might be faster than the free market would deliver.

The focus of the group was to consider where innovation might be needed; how more innovation could be delivered; and the way in which it might be incentivised. In addition the group looked at what barriers (issues) are evident and ways in which these could be overcome (solutions).

This working group report focuses on five key aspects which the group believes are essential to facilitate further innovation going forward:

- Financial Affordability;
- Market / Regulatory Structure;
- Commercial Innovation;
- Intellectual Capacity;
- Operational Issues (i.e. issues which might arise as a consequence of innovation in the above areas).

2. Background/Context

The energy industry is facing major long-term change over the immediate and foreseeable future In light of emerging national and global issues surrounding:

- Depleting North Sea oil and gas reserves (giving rise to a greater dependence on supplies from less politically stable / friendly / reliable countries);
- Climate change (giving rise to political commitments to major reductions in CO_2 emissions); and
- Fuel poverty (exacerbated by global recession in the shorter term and upward pressure on energy prices in the longer term and by requirements for lower carbon, but potentially more costly, forms of energy).

Arguably, the changes will be most acutely felt by the electricity industry where, in order to address the above issues, the basis of electricity production will change radically from a traditional dominance of fossil fuel technologies towards a predominantly low carbon base. Not only that, but the demand for electricity itself will increase as a consequence of decarbonising (which largely translates to electrification of) heat and transport (not only electric vehicles, but also further electrification of our railway system).

GB's future reliance on renewable and intermittent forms of electricity production (namely wind and, to a lesser extent, solar, tidal and eventually wave) will have major impacts on both the operation of the market and the design and operation of electricity networks where 'smart grid' technologies coupled with greater energy storage will be essential enablers of a low carbon economy. Furthermore, gas networks will need to be capable of responding to potentially very rapid changes in demand due to variable wind farm output and the consequent need for CCGT (or OCGT) stations to respond to unpredicted shortfalls; as well managing a potential significant increase in the number of embedded gas entry points associated with biomethane entering the gas networks.

The Energy White Paper

The UK Low Carbon Transition Plan and Renewable Energy Strategy, both published in July 2009 (together with related publications), illustrate the scale of the low carbon energy challenge - and the opportunity. In terms of support, the Government proposes:

- £30m of financial support for renewable electricity and heat up to 2020;
- A commitment to developing a comprehensive renewables skill strategy;
- Working with industry to develop a clear vision of the technologies needed to deliver our low carbon goals and £450m to support investment in key emerging technologies;
- £60m to cement UK's position as a global leader in marine energy;
- Up to £120m to support the development of a GB offshore wind industry;
- Up to £10m to accelerate the development of electric vehicle charging infrastructure;

- £11.2m to help regions and local authorities speed up planning decisions on renewable and low carbon energy projects;
- Up to £6m to develop a ‘smart grid’.

In terms of opportunities for the economy, the Government estimates:

- An estimated 500,000 additional jobs in the UK renewables sector and its supply chains (an EU study estimates 2.8m people working in renewable energy sectors by 2020);
- 1.2m people in the UK working in 'green' sectors by 2015;
- In terms of economic opportunities, a global market for low carbon and environmental goods estimated at £3 trillion rising to possibly £4.3 trillion by 2015.

It follows that innovation and the development of 'intellectual capacity' is at the heart of Government's renewable and low carbon strategy, and is seen as key to UK maintaining its position as a leading world economy.

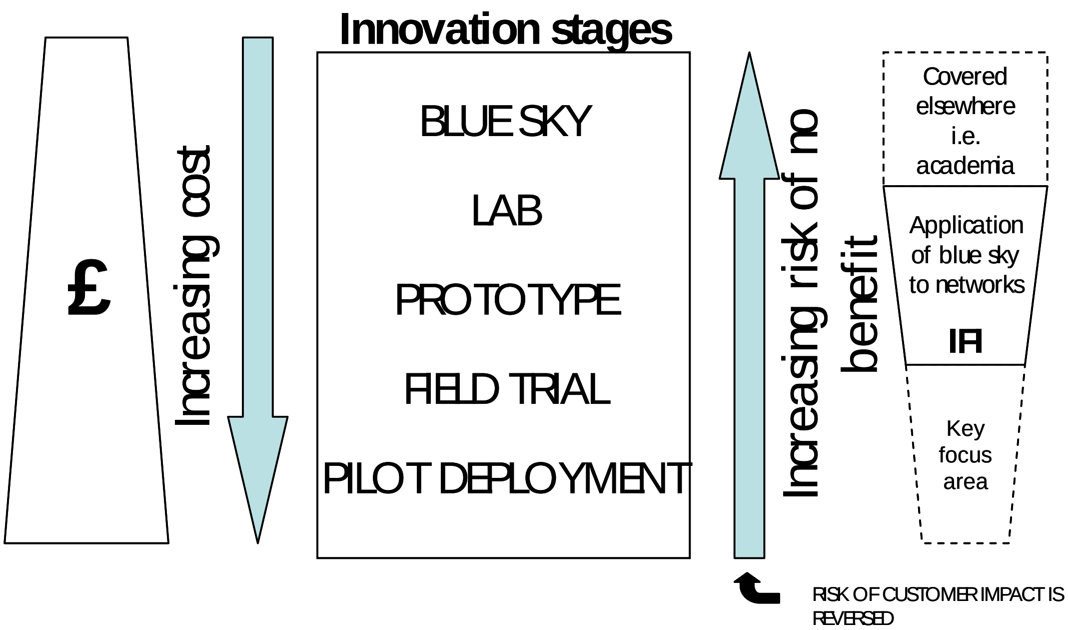
3. Affordability Issues

Since privatisation, the cost bases of energy network companies have been under considerable pressure due to the application of RPI-X regulation. This has driven out considerable costs providing massive benefits to all customers and users of the networks. However, the incentive properties of such a regulatory regime, combined with the inherent short-termism of a quinquennial review cycle act against pro-active investment in innovation. The parallel running of new equipment, earlier investment or the employment of additional people all appear inefficient in a regulatory regime dominated by quantitative comparative efficiency analysis. This has, to some extent, been addressed by the introduction of the IFI incentive framework.

There is, however, no incentive for energy network companies to act to reduce the carbon footprint of energy consumers or to facilitate such reductions. It will be essential for Government (in particular DECC) to ensure that funds and provisions set aside to address the low carbon challenge (building on the commitments in the Low Carbon Transition Plan and Renewable Energy Strategy) are efficiently channelled, providing the essential support to industry in developing the required future intellectual capacity and technologies to address these issues and support the efforts of others. Since all the above initiatives would require significant commitment (practical and financial) from the energy industry it will be essential that such effort is adequately supported by Government / EU in terms of grants and appropriate tax concessions, and from the industry regulator, Ofgem, in terms of allowed costs and more targeted and innovative incentives. There are incentives outside of the price control, such as the EU ETS and the RO, which help to facilitate the viability of low carbon generation which utilities are incentivised to connect.

Issues

Key financial and affordability issues associated with innovation were identified as being represented by the diagram below:



The diagram illustrates that the costs of developing and implementing various innovations, particularly technical innovations, tend to increase as the development progresses. Conversely, the risk of successful implementation as a workable solution tends to reduce. However, as innovations develop and move to field trials and pilot deployment stages the exposure of the network to these new technologies increases, increasing the risk of an adverse customer impact.

The group did not consider that there were particular issues associated with the affordability of funding blue sky thinking as this type of activity is more likely to be developed in academia and therefore, in the main, outside the scope of network innovation per se.

The group identified that the current Innovation Funding Incentive (IFI) covers developments at the laboratory and prototype stage, where developments focus on how new (blue sky) thinking can be applied to networks. Whilst the group agreed that the IFI mechanism had been a significant success in stimulating considerable investment in innovation within energy networks, some affordability issues potentially remained. The IFI mechanism sets specific financial limits for each company and the rules of the scheme that require publication of the results may serve as a disincentive to partnership with external bodies who may wish to develop their own intellectual property. Within the IFI scheme, for GDN's only, at present there is a 15% cap on internal spend of the GDN. For 2008/09 the 15% cap has been reached by some networks. Internal resources supporting projects in the future will increase as projects move through the 'technology readiness' levels and the 15% cap will constrain involvement and technical input in future stages of the projects.

The key focus area for potential regulatory change needs to be towards overcoming the risks and high costs for network companies of implementing field trials and deploying new innovations at the pilot level.

Overall, funding through regulatory mechanisms will be limited by regulatory measures of customers' willingness to pay, which may be different for different developments, such as those:

- to save money;
- to reduce carbon emissions or deliver other environmental benefits;
- to improve quality of supply and customer service;
- to maintain security;
- to improve UK competitiveness and GDP.

Whilst the group did identify that there is currently no specific mechanism (given the constraints of IFI and RPZ schemes) to fund field trials and pilot developments, they did note that Ofgem had recently publish ideas (for electricity distribution networks) for developing a new scheme, the Low Carbon Network Fund, to support this type of innovation, specifically focussed upon low carbon developments. The group welcomed this proposal and noted that consideration needs to be broadened to cover all energy networks and to future funding of the operating expenditure when a new (trial) device is commissioned onto a network.

The group also highlighted that the commercial risk associated with innovation is an issue if the resulting costs are not accepted as efficient expenditure.

In addition to the IFI mechanism, there may be alternative mechanisms to facilitate innovation. Where innovations are clearly part of the normal activities of a distribution business there is nothing to stop regulated companies from engaging in innovative schemes in the absence of specific regulatory funding to allow them to earn greater returns from potentially successful schemes. In many cases the rewards may accrue to the company over the course of the price control period via existing incentive mechanisms that reward improvements in efficiency or performance. However, where innovations are so different from current distribution business activities (e.g. use of electricity storage) it is not clear whether the activity would be included within the definition of a permitted purpose, or would be classed as de-minimis activity, in which case the activity would be limited to 2.5% of turnover.

Solutions

In terms pf potential solutions to affordability issues, the group agreed that the IFI mechanism had been a significant success in stimulating considerable investment in innovation within energy networks, but that some issues with the IFI scheme remain. The group identified a range of potential solutions to the affordability issues, improving IFI and tackling areas that IFI does not cover, all of which had some regulatory implications. Overall, the risk/reward balance related to speculative investment in innovation has to be adjusted in regulated monopolies to overcome the effects of the RPI-X incentive and the continual realignment of costs and revenues every five years, which limits the attractiveness of longer payback period investment.

The group noted that there was considerable financial support for innovation being introduced as a result of the Energy White Paper and recommended that companies and the industry regulator should agree how any such support might be treated within the revenue control framework.

Recommended enhancements to IFI and extensions to incorporate a Low Carbon Network Fund

Removal of the 15% cap on internal spend of the GDN is recommended to bring the Gas Distribution IFI schemes into line with other IFI schemes.

Leverage/Collaboration with other third parties could also be enhanced by a relaxation of some of the rules of the existing IFI mechanism, in particular the restrictions to rights to intellectual property and the forced sharing of innovation between network companies, which may discourage some third parties from participating. It is also worth considering whether novel commercial arrangements could, in future, be considered for funding under the IFI scheme.

Pooling/Sharing mechanisms could be introduced into the existing IFI mechanism, such that where one company did not use up its full limit of expenditure, this could be shared with another. Such mechanisms could be entered into voluntarily by companies or established by a managed re-allocation co-ordinated by Ofgem.

Higher Caps, up to a measured willingness to pay level, could be introduced into regulatory mechanisms.

Topic Specific Reopeners could be introduced into price controls so that there was an ex-post mechanism for companies to be able to receive contributions from customers to some or all of the costs of innovation. Specific re-openers could be designed to be automatic, recognising any expenditure made by companies, or could be more considered, reflecting an assessment of the net cost after the benefit of the innovation to the company concerned had been assessed. The group noted that there was potentially a limited palatability for these types of mechanisms as they introduce an increased element of regulatory risk.

If there were no IFI-type mechanism, the group agreed that a *higher level of regulatory return* and other stronger incentives would be required to overcome the effects of the RPI-X incentive to cut costs. These might include stronger incentives for improvements in efficiency or stronger incentives to deliver outputs. Alternatively the return earned from innovations could be ring-fenced in some way to ensure that it was sufficient to overcome the effects of the RPI-X incentive to cut costs.

Another alternative to the IFI mechanisms considered was the ability to *include expenditure on innovation within the Regulatory Asset Value*, although it was noted that additional incentive might still be required to overcome the existing efficiency incentives in the RPI-X regime.

4. Market Structures

It was recognised that market structure can influence the level of innovation. Where parties are prevented from discussing innovative commercial options by for example business separation, this may limit the opportunity for innovation. Technical innovations may be less influenced by market structure, but these will generally occur over longer timescales than commercial innovations, thereby limiting their usefulness in addressing specific market issues. The discussion highlighted potential issues related to market structures, which then prompted a number of solutions to be considered.

Issues

Currently, there are ownership restrictions as a result of the 'Supplier hub' concept, where the responsibility or incentive for innovation is unclear. The relative remoteness of generation from the end consumer may also limit the application of technical innovation.

Innovation can overlap the traditional boundaries associated with monopolistic or fully competitive markets. However, innovation could reinforce one or other market condition. For example, an electricity storage innovation, if owned by an embedded generator could produce a local monopoly through the ability to set prices independently. What would be the regulatory response to these situations?

Conversely it can be envisaged that innovation could be produced by multi-party collaboration (if allowed). Would the industry regulator be happy with Suppliers and network companies (and others) collaborating? How would this affect business separation?

Any innovation will progress through a development lifecycle of laboratory test, field trial, and full scale implementation, each with different and escalating costs. At the early stages when costs are lower, there needs to be an appetite for speculation, recognising that many ideas will ultimately fail. To avoid repeating mistakes, there will need to be an industry forum to share the results of tests and trials.

Market structures in the industry have had a lifetime of around 10 years typically (The Pool -> NETA -> BETTA -> …). Whereas asset lifetimes of applicable innovative technology (hardware), is usually in the range 30 to 50 years, thereby possibly providing a conflict of interests.

Solutions

Recognising the higher levels of risk at the early stages of innovation, there should be de-minimis levels for the market rules. Perhaps regulatory requirements may be relaxed at the laboratory test, or field trial stages.

At higher levels of cost, perhaps at full scale implementation, the industry regulator will need to indicate approval through a general agreement or by specific exemptions. This would be an ex ante approach, thereby providing more certainty for the investment.

Conversely, the industry regulator could indicate a flexible application of rules, and this would be an ex post approach, providing less certainty for the investment.

Ultimately, if the innovation has overwhelming benefits, the current rules could be removed or suspended, which would need an agreed change process. It is recognised that flexibility will be required of the industry regulator and Industry when adapting to changing market structures. It is to be noted that commercial innovation is inherently more flexible within shorter (<10 year) timescales. Commercial organisations require a degree of certainty, or at least a trade off between certainty and those risks that may be recouped through the market.

Regulatory rules in any event should be reviewed regularly in the light of technical and/or commercial innovations. In the event of inadvertent transgression of the regulatory rules, in the application of an innovation, the industry regulator should be able to be taken account of mitigations.

It is perceived that a number of companies are looking for new products that will 'tick a number of boxes', supporting the carbon reduction targets, satisfying regulatory requirements and providing suitable returns. Whether this is possible depends on how effectively potential problems with implementing new innovative solutions that span the entire supply chain are overcome. At present there is separation along the supply chain, which could create logistical and commercial problems.

Conversely, where no business separation exists, innovative applications which affect the whole of the supply chain may be easier to implement. An example is the large scale implementation of smart metering and smart grids in Boulder City, Colorado, USA, whose success in integrating distributed generation and demand-side management into the day-to-day operational management of the electricity network and the electricity market should be a useful input into the RPI-X@20 debate.

5. Commercial Innovation

Other than the issues associated with affordability that have been addressed earlier in this paper, the group sought to highlight potential issues associated with commercial innovation. It then addressed a number of possible mitigations that could be considered.

Issues

The potential commercial issues identified by the group fell broadly into the following categories:

Scope of Incentive Schemes: under the existing innovation incentive framework, specific funding for innovation is limited to the scope of the IFI scheme. This could be restrictive in that an innovative idea that does not meet one of the industry regulator's pre-defined criteria would not be funded by the scheme and therefore may not be progressed. In addition, the financial limits of the current IFI scheme could prevent the development of larger-scale, higher cost projects.

*Legitimate costs**:*** there is a risk that innovative commercial solutions to investment issues do not receive the same recognition within the regulatory framework and therefore may be discouraged. In addition, commercial costs of innovation need to be legitimised and it must be recognised that both internal and external costs need to be equally accommodated within any incentive scheme to ensure that those innovative ideas that are more focused around, for example, revised commercial arrangements are not discouraged through lack of internal funding. This would also need to be considered in the context of the subsequent roll out of an initial trial where more overhead costs will be incurred.

Market arrangement: the existing commercial framework within, for example, the relevant code governance arrangements could restrict the commercial freedom of a network to be commercially innovative; for example:

- Prescriptive code/commercial rules could present a barrier to network companies entering into bilateral commercial arrangements within the innovation timeframe before proposals become "mainstream" and inserted into code;
- Even if commercial barriers associated with the codes can be overcome, code governance rules could present a bureaucratic barrier to innovation, for example, where different parties to the code have different commercial objectives and therefore a potential innovative solution is, in effect, "blocked".

Intellectual property rights: commercial issues are also associated with intellectual property rights (IPR) where initiatives move from being associated with a single network to becoming a multi-party initiative or to a more general roll out. The ability to generate IPR is an incentive to innovate and the regulatory mechanisms which require sharing this knowledge work against this. Furthermore, if an innovation is sponsored by a company and the IPR rests with another party, e.g. a manufacturer, this may restrict the willingness of either party to work together to innovate. Equipment manufacturers and vendors operate in a competitive market and generally require strong safeguards to protect their IPR and knowledge. This can conflict with the aims of IFI which is to share knowledge gained through R&D outcomes with all network companies.

Regulatory approval: in addition to the code issues identified above, a network company's ability to innovate commercially could be restricted by the industry regulator itself. For example, the ability to change the charging structure is potentially limited by the requirement of the industry regulator to approve charges. This issue has the potential to be exacerbated by a move towards a common charging methodology which would restrict a network company's potential to innovate and act unilaterally in the first instance.

Solutions

In order to address some of the issues identified above the group identified the following potential solutions:

Scope of Incentive Schemes: the scope of any future IFI / innovation incentive scheme should be such that it does not restrict potential ideas. In particular it should specifically allow for the cost of setting up commercial arrangements and also allow for greater internal costs.

Legitimate cost: in order to incentivise commercial solutions, there should be recognition that commercial solutions (opex) can be used to resolve asset problems (capex); for example allowing opex spent to avoid capital solutions to be capitalised. This would incentivise network companies to negotiate commercial solutions. In doing so, it must also be recognised that internal costs associated with negotiating such solutions should be regarded as legitimate costs within the incentive funding scheme.

De-minimus activities: consideration should also be given to the treatment of commercial arrangements as an unregulated income opportunity which could involve changes to the existing de-minimis and excluded service restrictions. Under the existing regulatory arrangements, if a new idea generates new income under a de-minimis activity the extent of this activity is limited by the licence. Furthermore, the regulatory framework should encourage the hive off/sale of a successful de-minimus activity rather than penalising the initiative by, in effect, reducing the RAV in line with the value of the sale (as is currently the case).

Market arrangements: consideration should be given to allowing greater scope for diversification between network companies in terms of: charge setting; other commercial arrangements; and operational code arrangements. In particular, consideration should be given to granting consents to allow network companies to invoke alternative solutions which are outwith the established commercial / code / charging arrangements to facilitate specific trial commercial solutions.

6. Intellectual Capacity in Innovation

The English dictionary defines 'intellect' as 'the faculty for reasoning, knowing and thinking as distinct from feeling'. Applying intellect to innovation should therefore result in reasoned justification for innovation based on knowledge (which implies experience as well as intelligence) and objective reasoning (i.e. objectivity rather than subjective feeling). It follows that intellectual capacity is the extent to which this capability is invested in sufficient numbers of people to ensure that all innovation is subject to these criteria.

Issues

As highlighted earlier, since privatisation, the cost bases of energy network companies have been under considerable pressure due to the application of RPI-X regulation. This has driven out considerable costs providing massive benefits to all customers and users of the networks. However, the incentive properties of such a regulatory regime, combined with the inherent short-termism of a 5-yearly review cycle have acted against pro-active investment in innovation which might generally be expected to deliver efficiencies only over longer timescales (and indeed might involve higher initial costs and risks). A closely related factor is the impact that short-termism and a 5-yearly review cycle have had on the retention (let alone enhancement) of intellectual capacity.

The Demographic Challenge

The UK energy industry has its own demographic intellectual capacity challenges due to an aging (and aged) workforce. Pressures to reduce costs have resulted in strategies to reduce staff levels, in particular through voluntary redundancy mechanisms and minimalist succession planning policies. This has resulted in levels of directly employed staff in the electricity supply industry falling by around 50% since 1990 and has created a situation wherein the age profile of the workforce has increased to the extent that a large percentage are approaching retirement age and are due to exit the industry.

A consequence of this is that the GB electricity network companies are now estimating that some 9,000 new recruits will be required (including through contractors) by 2015 simply to cover anticipated retirements and to deliver against heightened levels of network investment made necessary by the increasing age profile of the networks.

Meanwhile, the trend in undergraduates studying for energy-related degrees has been steadily downwards for many years with fewer school leavers feeling inclined towards a career in 'engineering' and fewer universities offering power engineering degree courses. Figs 1 and 2 below show (respectively) the numbers and percentages of students accepted to begin studies in engineering as a whole, and in particular electrical and electronic engineering, at UK higher education establishments.

The future prospect for reversing these trends is compromised by a further demographic trend; viz. the UK population of 18 year olds is set to fall by nearly 15% between 2009 and 2018.

Fig 1 – acceptances for study at UK higher education institutions

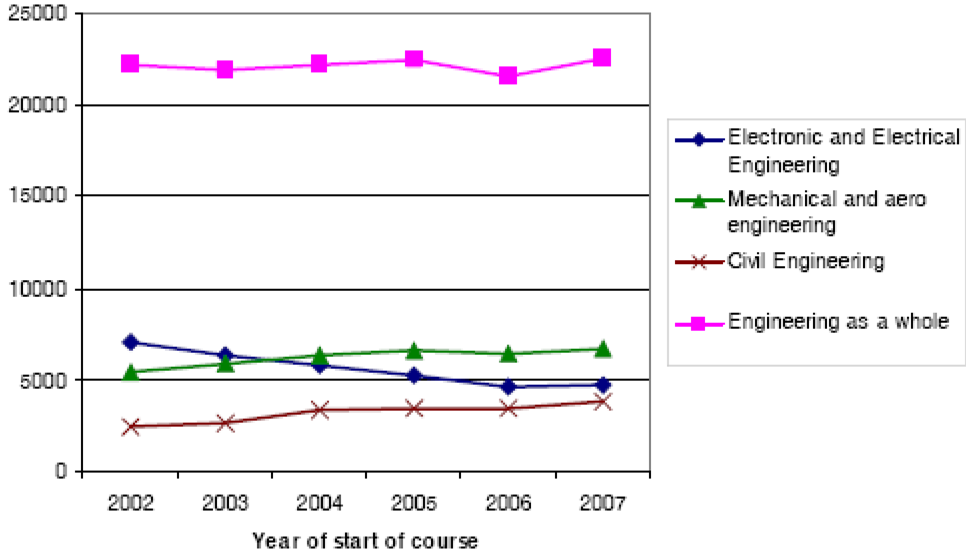
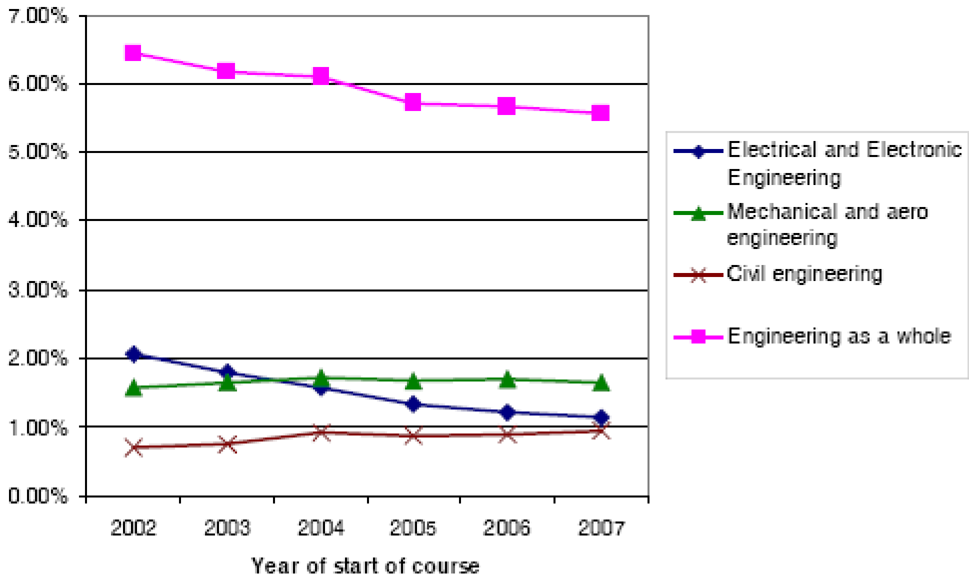


Fig 2 – acceptances for study at UK higher education institutions as a percentage of acceptances for all subjects



Sources: (Fig 1 and Fig 2) UCAS statistics online and 'The Power Academy in the UK: A Successful Initiative to Attract Graduates to the Power Industry' August 2009

The development and retention of relevant intellectual capacity is therefore clearly the most fundamental challenge for the UK energy industry. However, before intellectual capacity is able to deliver innovation, there will clearly need to be considerable innovation in developing intellectual capacity; current strategies and policies alone will not deliver the numbers of skilled people required to deliver the UK Low Carbon Transition Plan and Renewable Energy Strategy.

Key Disciplines of Intellectual Capacity Required

While there will be a need for increased levels of energy professionals in disciplines other than engineering, it is in the field of engineering (and especially electrical engineering and telecommunications technology) that the challenge to meet our requirements for intellectual capacity is most likely to be felt. Key engineering disciplines will include:

- Engineering design and analysis;
- Project Management;
- Commissioning;
- Power System Planning;
- Telecommunications;
- Asset Management; and
- Power System Operation.

A study commissioned by the Royal Academy for Engineering in 2006 concluded that future engineering graduates will need to fulfil the following key intellectual roles:

- Specialist engineers providing world class technical expertise;
- Integrators who can operate and manage across boundaries in a complex business environment; and
- Change agents who will play a pivotal role in providing the creativity, innovation and leadership needed to guide the industry to a successful future.

Solutions

Innovation in Developing Intellectual Capacity

It is clear from all the above that the current 'supply chain' strategy for acquiring people with the relevant skills will need to be fundamentally reviewed. A holistic approach to developing intellectual capacity will be required with strong support from Government and the Industry Regulator. Some elements of this holistic approach could include the following; this is by no means an exhaustive list:

- Establishing a UK energy strategic research agenda that will identify the key technologies, the scale and speed of development necessary, and the financial support required.
- Developing a UK energy technology development and deployment strategy to ensure that research and innovation is carried forward to prototyping, field trials of 'flagship' projects and development of commercial products.
- Identifying the key strategic research partners from Government, industry and academia (including from Europe and globally) who can collaborate to deliver the strategic research agenda and sponsor, resource and deliver the flagship projects. Examples include: the Technology Strategy Board (TSB), Engineering and Physical Sciences Research Council (EPSRC), Centre for Sustainable Electricity

and Distributed Generation (SEDG), Energy Research Partnership (ERP), Energy Technologies Institute (ETI), ENARD (the International Energy Agency Implementing Agreement on 'Electricity Networks Analysis, Research and Development' - overseen by EA Technology in UK), Power Networks Research Academy (PNRA), New and Renewable Energy Centre (NaREC), Engineering Technology Board (ETB), United Kingdom Energy Research Council (UKERC), etc.

- Encouraging professional bodies and institutions to more effectively co-ordinate their activities in terms of professional engagement and development, and dissemination of knowledge, building on their natural synergies and their common objective of building and sustaining a future UK low carbon economy. Relevant bodies and institutions would include: Institute of Engineering and Technology (IET), Institute of Electrical and Electronic Engineers (IEEE), Royal Academy of Engineering, Institute of Mechanical Engineers (IMechE), Institute of Civil Engineers (ICE), Royal Institute of Chartered Surveyors (RICS) and Institute of Asset Management (IAM).

- Informed by the above, determining the projected numbers of people required in each core discipline, including professional (esp. engineering but also other key business disciplines), technician and craft skills to embed the new technologies and market models as 'business as usual' within the energy industry. This will determine the 'skills gap' – i.e. the additional people required above current projections.

- Encouraging school leavers to take up a career in the energy industry (in all disciplines but with emphasis on engineering and telecommunications) by offering financial (sponsorship) and career structure incentives (one example being the Power Academy and its associated Power Networks Research Academy).

- Establishing with academia new curricula and energy-related first degree courses which, while retaining an energy engineering focus, also capitalise on the potential attraction of 'low carbon' engineering. This might open up new recruitment opportunities by inspiring school students (who will inevitably be aware of the 'carbon' challenge) to take up a career in what they might then see as a high profile industry.

- Working with academia to set up new skills-transfer courses enabling both engineers, and non-engineering professionals from non-energy disciplines, to gain a degree in an energy-related subject without having to undertake all elements of the normal 3-year course prospectus.

- Recognising that most school students probably make career choice decisions before sitting GCSE exams, investing time and effort in promoting the energy industry as an exciting career option (one good example of this is the annual East of England 'High Energy Schools Challenge' where schools enter a 'University Challenge' type knock-out competition which is broadcast on local radio, the questions being a mix of general knowledge and energy related subjects).

- Working with the Department for Education and other related Government departments, undertaking a radical overhaul of the GCSE curriculum to establish 'energy' and low carbon engineering as core subjects covering all key stages. This would require considerable input from industry in developing the curriculum.

- Capitalising on the introduction of Feed-in Tariffs from 2010 which will provide real incentives for micro / small scale / community generation schemes. Schools could be ideal targets for such projects. As well as being financially viable in their own right, such projects could also be promoted as a learning opportunity for students by incorporating the project within the school curriculum.

- Reinstating 'student' apprenticeships. This would enable GCSE school leavers to gain immediate employment (which might be a more attractive prospect than taking out a student loan to embark on a 3-year degree course with no income) and, through day-release and other forms of study, to achieve technician or professional status. Whereas the above-mentioned Power Academy is focused on graduate engineers, bodies such as Energy and Utility Skills and the National Skills Academy for Power have, as part of their objectives, the promotion of apprenticeships.

- Establishing career paths within industry to develop selected craftsmen into technicians, and technicians into professional engineers. The industry would benefit through having an additional source of feed-in to its professional recruitment and succession planning strategy.

- Establishing new sources of recruitment from overseas (e.g. China and India) and putting in place purpose-designed 'induction' courses that include key skills such as European Culture, English Language, UK and EU legislation, GB Energy Industry Regulation and Governance, etc. Such courses could provide a real stimulus for overseas students and enable the industry to benefit from new recruits being more quickly brought 'up to speed'. Indeed more of the many overseas students who undertake engineering degree courses in the UK might then be encouraged to pursue a career in the UK.

- Recognising the huge level of intellectual capacity invested in the current (but aged) workforce, consider steps to extend the careers of the most intellectually equipped staff beyond normal retirement age. These people could provide an invaluable mentoring service for new recruits and ensure essential knowledge transfer.

- Establishing relevant forums wherein industry stakeholders can pursue common objectives within clearly defined terms of reference, and sponsor specific areas of study and research. An example would be the Electricity Network Strategy Group (ENSG) which has sponsored two key pieces of work concerning the (transmission and distribution) network impacts arising from the UK's 2020 objectives for renewable and low carbon electricity production.

- Reintroducing the concept of 'Imagineering' which should form part of an overall culture shift for the regulated energy industries, encouraging out-of-box thinking based on unconstrained imagination of how things would ideally be, and then exploring the barriers (if any) to realising that vision. This could be a further catalyst to recruitment into an industry that has perhaps hitherto appeared conservative in its outlook compared with other areas of engineering such as automotive design (a good illustration being Honda's highly acclaimed 'Impossible Dream' TV campaign launched in 2005).

7. Operational Aspects of Innovation

The group recognised that the effective integration of innovation in each of the fields outlined above would require due consideration and mitigation of the risks that such innovation might inadvertently introduce to the energy industry. These are outlined below, together with a number of recommended solutions.

Issues

- *Network Risk*: as soon as any trial deployment of new technology commences, e.g. by connection to a real network, the risk of interference or interruption to that network and its users changes and usually increases. Commonly a network operator is rewarded/penalised within the provisions of its licence for good/poor performance and this can be a disincentive to innovate. The impact of this risk should not be underestimated; at best it might, for example, create a need for outage/work re-planning and at worst it might cause customer supply/demand disconnections. Usually precautionary measures can be taken to mitigate risks and these should be implemented wherever practical.

- *Constraints*: care has to be taken to minimise interference with energy markets. For example a new device could impact positively or negatively on a network capacity constraint with consequent financial implications for market participants.

- *Role of Manufacturers and Innovation Suppliers*: usually a network demonstration project requires significant investment, backing and collaboration from an equipment manufacturer. Manufacturers also play a key role in helping to ensure that such equipment is compliant with relevant legislation, standards and safety requirements.

- *Interoperability - Open Protocols and Standards:* with a number of parallel innovation paths being followed there is a risk of incompatible solutions being developed and a race to deploy one against the other (e.g. a VHS versus BetaMax scenario). There is a need for open protocols and standards to align potential outcomes and solutions to the benefit of all potential adopters (the PC USB port being a successful example). Conversely we also need to ensure that established and widely followed rules or protocols do not prohibit a cross cutting innovation (for example electronic images versus camera film and photocopies) i.e. where it is important to avoid being constrained by rules. Smart Grids/Smart Metering is a key area where this will apply.

- *Safety and Operational Policies/Standards:* when any new technology is deployed it needs to have underpinning safety and operational standards/policies in place. This might include: possible safety case examination by HSE; internal risk and/or safety assessments by network operators; type registration; creation of new commercial procedures; etc.

- *Staff Skills - Training and Development:* we need to equip people with the skills to manage and operate new innovations. Skilled staff also will be needed to undertake the safety, policy and standards work covered above. Because of the specialised nature of this work there will be a need for more people with this capability to match the speed of innovation; an inability to resource this skill would constrain innovation.

- *Sustainability and Asset risk management:* the capability to sustain development through to a comprehensive deployment is required if we are to avoid expensive 'one off' designs. Key amongst the requirements to ensure success are the ability to forecast end of life failure modes, expected asset life, standard and special maintenance requirements, operating costs and spares cover. It is very difficult to apply asset risk management techniques to innovative products which, by definition, will lack a previous track record of reliability.

- *Security:* there is a need to understand serious failure modes which might impact on other services. This would include an assessment of vulnerability to external interference and, in the case of electronic equipment, cyber security.

Solutions

- We should recognise that innovation development and network trials may initially lead to sub-optimal costs (e.g. one-off's and additional/special expenditure) and also lower performance against quality of supply standards, market rules, network reliability incentives, licence obligations, service standards, etc. This might require flexibility in the application of rules so that encouragement is given to taking the right "innovation risks' and without being penalised for incurring early or inefficient investment.

- Care must be taken to ensure the normal rigorous application of safety and policy standards is continued, but in a way which does not stifle innovation.

- The early adoption of new common standards to ensure interoperability is to be preferred.

- Asset risk management techniques will require adaptation to encompass innovation.

- Innovation will bring changed and possibly increased vulnerability to external interference which will require special expertise to assess the risk and guard against it.

- We should ensure that the correct profile of people with the right skills are available to the industry in a timely manner.

8. Innovation in the context of RPI-X@20

The group considered whether the issues that had been discussed throughout the sessions were resolvable and whether the associated solutions put forward would be possible to achieve via the existing RPI-X framework. The group recognised that the majority of the solutions suggested were not fundamental changes to the regulatory framework but rather represented an evolution of the regime. The group therefore felt that most of the solutions in this report would be possible to progress within the RPI-X framework.

The group felt that, where solutions were able to deliver value for money and efficiency, they could be linked to any regulatory framework. However, this would be dependent on the extent to which changes to the regulatory framework were implemented as part of RPI-X@20; e.g. it is unclear what the implications would be of introducing competition within the networks. Whatever the different model is that might be proposed, the group thought that this would need to address the issues associated with innovation more effectively than RPI-X if it were judged to be a better model from an innovation perspective. However, the group recognised that the benefits of a modified regulatory regime would need to be considered in the round, noting that there may be other benefits delivered by an alternative framework.

The group had remaining questions about whether, if the energy industry engages in additional innovative activities, it will be possible to operate in an environment that requires cost control below inflation.

9. Key conclusions

The results of the working group session have highlighted that more innovation is needed, and one of the key drivers for this is environmental requirements as outlined in the Energy White Paper. However, it is recognised that there are a number of other drivers including security of supply and the potential achievement of competitive advantage in the UK through delivering innovation.

Other commentators have demonstrated that increased funding for innovation will deliver greater benefits than the associated costs, and may deliver 'global' benefits. This group has adopted this assumption as the basis for taking forward this report. A number of the solutions suggested deliver benefits that would overcome the inherent 'incentives' that are currently creating barriers to innovation within the RPI-X framework. This has already been done relatively successfully via the IFI but this mechanism does not so successfully support the later stages of the innovation development cycle; this is where additional support is required within the regulatory framework. There are a range of different solutions that could facilitate this outcome; however, an extension of the IFI principle would be preferable to some other possible solutions.

Some flexibility, on the part of the industry regulator or within the regime itself, in relation to innovation would be desirable. This relates to market structures, commercial arrangements, including charging structures and codes, licence obligations, and operational standards and rules. Innovation inherently leads to greater risk and this needs to be recognised in any decision to relax rules. It should be possible for regulating bodies to relax rules where new innovations are emerging, and need to be trialled, and the case can be made by the relevant party. In this case, the party could approach the relevant regulator(s) and seek some sort of 'workable' derogation from the constraining market structures.

The regulator(s) would need to have a requirement to consider these types of derogations from the existing regulatory structures and this would amount to an exception process to allow testing to be undertaken. There may also be some rationale for allowing derogations from the regulatory arrangements following the completion of successful innovative trials which had unintended operational effects. However, the group recognised that the receipt of derogations in advance of the onset of innovative trials would be a more preferable route as this would reduce associated risk.

It may be that the costs required in the short term, whether resource or investment, appear inefficient, but that in the long term these might lead to benefits. When undertaking analysis of the efficiency of network companies, the industry regulator may need to be flexible in explicitly recognising this initial 'inefficiency' alongside the potential benefits that may be delivered in the future.

The potential to take forward innovation, which requires a relaxing of operational rules, may need to be linked to customer expectations regarding the quality (and convenience) of the service they will receive. For example, while they may (or may not) initially experience a degradation in quality of supply, they may nevertheless need to understand the need to change their behaviour (or lifestyle) in terms of their use of energy, in order to facilitate the delivery of the desired outcomes of innovation.

In the case of intellectual property, there should be some additional legal provisions in place, outside of the regulatory framework, to enable the preservation of intellectual property in some areas.

Innovation and intellectual capacity are synonymous, but sustaining intellectual capacity requires experience as well as intelligence. RPI-X regulation has created a focus on cost-reduction, resulting in minimalist recruitment and succession planning polices, which in turn have given rise to a current industry employee age profile that is becoming increasingly skewed towards the older end of the age spectrum. As a consequence, the number of people now approaching retirement age poses a near-future threat to the energy industry's capability to deliver and sustain the innovation that will be required to achieve the UK's Energy White Paper objectives. The imperative is therefore to reverse the current demographic trend by recruiting in sufficient numbers, and in sufficient time, for effective knowledge transfer to occur. This will require the industry to engage more widely and deeply with academia, and more effectively market the energy industry as an attractive alternative career option to non-engineering disciplines such as banking and IT, as well as other engineering disciplines such as automotive design.

The link between energy and climate change, and the innovation and 'imagineering' required to develop a low carbon economy, presents new opportunities to market career options in energy. Key target areas include: schoolchildren, overseas students, existing practising professionals outside of the UK, and transfers from other professions and industries (including oil, gas and telecommunications). However, capitalising on these opportunities will require investment and innovation in recruitment, training, and career development and support; any new regulatory regime must support that investment and reward successful initiatives.