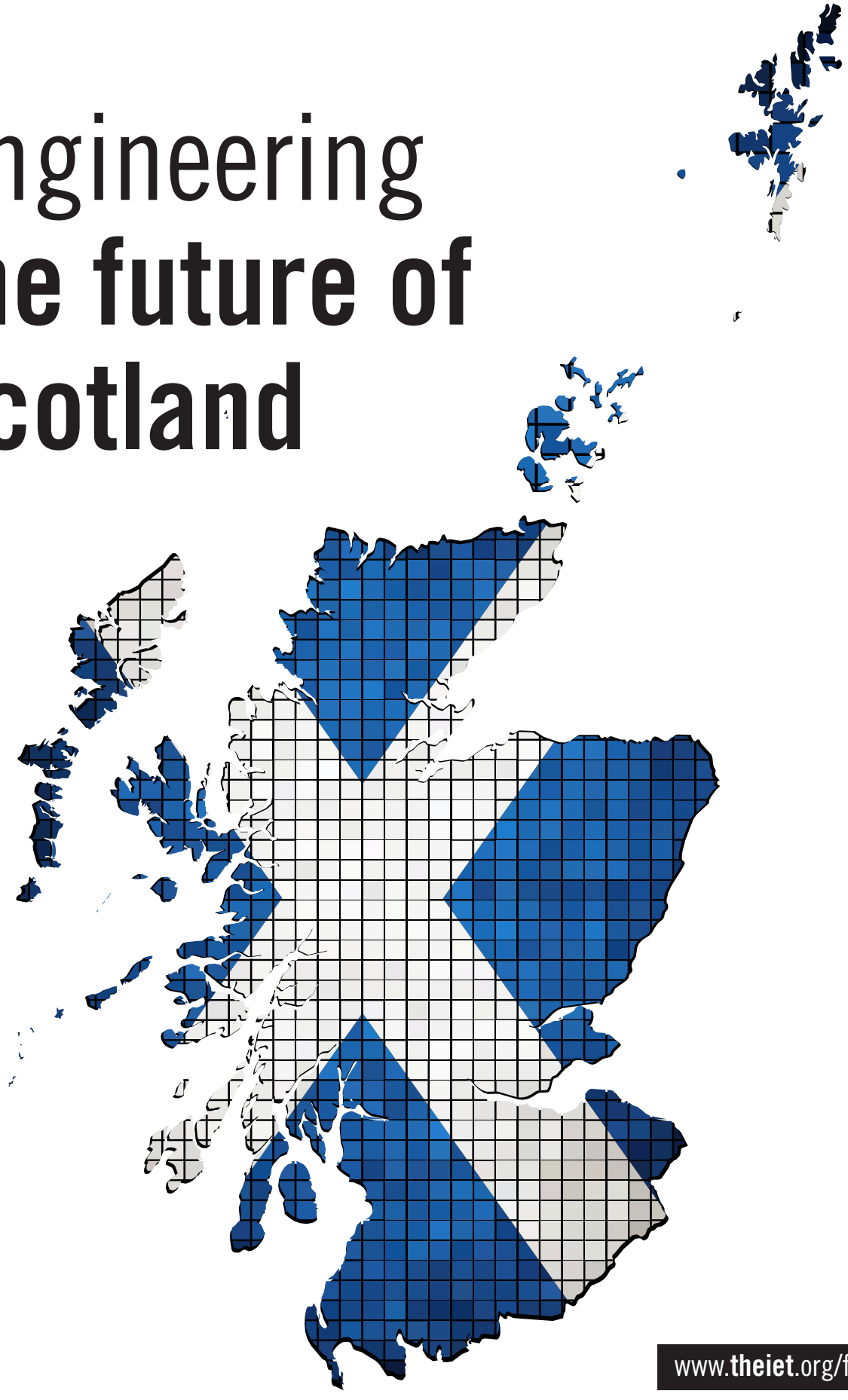
The Institution of Engineering and Technology

# Engineering **the future of Scotland**



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## The Engineering Policy Group Scotland

With a combined membership of 40,000 Scottish engineers and scientists, the Engineering Policy Group Scotland (EPGS) acts as a two way link between the professions and government in Scotland. It aims to provide feedback into government thinking and proactively raise matters of relevance with government.

The EPGS comprises senior members from across Scottish industry academia and professional organisations.

The leadership is provided by a core group of senior professional Engineers and Scientists from key professional bodies in Scotland.

The information given in this document represents the outcome from an event organised by EPGS. It does not necessarily represent the definitive subject views of the participating organistations.

As engineering and technology become increasingly interdisciplinary, global and inclusive, Professional Bodies reflect that progression and welcome involvement from, and communication between, all sectors of science, engineering and technology.

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http://www.theiet.org/policy/panels/




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## Enquiries

To discuss any of the issues in this document please do not hesitate to contact:

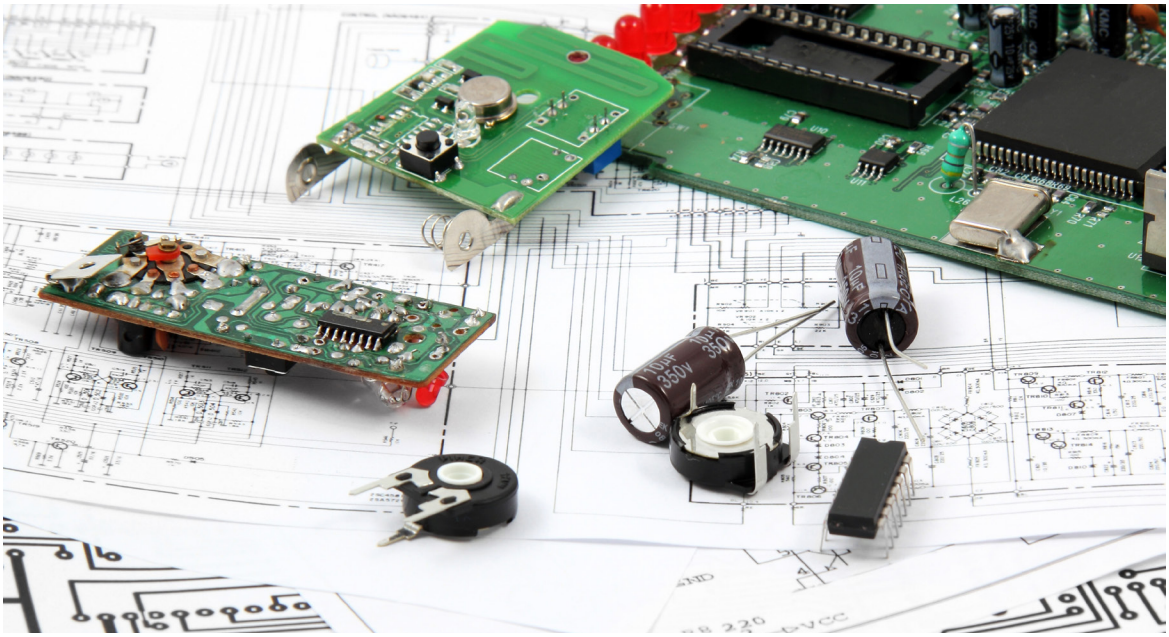
■ policy@theiet.org

## Our vision

IET calls on all MSPs in Scotland to recognise the role of engineering in: providing jobs; creating opportunities and; shaping the future of Scotland. Engineering, whether in manufacturing industry, information technology, construction or energy, underpins vital sectors of the Scottish economy and provides the platform for innovation in which the Scottish economy can grow and create jobs to compete with the rest of the world.

## Key points

1. Engineering is important to the Scottish economy and for the future of the country. It needs your support.
2. Education which includes early encouragement in Science, Technology, Engineering and Mathematics (STEM) is a key battleground. We need to encourage and inspire all school students - girls as well as boys - and promote technology training for their teachers.
3. Engineering is a wide discipline with opportunities not just for graduates but also at technician level. Flexible training and apprenticeships can maximise opportunities in many areas of engineering in which there are skills shortages.
4. The office of Chief Scientific Officer for Scotland is still vacant. This role must be filled soon so that Government can avail of independent evidence-based engineering advice in formulating policy.
5. Funding for research and the encouragement of links between research bodies and commercial enterprises is a priority.
6. Energy is a vital sector for the Scottish economy but Scotland needs a mix of power generation sources. The extension of the lifespan of the Torness nuclear plant to 2030 is a positive move but vulnerabilities remain due to the intermittent nature of some sources of renewable energy (e.g. wind).
7. Bodies such as the professional engineering institutions can provide input and technical advice in relation to Scotland's current and future energy strategy.
8. Investment is needed to provide resilient infrastructure. The recognition that many types of infrastructure are inter-dependent also needs to be recognised.
9. There has to be a major education campaign to alert business, particularly small businesses to cyber security threats and risks.
10. Consideration should be given to setting up a single Government department to deal with cyber security matters.
11. The commitment to investment in communications infrastructure, particularly high speed broadband must be sustained.



# Introduction

The technology and engineering sector is a key driver of the Scottish economy. In addition to the major physical infrastructure projects traditionally associated with engineering, this sector also involves the creation of digital infrastructure such as the super-fast broadband connections or fourth and fifth generation mobile phone signals which have the capacity to improve Scotland's economic and social performance.

Currently, engineering, electronics and information technology businesses employ nearly 150,000 people, contributing over £10 billion a year to Scotland's economy. That's almost 10% of national output[1]. Advanced engineering provides the infrastructure foundation for the success of key sectors such as energy, telecoms, construction and manufacturing where thousands more skilled engineers and technicians are employed.

Every type of business in all sectors of the economy has an ever increasing reliance on the products and skills of technologists and engineers. Many Scottish technology and engineering companies also have a strong international outlook, exporting around £6.5 billion of products and services to international markets each year. Yet engineering as a sector has persistent skills shortages. When surveyed in October 2015 for the IET Skills survey, 59% of the Scottish companies which responded declared that a skills shortage represents a threat to their business.

The new Scottish Government must think in the long term, to set the ground work and create the commercial environment which can enable people and businesses in Scotland, both small and large, to reap the benefits and efficiencies which engineering and technology can generate.

To achieve growth and jobs within the Scottish economy, engineering and technology needs to be promoted in several different ways though a variety of channels: via the education system; by encouraging research, investment, and innovation; as well as  though collaboration among these different sectors.

Technological change will revolutionise how we live in the near future. We are already seeing the development of the "smart city". Driverless cars are on the horizon and digital boards at bus stops are now commonplace. Soon parking apps will be able to direct motorists to vacant spaces and "intelligent" street lighting will provide safety and security while saving energy.

For Government the main challenge will be to ensure that the social benefits of new technology can be used to benefit all sectors in society. Too often technology is seen as something primarily for the young. Consider for instance older people trained to shop on-line and equipped with wearable health monitors who can then stay longer in their own homes, saving large sums in social care spending and enabling them to retain their quality of life. Investment in engineering and technology will often save money long term.

# Education

Support for engineering is needed at many levels. Educating the engineers and technicians of tomorrow requires sustained commitment to Science, Technology, Engineering and Mathematics (STEM) from an early age. Children need support but parents too need to understand that engineering and science are good career pathways for both girls and boys.

HMIE should monitor the performance of Science, Technology, Engineering and Maths teaching in schools and colleges to ensure it includes practical activities, industry engagement and exposure to real-world problems.[2]

***Case study***

***FIRST® LEGO® League (FLL) is an international, robotics-based programme which ignites the imagination and problem solving abilities of children through engineering, computing, creativity and teamwork. It is designed to inspire the next generation of tech-savvy inventors!***

***Lambda Jam work in partnership with the Young Academy of Scotland to bring this exciting programme to Scottish children with support coming from the Institution of Engineering and Technology, (which oversees FLL in the UK), Skills Development Scotland, and many other generous organisations and volunteers.***

To encourage the new generation of young people who are excited by science and technology, STEM teachers also need more direct experience of STEM-related careers through contact and collaboration with local employers. A school with clear evidence of these approaches should be deemed outstanding.

Training and development is a life-time process. Engineering needs people at a wide variety of levels. Qualifications such as Eng Tech can provide Engineering Technicians with qualifications which enhance employability and which they can then develop further. Flexible training options and the encouragement of part-time working will encourage diversity in engineering and retention of female engineering workers who form only 12% of the engineering and technology profession in Scotland at the moment.

# Research and innovation

Advances in engineering to create the jobs of the future depend on research and the funding to support this research. Figures from the Department of Business Innovation and Skills show that the UK has 31 institutions in the world's top 200 universities, with five (16 per cent of the UK's representation), located in Scotland. There are more research professionals per capita in Scotland than in the rest of the UK, with around 32,000 in Scotland (1.3 per cent of all employment in Scotland) and 279,000 in the rest of the UK (1.1 per cent of all employment).[3]

The expansion of funding in respect to research must be continued. Also important is the application and commercialisation of this research. In today's technical world, innovative products are often the result of successful collaboration between commercial enterprises and research institutions.

Scotland needs not just the commitment and funding for innovation but also a structure which can provide it and encourage participation. New catapult centres such as the centre for precision medicine in Glasgow are an example of targeted funding which offers the potential for future growth.[4]

The UK has an excellent science and research base but far too often the output is exploited abroad rather than in the UK. More should be done to help UK businesses - particularly small and medium-sized enterprises (SMEs) - increase investment across the whole development cycle, scale up ideas for commercial success and create new high-value jobs.

SMEs play a major role in innovation but often lack time and knowledge to access government support schemes. To promote productivity and high-value jobs, the creation of more local and city-based networks which can advise on support available for SMEs are a good way forward.[5]

***Case Study***

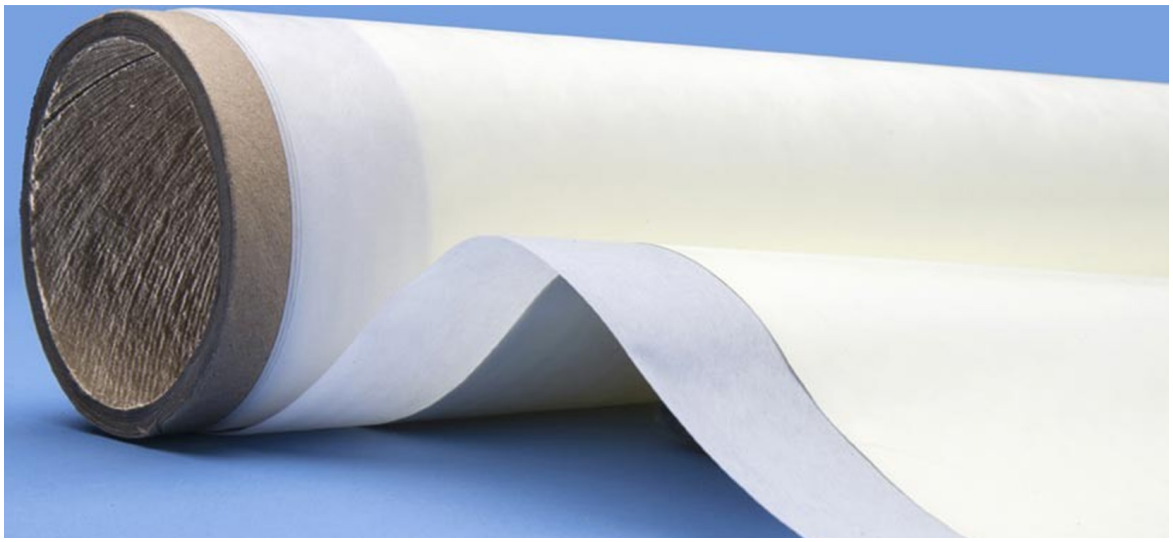
***Earlier this year, a tie-up between the University of Strathclyde, the Oil & Gas Innovation Centre (OGIC) and US company Blueshift has helped accelerate the development of a new product that aims to reduce the cost of pipeline installation.***

***This product, a new "polymer aerogel" technology should improve the insulation for deep-sea oil and gas pipelines, reducing the amount of steel used in construction while increasing the rate of flow. Aerogels are the world's lightest solid materials, composed of up to 99.98 per cent air by volume.***

***Blueshift was founded in 2013 to focus on the commercialisation of polymer aerogels for application in oil and gas, aerospace, radar, automotive and building materials.[6]***

***These new gels are 500 times stronger than conventional silica aerogels.***

***The firm linked up with OGIC to support the development of the polymer aerogel blanket, and selected Strathclyde as its academic partner. Blueshift required fast track delivery and Strathclyde's multi-disciplinary, integrated approach accelerated the project. Blueshift is continuing to work with the University of Strathclyde as it takes this project on to the next phase of development.***



# Energy

Manufacturing has long been a driver of the Scottish economy but so too is energy.

The oil and gas sector have driven the Scottish economy forward for the past forty years. Developments in sub-sea engineering will continue to provide jobs, growth and opportunities even as the oil and gas revenue decline.[7]

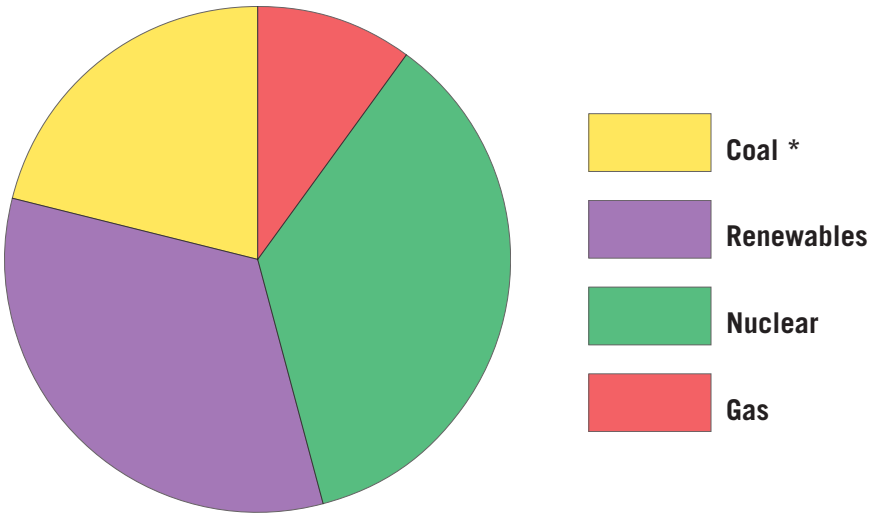
Scotland is also a leader in relation to innovation within the field of renewable energy. Innovative schemes such as the Islay tidal array show the potential which may lie ahead.[8]

The pie chart presents the picture of Scottish Energy in 2015. The December 2015 edition of Energy Trends shows that in 2014, some 24% of electricity generated from all sources in Scotland was exported to the rest of the UK. From 31 March 2016, with the closure of Longannet, a major coal fired power station, the picture for Scottish energy has changed drastically. This power station was the largest in Scotland and the second largest in the UK, with capacity to supply power to 2,000,000 homes. The impact of this closure has major consequences. While the drive towards low carbon energy is now enshrined in UK law and also an international obligation under the Paris Agreement signed in December 2015, the sudden removal of a carbon-emitting power source which is also a stable feature of the network, might have considerable knock-on effects particularly in a situation of grid failure where the system has to be "kick-started".

In the past, coal (and also gas) fired power stations were useful in that they not only contributed to base load capacity but were also a flexible resource in that outputs could be adjusted relatively easily. This is not possible in relation to nuclear power plants. The rapid closure of many conventional power stations may result in an over-reliance on renewable power generation which has a major disadvantage in that wind power, for instance, is often intermittent. Flexibility can in part be provided by methods such as pumped storage schemes, or the use of inter-connectors assuming that excess power is available elsewhere. Neither of these options is a complete answer to base load deficiencies. Over-reliance on intermittent power sources can also affect the stability of the grid. The resilience of the system must be a major factor in any future energy planning.

Achieving a balanced energy policy will probably be the single most important element in the programme of future Scottish Governments. As well as encouraging innovation and emerging technologies this will comprise many elements including:

- The need to ensure a mix of power generation sources coupled with renewed drive towards energy efficiency.
- Insulating homes to provide greater comfort, lower bills and energy savings.
- Promoting community heating schemes in urban areas using Combined Heat and Power systems.




**This is mostly power produced by Longannet station, which closed in March 2016*
*https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/487870/ET_Dec_15.pdf*

# Infrastructure

Major investment in power generation will be needed in the coming decades but the transport network also requires considerable sums of money. Scotland is distant from many major markets and also has many small communities scattered over a large area. Therefore it needs a good transport network. Early suggestions that HS2, the proposed high speed rail network should extend northwards have yet to be taken forward, although options for upgraded and high speed lines are still being discussed.[9]

The length of time taken to decide on choosing a new UK airport hub is also detrimental to Scottish interests.

Planning large transport investments requires joined up thinking to ensure that projects are part of an efficient and fit-for-purpose national infrastructure strategy. Otherwise we risk wasted investment, lost opportunities and a dysfunctional transport system.

Investment in infrastructure is vital but so too is a realisation that many forms of infrastructure are inter-dependent. Planning for infrastructure needs must take into account the interdependence of various types of infrastructure.

For instance, water and transport (both devolved matters) are each closely intertwined with UK national electricity infrastructure and its design. Resilience needs to be built into the system at all levels to ensure that there is no domino effect when the failure of one asset impacts on the performance of other systems.

Infrastructure investment is required not only in the built environment but also in relation to broadband capacity which drives the new digital economy. Communications infrastructure with good download speeds is vital for economic and social activity. Within Scotland, while urban areas generally have good mobile phone and broadband coverage, in many rural districts it is inadequate, hindering development in areas which are already isolated and disadvantaged. Initiatives such as BDUK are welcome but many parts of Scotland still have inadequate communications infrastructure.[10]

New industrial sectors such as the creative industries (covering activities from publishing to design) already employ over 60,000 workers in Scotland. This sector which the Government has already targeted as having “high growth potential” relies on good communications infrastructure.[11]

# Cyber Security

Trends in the immediate future point towards increasing technological dependency. In the coming decades many of us will live in "smart homes", with heating, lighting and security capable of being controlled remotely. The new "internet of things" through which vehicles, buildings and hand held devices can exchange data and filter information point the way towards "smart cities" whereby local government will co-ordinate information systems in everything from health care to traffic management. Taken together, these developments along with new innovations in both drones and driverless technology highlight an increasing level of cyber security risk on many levels.

Data security underpins the development of the new digital economy and will also be crucial in a more interconnected future. The Government is well aware of this and has now backed rhetoric with action as the plans announced in the 2015 Autumn Statement to spend £1.9 bn in this area indicate.[12] At an EU level too, the new General Data Protection Regulation will impose duties to proactively carry out risk assessments, appoint a data protection officer and provide national authorities of early notification of data breaches. After long negotiations, the newly agreed EU Network and Information Security Directive is another initiative which imposes new duties on those deemed to be essential services and which underlines the message on data security.

While high profile companies like Talk Talk achieve publicity when data breaches occur, small and medium sized enterprises (SMEs) are increasingly finding themselves in the line of fire. Indeed the Scottish Business Resilience Centre warns that particularly when an SME is part of a supply chain, the scale and cost of the cyber-attack is magnified.[13]

The supply chain includes operations involving information and communication technologies, software distribution and operations within the "cloud". Given the extent of the threat, businesses in Scotland (particularly small businesses) need to made aware of the risks and ought to receive comprehensive training on counter measures. The nature of cybercrime opens businesses to a range of issues including sabotage, extortion, blackmail and fraud from anywhere in the world. Globalisation now extends to criminal activities.

Given the rapid speed of technological change, cyber security is now a challenge on many levels, for consumers, for businesses and indeed for Government, the guarantor of national infrastructure security. Consideration should be given to setting up a single Government department to deal with all cyber security matters. In an increasingly interconnected world, a co-ordinated response is needed to combat the new range of threats.

## Harnessing expertise

The Office of Chief Scientific Officer for Scotland has been vacant since December 2014. It is very useful for Government to have someone who can provide independent expert advice on any aspect of science, technology and innovation so that scientific advice informs Government policy.

Professional organisations such as IET and the other professional bodies in the Engineering Policy Group Scotland have a wealth of professional expertise. which can be used in the development of evidence based policy. Regular events are held in Holyrood to bring engineering issues to Scottish Parliamentarians and submissions are made to parliamentary inquiries both in Edinburgh and in London.

## Looking forward

In Scotland as in the rest of the UK, growth rates in productivity have persistently lagged behind those in other major economies (e.g. France, Germany, US) in recent years. This is a huge problem. Even small improvements in productivity would have transformative effects if sustained over a long time (e.g. in reducing public sector debt ratios).

Key aspects of raising productivity include: encouraging long term investment in infrastructure: and raising skills and knowledge. This will involve: investment in training; supporting world leading universities open to all; good digital infrastructure, together with high-quality science and innovation.

## Relevant IET documents

Recent events in Scotland have included:

- a major seminar on Nuclear Power - Opportunities for Scottish Engineering http://www.theiet.org/factfiles/scotland/scot-nuc-page.cfm
- a submission to the Scottish Affairs Committee at Westminster on The Renewable Energy Sector in Scotland http://www.theiet.org/policy/submissions/s1028.cfm

Earlier reports and briefings on topics as diverse as Education Policy, the Science of Running Smart Cities, Exploiting Scotland's Shale Gas Opportunities and Scotland's Infrastructure can be viewed on the IET Scotland Policy Panel website.

- http://www.theiet.org/policy/panels/scotland/index.cfm

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The Institution of Engineering and Technology

The Institution of Engineering & Technology
Michael Faraday House
Six Hills Way
Stevenage Herts
SG1 2AY

**T:** +44 (0)1438 765690
**E:** policy@theiet.org
www.theiet.org/policy

IET GLASGOW TEACHER BUILDING

IET Glasgow: Teacher Building
14 St Enoch Square
Glasgow
Scotland
G1 4DB

**T:** +44 (0)141 566 1871
**E:** teacherbuilding@theiet.org
http://teacherbuilding.theiet.org/