INTRODUCTION

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1. INTRODUCTION

The Smart Energy Regions (SmartER) COST Action TU1104 (COST, 2014) takes a regional perspective on energy and the low carbon agenda. It focuses on a systems approach, including low carbon energy supply, energy demand management and energy storage, and the associated distribution networks. It looks at links between technology and training, and to end user activities, covering the fields of 'smart grids' to 'smart living'.

As part of this COST Action members have investigated how different policies are being implemented to progress the low carbon agenda and how industry and broader stakeholder groups are involved in the process. This publication is supported by COST. Cost and value are also important factors that influence the take up of low carbon technologies and lifestyles. The regional approach covers the development of policy, planning and regulations, and how government incentives and industry responses can encourage the transformation of low carbon policy to practice, through innovation and competitiveness. *Figure 1* summarises the main topics, from international 'drivers', to policy, and then to practice.

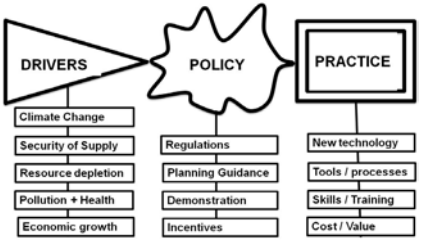

Figure 1 - Main topics associated with the route through drivers to policy to practice

In European politics, a region is the layer of government directly below the national level. The term is especially used in relation to those regions, which have some historical claim to uniqueness or independence, or differ significantly from the rest of the country. The current historical trend in Europe is for the devolution of power to the regions from central authorities. The European Sustainable Energy Innovation Alliance has called for regions to play a crucial role in relation to Europe meeting its 2020 emission reduction targets. It believes regions will have to become the innovators and bring together actors of the knowledge triangle, from innovation, research and education to create sustainable energy solutions.

For regional success it is vital to improve the cooperation between science, industry and politics, with research and innovation being key drivers of competitiveness, employment, sustainable growth and social progress. eseia promotes the formation of clusters to bring together research and innovation, addressing major challenges and fostering regional energy systems within the European Union.

SmartER follows this approach and considers the combined roles of government, industry and academia in delivering the low carbon agenda to individuals and organisations. *Government* needs to implement policy through regulations, guidance and incentives, giving clear signals to industry of its future intentions. It needs to be aware of what industry's strengths and aspirations are in relation to supplying goods and services to the region and exporting from the region. Government's commitment to raising standards can drive forward innovation and competitiveness, encouraging industry and academia partnerships.

Industry needs to plan for future changes. Industry has a diverse range of interests in relation to pushing forward the low carbon economy; manufacturing and consultancy services generally welcome change as it can result in new and high value markets. On the other hand developers and the energy utilities tend to be more conservative, and may

associate change with increased costs and/ or loss of profit. Government needs to take a considered and balanced approach to industry 'lobbying', and look at the wider economic benefits of a green economy.

Academia in general has two main interests; firstly, research partnerships with industry can drive forward innovation and assist industry with developing new products; secondly, research leads to improved understanding of low carbon technologies and applications, which can then be disseminated through education and training programmes.
The development, and joint ownership, of the understanding of low carbon regions is fundamental to future government and industry thinking. It is particularly important that decision makers and their advisers have the appropriate information for short and long term decision making. SmartER will explore the understanding and relationships between government, industry and academia in relation to the low carbon agenda, centred on the built environment, up to regional scale, and how this can help inform decision making.

BACKGROUND

Although the world's attention has been focused on economic issues in recent years, the impacts of climate change and environmental harm associated with energy use continue to grow. This is manifest not only at a global level, but also at a local, individual and organisational level. On the 10th May 2013 the UK's BBC reported that daily measurements of the carbon dioxide level at a US government agency laboratory on Hawaii exceeded 400 parts per million (ppm) for the first time in three to five million years. At a global level, if fossil fuels continue to be burnt at a 'business as usual' trajectory, in a matter of a couple of decades, we will cross the 450 ppm level, taken as the limit for keeping global warming under 20°C (BBC, 2013). At a local level, there is a growing concern over the pollution impact of burning fossil fuels, and also over the potential environmental risks associated with shale gas and open cast mining. At an individual and organisational level, there are financial risks associated with increasing energy costs and the future asset value of buildings that are not energy efficient.
Even though society has been aware of the issues associated with burning fossil fuels since the mid-70's, their use has continued to rise. Since the start of the industrial revolution some 200 years ago, society, especially in the developed world, has locked itself into a fossil fuel economy, and the developing countries are rapidly following suit. Change will be difficult. Society has become very effective at being inefficient, and increasingly irresponsible, in the use of resources, and in particular energy. The economy has developed to support the fossil fuel habit. Amory Lovins explains in his recent book 'Reinventing Fire' that the fossil fuel industry receives enormous subsidies both directly and indirectly (Lovins, 2011).
Reports from the International Panel on Climate Change (IPCC) (IPCC, 2007) have frequently been referred to when developing government policy, but this policy is slow to be implemented in practice. Even the Stern review on the economics of climate change, which identifies the enormous costs faced with dealing with climate change, has not changed our behaviour (Stern, 2006).

Of more immediate concern in the European Union at the moment is the issue of security of energy supply and the enormous cost of importing energy. The EU imports some 53% of the energy it consumes. The value of imports in 2013 was more than 1 billion Euros per day, with energy supplies from Russia accounting for 42% of EU natural gas imports and 33% of oil imports. (European Commission, 2014).
The need to reduce our dependence on imported energy is closely aligned to the need to develop our low carbon economy. The low carbon economy is likely to be a major area of future growth, and one in which Europe may already be lagging behind China and US (K. Neuhoff, et al 2014). Although Europe has plenty of innovation, it has generally had limited success at implementation in the market. There is generally a lack of investment in new technologies and the transition to a low carbon economy seems to be slow. This is of growing concern to the European Union and is driving its policy development.

LOW CARBON TRANSITION

It is not really surprising that there is a huge resistance to changing to a low carbon economy, and perhaps the 200 year dependency on fossil fuels cannot be expected to be turned around in the relatively short time available to avoid serious climate change impacts. The current austere economic period is also frequently stated as an excuse to delay climate change action. Future policy will therefore attend to adaptation to climate change as well as mitigation to reduce future impacts.

Low carbon technologies have developed considerably in recent years, but the economies of scale are slow to take effect, both in areas of low carbon energy supply and reducing energy demand. Governments tend to focus more on large scale projects on the supply side, rather than the more scattered subject of reducing demand, and they also seem to favour 'big industry' solutions. Increasingly nuclear and fossil fuel with carbon capture, and large scale wind, tidal and solar, are preferred to smaller more disparate demand side technologies. This may be considered a top down 'large scale supply' approach rather than a bottom up 'demand reduction and small scale renewables' approach. However, recent concern over the limitations of the electricity grid has resulted in increased interest in distributed energy supply and demand reduction.

Future policy needs to recognise the need to combine thinking on traditional fossil fuel energy supply and low carbon technology. Although in the long term the planet may be 'zero carbon', probably for the large part of this century, fossil fuels will still play a major part in our energy economy. The development of low and zero carbon technologies will need to accompany efforts to 'clean up' the use of fossil fuel, through carbon capture and more efficient use. Also, the transition to a low carbon economy will probably involve a combination of the 'bottom up' approach at building and community scale, as well as a 'top down' approach through large scale renewables, combined with traditional energy supplies. Both approaches will need to be linked with energy storage, both for heat and electricity, and this is likely to become a major growth area for research and development. Related to this is the conversion of electricity to heat and vice versa, in order to provide a stable and balanced energy future.

To some extent there may be some degree of 'low carbon fatigue', perhaps association with the overall negative message of climate disaster, rather than focussing on the positive aspects of a low carbon future, such as a clean healthy environment, and the economic and social benefits from a low carbon society. The economic mechanism of carbon trading, namely the European Carbon Trading System, (ETS) has not been successful, in part because of the economic downturn reducing energy use and the need to trade in carbon.

So why is it advantageous to look at the transition to a low carbon economy at a regional scale? At a regional scale, there is often devolved government decision making, with the subsequent development of policy through, for example, Building Regulations and Planning Guidance. Issues resulting from government's policy aspirations can be followed up through regional research and development activities. Although large-scale energy supply policy may be decided at a national level, associated planning issues and smaller scale energy supply is generally handled at a regional level. As is demand side management, the development of low carbon technologies and processes, and how collaborative research across the region's universities can help government and industry take forward the low carbon agenda.

There has been little attention to how the various issues across policy and practice can be 'joined-up'. An overall low carbon strategy should link government policy to business opportunities, technology advances, training and awareness raising, and, cost and value. This may be best addressed at a regional scale, where there is autonomy, understanding and decision-making that take account of specific regional attributes. This is the subject of this EU COST Action on Smart Energy Regions.

POLICY TO PRACTICE

In a recent speech, the European Commissioner for Energy, Günther Oettinger, stated that '*People's wellbeing, industrial competitiveness and the overall functioning of society are dependent on safe, secure, sustainable and affordable energy*'. He followed on by saying that: '*The energy infrastructure which will power citizens' homes, industry and services in 2050, as well as the buildings which people will use, are being designed and built now. The pattern of energy production and use in 2050 is already being set*' (Günther Oettinger, 2014).

The European Council has ambitious energy and climate change objectives for 2020, including: reduce greenhouse gas emissions by 20%, rising to 30% if the conditions are right; increasing the share of renewable energy to 20%; and, to make a 20% improvement in energy efficiency (European Commission, 2008). There is a long term commitment for 80 – 95% cuts in emissions by 2050 (European Commission, 2011).

In March 2013 the European Commission published its Green Paper entitled, 'A 2030 framework for climate and energy policies' (European Commission, 2013), which proposes a range of actions to provide clear intentions for GHG emissions beyond the current 2020 targets and on route to the long term 2050 target of 80% reduction. in GHG emissions. This 2030 policy framework aims to make the European Union's economy and energy system more competitive, secure and sustainable. It includes:

- reducing greenhouse gas emissions by 40% below the 1990 level;
- increasing the share of renewable energy to at least 27%, aimed to drive continued investment in the sector, thus helping to create growth and jobs;
- continued improvements in energy efficiency which will be considered in a review of the Energy Efficiency Directive due to be concluded later in 2014;
- reform of the EU emissions trading system responding to the issue that the ETS has had limited success;
- achieving competitive, affordable and secure energy with a set of key indicators to assess progress;
- a new governance system with a more centralised approach.

These 2030 targets, if adopted, will need to be linked to the European Commission's Integrated Energy Roadmap (European Commission, 2011) which is putting forward an action plan that:

- addresses the energy challenges in a system approach;
- consolidates and aligns the various existing technology roadmaps;
- covers the entire research and innovation chain;
- identifies pathways for work and synergies between various EU programmes, stakeholders, instruments, authorities.

This roadmap will need to practically address a series of existing challenges for implementation, including:

- how and what to prioritise in relation to short-term, medium-term, long-term targets;
- what we can learn from each other across sectors, across borders, and along value chains;
- how to create synergies among different instruments, different sectors, and different technologies;
- how to balance the (sometimes competing) targets considering technological, economic, environmental and social aspects.

The above new policy relates to evidence that, 'despite the importance of energy policy aims, there are serious gaps in delivery' (European Commission, 2011). New technologies are being developed but they are not finding their way easily into the market. Intellectual Property Rights (IPR) are often needed to encourage investors, but many low carbon technologies may not have significant IPR. Many policies, are concerned with large scale 'top down' initiatives, for example, large scale renewable, smart meters, district heating, etc. However, as stated above, there is now a growing interest in 'bottom up' solutions based around buildings and communities, adopting a systems approach to energy supply, demand and storage. The new policy is therefore intended to provide clear signals to investors and industry

of the intention to drive towards the low carbon economy and to achieve economic growth in this area.

A SMART ENERGY FUTURE

At a regional scale SmartER aims to consider electricity networks and storage, smart distribution, and demand management technologies. Although buildings have become more efficient, the demand for heat still dominates the energy supply scenario in most northern European countries. Many houses needing major retrofitting measures to improve their energy efficiency and overall living conditions. In particular, the built environment has huge potential for reducing energy demand and promoting low carbon applications. Across the EU there is an ambition that all new buildings will be '(near) zero carbon'. This political aspiration has resulted in innovation in construction, and a number of government subsidised demonstrator low carbon built environment projects to see what can be achieved in practice (LCRI, 2011).

In many EU regions, activities, across energy supply and demand scenarios, have begun to highlight a range of issues associated with the energy futures. These include:

- how to balance large-scale renewables versus building scale energy efficiency measures often combined with building integrated renewables;
- the general shift to electric, including distributed PV, heat pumps, future electric vehicle charging, which places a huge demand on the grid;
- an appropriate balance between renewables versus large-scale power projects (e.g. future nuclear and shale gas);
- the need for energy storage at local level and larger scale, combined with distributed energy supply;
- capital cost and cost savings associated with low carbon buildings, and new and retrofit technologies.

Our existing energy grids are ill equipped to deal with the new mix and balance of supply and demand. However, renewal of the grid would take many years by which time technologies would change further. Therefore the role of the grid needs to be addressed and the mix of 'top down' and 'bottom up' approaches examined. Utilities are perhaps becoming more interested in renewable energy systems and storage at building and community scale, to help stabilise the situation by using renewable energy close to source, adopting a distributed supply system. This 'bottom up' approach would take the pressure of the grid, but would need to combine with the 'top down' approach of large grid scale energy supply (including renewables).

The drive towards a low carbon built environment requires development over a range of scales from new components, to buildings, to communities. At a city and regional scale, large-scale housing retrofit programmes have the potential to significantly reduce energy demand and CO_2 emissions, whilst at the same time, having other positive impacts such as affordable warmth, improving health and quality of life. New finance models are needed to provide the incentive for large scale whole house 'deep' retrofit programmes, as well as near zero carbon new build.

Generally speaking, 'low carbon' research is currently centred on technology developments at an individual component level. Current technical solutions for energy demand reduction and supply have been mainly based on a component approach. However, it is the practical implementation of low carbon technologies as part of a 'smart' system that determines the extent to which they are successful, and to what extent predicted targets can be achieved in practice. In particular, it is at the interfaces of supply and demand technologies that often determine performance. Many technologies, when applied, do not deliver their optimum performance and cost, as they are often 'bolt on' solutions, e.g. increasing insulation standards for buildings may reduce the heating demand but may not result in an appropriately reduced capacity heating system. The temporal and spatial relationships between demand and supply need to be addressed through new and emerging technologies, such as energy storage and smart controls, in order to create an appropriate balance. Therefore a more systematic and holistic approach is necessary.

This needs to be combined with the need for new financial models, which take a more systems and life cycle approach, and fully address issues of value and yield on investment in relation to low carbon developments. Building regulations are also needed to drive innovation and promoting associated high value industries, while accepting and dealing with the concern over developer costs.

Many regions have low carbon policy aspirations; however, they generally experience difficulties in implementing them into practice. There are a number of reasons for this. Firstly, the energy agenda and the shift to a low carbon economy is a moving target. Priorities change quickly in response to developments in global and local economies. Government policy can change overnight, while industry needs clear longer-term targets. The gap between technology development and its application seems to be growing which is a disincentive for innovation. There are also uncertainties over cost and skills availability associated with low carbon technologies and processes, especially at the large scale needed. Technology is being advanced at a number of scales, from energy efficiency measures in buildings to new large scale energy supply programmes. There is pressure from big industries, such as nuclear and the fossil fuel industries (e.g. linked to future shale gas opportunities). These carry big industry lobbying, and the offer of a 'business as usual' approach. It seems that governments tend to prefer big industry solutions, compared to the more disparate nature of demand reduction and distributed energy supply. Both approaches are needed if Europe is to take a lead in the global low carbon economy.

Smart Energy regions also need to link the urban and rural economies. Many regions have a post-industrial fringe, which can provide an interface of resources (land, people and infrastructure) to facilitate this link. Such links can localise the environmental footprint, improving accessibility to materials and services, and reducing transportation energy consumption and providing economic benefits by combining the urban and rural economies (*Figure 2*).

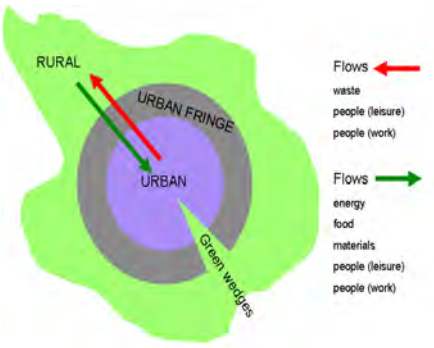

Figure 2 – Linking urban and rural economies, including energy systems;

Finally, 'smart' does not necessarily mean complex. Many existing energy management systems do not function because they are not commissioned, maintained, cannot adjust to change of use, or are simply too complicated to use. The development of new technologies through a systems approach should therefore recognise the needs and capabilities of people.

CONCLUSIONS

The economic benefits of a low carbon economy are huge, with opportunities for both wealth and job creation. There are other 'softer' societal benefits through improved quality of life, more efficient resource management and less pollution. However, the transition to a low carbon economy is not obvious and we must find a balance between the instabilities that might arise from climate change versus the instabilities from economic change.
The current tension between the 'clean' and 'dirty' economies needs to be relieved, and both sides need to work together recognising each other's views. Fossil fuel will be with us for a while, so we must learn to use it cleanly and efficiently, and at the same time develop renewables at all scales.

The biggest early win is to reduce energy demand and this can provide the bridge to the low carbon future. Whether the current austere times are an advantage or disadvantage remains to be seen, together with, to what extent the low carbon agenda can drive the economy. We must accept that delivering reductions in energy and carbon dioxide emissions, should also achieve cost and socio-economic 'products' in the development

of regional built environment programmes, linking the low carbon agenda with economic growth.

The SmartER COST Action will address the above issues, through:

- the need to secure energy supply and become less reliant on energy imports;
- the need to coordinate industrial initiatives in terms of market transformation of low carbon technologies. Europe has ideas but is slow to put them into practice;
- the need for innovative and sustainable technologies, and skills, for society, at work and at home, which can be used across the economy and which can transform society;
- a systems approach at all scales linking energy supply, demand, storage and networks;
- the need for better investment tools for a more sophisticated approach to cost and value modelling.

All this seems to be best driven forward at a regional level, linking policy to industry and societal needs for maximum benefit. SmartER is identifying new technologies and processes across Europe, how these can be integrated into a systems approach, linking with government and industry, on skills and training, and cost and value models, to help facilitate the transition to a low carbon economy. It will also produce information to inform 'decision makers', including how government policy and regulations can help drive forward innovation and competitiveness in industry, and what research is needed to support the transition to a low carbon future built environment. A more positive spin is needed to promote the low carbon agenda. Rather than global impacts of climate change it may be better to promote local agendas related to cleaner environments and economic and social benefits, together with healthy, comfortable, productive energy efficient buildings.

Europe has plenty of ideas relating to the low carbon technology, the main issue is getting these ideas into practice and developing a robust low carbon economy, which can attract long-term investment and create economic growth.

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The COST Action TU1104 Smart Energy Regions brings together over 70 researchers from European institutions to investigate the drivers and barriers that may impact on the large scale implementation of low carbon technologies in the built environment. The book "Smart Energy Regions" is the outcome of the Working Group 1 of the Action and collects analysis and case studies from 26 European countries. For more information about the Action and COST please visit www.smart-er.eu and www.cost.eu.

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COST DESCRIPTION

THE ORGANISATION OF COST

COST - European Cooperation in Science and Technology is an intergovernmental framework aimed at facilitating the collaboration and networking of scientists and researchers at European level. It was established in 1971 by 19 member countries and currently includes 35 member countries across Europe, and Israel as a cooperating state.

COST funds pan-European, bottom-up networks of scientists and researchers across all science and technology fields. These networks, called 'COST Actions', promote international coordination of nationally-funded research.

By fostering the networking of researchers at an international level, COST enables break-through scientific developments leading to new concepts and products, thereby contributing to strengthening Europe's research and innovation capacities.

COST's mission focuses in particular on:
- building capacity by connecting high quality scientific communities throughout Europe and worldwide;
- providing networking opportunities for early career investigators;
- increasing the impact of research on policy makers, regulatory bodies and national decision makers as well as the private sector.

Through its inclusiveness, COST supports the integration of research communities, leverages national research investments and addresses issues of global relevance.

Every year thousands of European scientists benefit from being involved in COST Actions, allowing the pooling of national research funding to achieve common goals.

As a precursor of advanced multidisciplinary research, COST anticipates and complements the activities of EU Framework Programmes, constituting a "bridge" towards the scientific communities of emerging countries. In particular, COST Actions are also open to participation by non-European scientists coming from neighbour countries (for example Albania, Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Jordan, Lebanon, Libya, Moldova, Montenegro, Morocco, the Palestinian Authority, Russia, Syria, Tunisia and Ukraine) and from a number of international partner countries.

COST's budget for networking activities has traditionally been provided by successive EU RTD Framework Programmes. COST is currently executed by the European Science Foundation (ESF) through the COST Office on a mandate by the European Commission, and the framework is governed by a Committee of Senior Officials (CSO) representing all its 35 member countries.

More information about COST is available at www.cost.eu.

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