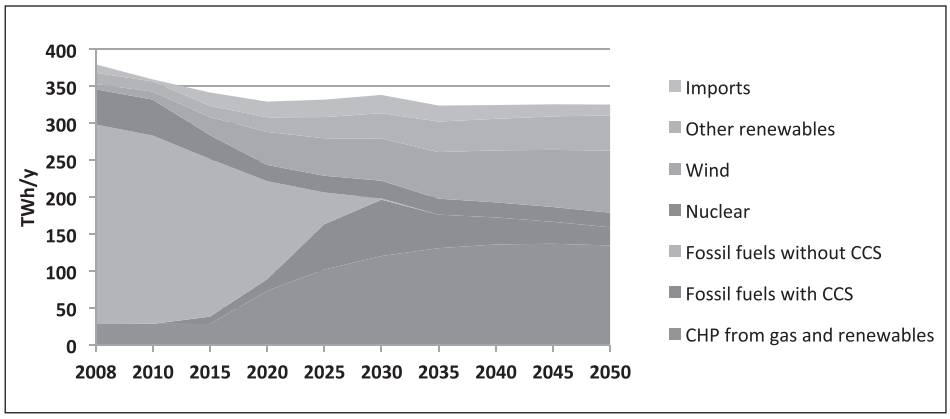

Figure 2. Electricity generation (TWh/y) in the community-led pathway 2010-2050[5]

other work can contribute to a more informed and engaged public debate about what kind of low carbon future we want, which is surely needed.

Acknowledgements

This article draws on the work of colleagues in the Transition Pathways project team from the Universities of Bath, Cardiff, East Anglia, Imperial College, Leeds, Loughborough, Strathclyde, Surrey and University College London, see www.lowcarbonpathways.org.uk The project was supported by the UK Engineering and Physical Sciences Research Council and the energy company E.On UK.

Dr Tim Foxon is Reader in Sustainability and Innovation at the University of Leeds, and a member of the SGR National Coordinating Committee.

References

1. Department of Energy and Climate Change (2011). The Carbon Plan: Delivering our Low Carbon Future. http://www.decc.gov.uk/en/content/cms/tackling/carbon_plan/carbon_plan.aspx
2. Department of Energy and Climate Change (2011). The Green Deal. http://www.decc.gov.uk/en/content/cms/tackling/green_deal/green_deal.aspx
3. Foxon TJ, Hammond GP and Pearson PJ (2010). Developing transition pathways for a low carbon electricity system in the UK. Technological Forecasting and Social Change 77, pp. 1203-1213.
4. Foxon TJ (2012). Transition pathways to a low carbon electricity future. Energy Policy (in press).
5. Foxon TJ, Pearson PJ, Arapostathis S, Carlsson-Hyslop A, Thornton J (2012). Branching points for transition pathways: assessing responses of actors to challenges on pathways to a low carbon future. Energy Policy (in press).
6. Transition Pathways team (2012), Layperson's guide to Transition Pathways. http://www.lowcarbonpathways.org.uk/lowcarbon/news/Pathways_A4_final.pdf

Energy from the ocean: the UK dimension

AbuBakr Bahaj outlines the recent positive progress in generating electricity from offshore wind, wave and tidal current resources in the UK. He also assesses the future challenges in a sector in which the UK is a global leader.[a]

Over the last 20 years, renewable energy has become a critical part of the supply mix, driven by our desire to use sustainable resources, reduce pollution emanating from fossil fuels, and create new industries and jobs. Although still driven by what are termed as subsidies, the renewable energy industry is maturing, with huge investments being ploughed into it. Global investment in the sector in 2011 was estimated at $257 billion, a 17% increase on 2010. A large proportion of the funds have targeted solar and wind power, and overall investment in these two sectors exceeded that for traditional fossil fuels. This is now a major industry that is likely to grow further, displacing and augmenting traditional electricity generation facilities.

Offshore wind power

In the last five years, the deployment of offshore wind power has rapidly increased – particularly in the UK where 1.8 gigawatts (GW) of installed capacity was achieved in early 2012. Going offshore, the wind resource is much larger than onshore – with higher wind speeds being present for longer periods. It also avoids the aesthetic objections that some have to onshore turbines. Currently the UK is leading the way with a potential of 18 GW of capacity to be realised by 2020. These achievements are extremely important, especially in responding to government targets for reducing carbon emissions from energy generation, while diversifying the energy mix and creating new industries. The UK's targets and support policies have resulted in major investments by large companies, such as Siemens and Samsung, in manufacturing, installation, infrastructure, and job creation – especially in 'Round 3' wind farm development, which is planned to take place up until 2020.[1]

The challenges of an expansion in offshore wind generation are multifaceted, encompassing the technical, economic and human resources needed to support the deployment and maintenance regimes for these wind farms. Initially, wind turbines with a power rating of 2 MW were installed in the early 2000s, but now 5 MW is the norm with 10 and 20 MW machines under serious design consideration. Prototypes of these latter turbines are expected to come on stream within the next three years. From a technical viewpoint, operating in the sea clearly has its own challenges, including the design of the foundations, electrical cabling and operation within a constrained weather window. Going far from the shore and using larger machines will need new and innovative thinking in terms of materials, components and other measures to enhance reliability and ease of maintenance. Bringing power to the shore will require new infrastructure at ports to support manufacturing, deployment and maintenance, as well as new cable topographies based on high voltage DC and – more importantly – grid outlets geared to cope with the intermittence of power generation sources.

Power from waves and tidal currents

Other ocean-based energy resources are tidal currents and waves. The UK is at present the world

The Pelamis Wave Power device

leader in both wave and tidal current conversion[2] both technologically and in their deployment at sea. In terms of the latter, the UK has a shoreline energy resource of approximately 10% of the 2500 GW estimated to be available globally. If the UK were to make full use of, say, 10% of its resource for power generation – which would require a very large capital investment – tidal currents could deliver around 220 terawatt-hours per year (TWh/y), roughly half of the UK's electricity consumption today.

While most incident wave energy is dissipated in deep water, there is nevertheless a significant nearshore resource estimated to be 1300 GW globally, with a technically exploitable resource of 100-800 TWh/y. The UK has one of the most energetic wave climates in the world, with the potential to provide up to 50 TWh/y.

At present, there are no arrays of multiple devices of wave or tidal technologies operating out at sea, and many of the challenges of offshore wind mentioned above also apply to wave and tidal energy generation. However, individual devices at capacities of around 1 megawatt (MW) or less are currently operational at test centres or in sheltered sites in the UK and elsewhere. Most notable are the SeaGen device of Marine Current Turbines Ltd, rated at 1.2 MW and operating at Strangford Lough, Northern Ireland, the Pelamis Wave Power device rated at 0.75 MW and Aquamarine's Oyster machine rated at 0.80 MW, which are currently being tested at the European Marine Energy Centre, Orkney Islands.

The next steps for all these technologies will be to achieve credible operational experience in the sea, including testing out arrays or farms of multiple devices. This will help to improve the economics by reducing the installation cost of the technologies. For example, the installation cost per MW for the leading wave and tidal current technologies is currently in the range £7 – £10 million, with the lower value representing multi-MW installations and the higher for a single commercial prototype. A pathway to cost reduction to attain future parity to the presently 'acceptable' cost of £3 million per MW for offshore wind is currently being pursued by developers supported by funders, either through economies of scale or by optimising and streamlining the operation and maintenance of the devices.

A promising future

Project development for wave and tidal technologies in the UK is now following a similar procedure to that taken for offshore wind farms. The Crown Estate, which owns the seabed around the UK coastline, has awarded leases to marine energy projects for a series of sites in the Pentland Firth and Orkney waters. These 'Round 1' leases for marine energy permit ten demonstration and commercial projects totalling 1.4 GW of potential capacity for different technologies (600 MW wave energy devices, 800 MW tidal current devices) at an estimated cost of £4bn to be installed by 2020. These schemes will require an additional investment of up to £1bn from public sources to develop and build new grid connections, harbours and other supporting infrastructure in Orkney and Caithness. The idea behind the venture is that the Crown Estate will support these activities as a powerful partner with the ability to tackle bottleneck issues such as permitting, consenting and financial support. The government has proposed that the current system of Renewable Obligation Certificates (ROCs) will be used to support marine energy development, allocating 5 ROCs per MWh to the first projects – which is approximately 2.5 times that for offshore wind. As a result, electricity utilities are now starting to make large investments that will allow array-type technologies to be deployed.

Professor AbuBakr Bahaj is the head of the Sustainable Energy Research Group (SERG) and the Energy and Climate Division at the University of Southampton, http://www.energy.soton.ac.uk/

Notes

1. Offshore wind farm development in the UK to date has taken place in three stages – known as Rounds 1, 2 and 3 – the first of which began in the early 2000s.
2. Exploiting tidal currents avoids the use of barrages, which have been much criticised for their potential impacts on local wildlife.

References

a More details and references can be found in:
Bahaj AS (2011). Generating electricity from the oceans. Renewable and Sustainable Energy Reviews, vol.15, pp.3399-3416. doi:10.1016/j.rser.2011.04.032.
http://www.sciencedirect.com/science/article/pii/S1364032111001900
Copies of the paper are available from the author for personal use, email: <A.S.Bahaj@soton.ac.uk> More information is also available from the SERG website above.