IOP Institute of Physics

Submission to the House of Commons Energy and Climate Change Select Committee energy revolution inquiry

"Which innovations have the greatest potential to revolutionise energy markets, and why?"

1. The Institute of Physics (IOP) is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application. We engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, we are world leaders in professional scientific communications.
2. The IOP welcomes the opportunity to respond to the Committee's energy revolution inquiry.
3. Investment in physics and skilled people with an understanding in physics is essential to innovation in energy research, technology and the energy market, including those areas which we highlight below. We focus on nuclear and renewable energy, and hydrogen, but UK physics research is driving a wide range of exciting energy technologies. Realising any of these potentially revolutionary advancements will require sustained investment in research through the science budget to ensure a secure, sustainable and low-carbon energy future.

Nuclear: Small modular reactors

4. A number of upcoming and of-age nuclear technologies will be important to future energy markets, including nuclear fusion in the longer-term - with UK fusion research being of "world-class quality"[1].
5. Small modular reactors (SMRs) are self-contained fission reactors with a production capacity of under 300 MWe. They can be manufactured to be transported fully-constructed to an installation site and be used to provide power for specific local or industrial applications and to supply electricity, where possible, to the grid. This allows greater local control and ownership over power; reduced challenges in planning compared with larger stations; and can contribute to a reduction in local demand on the grid whilst helping to provide inputs when local use is lower. SMR's flexibility can also complement the intermittency of renewable energy generation,

[1] https://www.epsrc.ac.uk/newsevents/pubs/indrevfissionfusion/

while likewise being a low-carbon technology. The 2015 Spending Review announced £250m for "an ambitious nuclear research and development programme"[2] which includes plans for a competition to identify the best value SMR design for the UK[3] and plans to build one of the first SMRs in the UK in the 2020s. Sites in Wales and the North of England are currently being identified.[4] There are a number of active research groups in the UK whose nuclear research includes SMRs, including the University of Manchester and University of Sheffield who jointly lead the Nuclear Advanced Manufacturing Research Centre.[5] The National Nuclear Laboratory has been involved in producing a feasibility study for SMRs in the UK.[6]

Renewables: New solar technology

6. Deploying a mix of renewable energy technologies will be essential in any energy market – including solar, wind, tidal, hydro, wave and geothermal energy. The UK currently has a target of 15% generation from renewable sources by 2020.[7]
7. The development of solar energy, in particular photovoltaic solar energy, has been rapid over the past decade. Solar panels are now being deployed in private and council buildings across the UK, with the development of a number of larger-scale solar farms in recent years looking to capitalise on mass generation of solar energy.[8] As cells reduce in price and increase in efficiency they will likely comprise a greater percentage of the UK's energy market. Most physics research focuses on photovoltaics related to 'second-generation' solar cells, which are thin-film solar cells with lower production costs but reduced energy efficiency compared to first generation cells. The most promising technology are 'third-generation' solar cells, many utilising novel organic materials and which could potentially yield extremely high efficiencies and be as cheap as thin-film devices, but are currently not yet readily available on the market. Research groups at the University of Cambridge[9], University of Exeter, University of Warwick[10], University of Southampton[11], Swansea

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/479749/52229_Blue_Book_PU1865_Web_Accessible.pdf

[3] https://www.gov.uk/government/publications/small-modular-reactors-competition-phase-one

[4] http://www.telegraph.co.uk/news/2016/04/02/mini-nuclear-power-stations-in-uk-towns-move-one-step-closer/

[5] http://namrc.co.uk/

[6] http://www.nnl.co.uk/media/1627/smr-feasibility-study-december-2014.pdf

[7] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48128/2167-uk-renewable-energy-roadmap.pdf

[8] http://www.renewables-map.co.uk/Solar.asp

[9] http://www.energy.cam.ac.uk/directory/research-themes/supply/Photovoltaics

[10] http://www2.warwick.ac.uk/research/priorities/energy/researchthemes/solarenergy/

University[12], Imperial University[13] and the University of Oxford[14] are among the most active in developing new solar photovoltaic technologies, including third generation cells. There are well over 2000 UK companies involved focused on solar photovoltaic technology – though many may be primarily involved in installation, rather than technological development.[15]

New fuels: Hydrogen

8. As well as energy generation for domestic and industrial use, transport energy is an area of high levels of innovation in research and development. Technologies such as biofuels, including algae-based fuels[16], compressed natural gas[17] and electric cars[18], present a range of possible transport futures.
9. Hydrogen in particular has the potential to revolutionise transport energy as a new "fuel". A hydrogen-fuelled transport market is the most analogous to the existing petrol and diesel market, with similar ranges to existing petrol cars and the ability to fill up a car's tank in minutes. Hydrogen also has the advantage of being a potentially low-carbon or "clean" fuel, provided that the method to produce hydrogen is in itself low-carbon. This means that renewable energy generation and SMRs could have an added role to play in developing a hydrogen economy infrastructure. The success of new fuels like hydrogen, as with renewable energy technology, is bound up in the development of effective energy storage, in particular in the efficiency (both in size and capacity) and safety of hydrogen fuel cells - with similar challenges in battery technologies for electric cars. Hydrogen fuels cells could, for example, take advantage of moments of high wind or solar energy supply while there is low demand on the grid, and allow the energy generated to be transferred for transport usage. Hydrogen fuel-cells are already being employed in limited numbers by major car manufacturers and power thousands of forklift trucks in North America and Europe. In 2013, the Government estimated that by 2030 over one and a half million hydrogen-powered vehicles could be on UK roads[19] and in 2014 announced plans to provide up to £11m of funding to bring this closer to reality including by establishing a

[11] http://www.southampton.ac.uk/~solar/
[12] http://cser.org.uk/
[13] http://www.imperial.ac.uk/plastic-electronics/research/solar-energy/
[14] http://www.energy.ox.ac.uk/
[15] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/416240/bis-15-206-size-and-performance-of-uk-low-carbon-economy.pdf
[16] http://www.parliament.uk/documents/post/postpn_384-biofuels-from-algae.pdf
[17] https://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/03/NG-84.pdf
[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239317/ultra-low-emission-vehicle-strategy.pdf
[19] https://www.gov.uk/government/news/future-of-hydrogen-powered-cars-mapped-out

network of hydrogen refuelling stations.[20] This has included the development of the London Hydrogen Network through funding from Innovate UK.[21] Research is being undertaken in over 35 academic research groups including at the University of Birmingham[22], University of Cambridge[23] and at the Hydrogen and Fuel Cell Research Hub, established in 2012[24]. There are over 100 UK companies currently active in developing hydrogen fuels cells and similar technologies.[25]

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[20] https://www.gov.uk/government/news/multi-million-pound-fund-to-get-hydrogen-cars-moving
[21] http://www.hydrogenlondon.org/
[22] http://www.birmingham.ac.uk/research/activity/chemical-engineering/energy-chemical/fuel-cells/index.aspx
[23] http://www.energy.cam.ac.uk/directory/research-themes/conversion/energystorage
[24] http://www.h2fcsupergen.com/
[25] http://www.ukhfca.co.uk/the-industry/