Net-zero carbon Wales 2040: A vision of the future

A summary of a workshop discussion held in Cardiff on 25 March 2019.

Net-zero carbon Wales 2040 brought together expertise from academia, government and industry to consider how science and the assets of Wales could be harnessed to develop the country as a world leader in low carbon technologies. It was organised in partnership with the Learned Society of Wales, and chaired by Professor Hywel Thomas CBE FREng FLSW FRS.

This paper has been compiled by the Royal Society and Learned Society of Wales based on discussions at the meeting and is not intended to represent either an agreed consensus of the participants or the official views of the convening institutions.

Summary

This workshop discussed three areas where scientific and technological developments could help the country decarbonise by 2040 and demonstrate a global leadership position in low carbon technologies. Those areas were:

- Agricultural innovation
- Data and digital technologies
- Hydrogen and other carbon-free fuels

These conversations covered:

- **The importance of immediate decarbonisation.** A number of activities could be put in place such as: supporting the deployment of digital technologies across all sectors, facilitating the integration of carbon sequestration in agriculture and carbon capture in industrial sectors, and continuing the transition towards a circular economy.

- **The value of the Welsh Government's** *Prosperity for All: A Low Carbon Wales* **report and Well-being of Future Generations Act as a roadmap for action.** Wales already has strong environmental legislation and regulation in place, along with clear political commitment to action; these statements articulate a clear direction for Wales.

- **The need to nurture new skills across key economic sectors and society as a whole.** The transition to a net-zero carbon society will involve important changes in production and consumption patterns facilitated by the uptake of new, low-carbon technologies. Wales is at a key moment for upgrading skills across its population to facilitate the integration of these technologies and should seek to articulate those needs.

- **There are substantial opportunities for Wales to grasp.** Wales has significant natural assets. By championing research and innovation in low carbon technologies, Wales can effectively lead the fight against global climate change while establishing itself as a developed world leader in this field. This could have significant positive effects for its economy, and contribute to the country's long-term prosperity.

Headline views expressed at the meeting

Presentations and the subsequent breakouts considered the roles of agricultural innovation, carbon-free fuels, and digital technologies in decarbonising Wales, and how they could be embedded into a whole-system approach for the country.

Agricultural innovation

The agricultural sector is critical to the Welsh economy and society as a whole. It employs over 50,000 people, and 85% of the land area in Wales is used for agriculture. Whilst there has been a decline in greenhouse gas emissions in this sector in the last two decades, the agricultural sector still accounts for 12% of Welsh emissions, mainly from livestock farming (53%), fertiliser use (21%), and mobile machinery (10%). Technological innovation presents the prospect of simultaneously improving productivity and delivering substantial reductions in emissions. A number of these solutions already exist or are in development and could soon be deployed with support from policy or investment. These include:

- Switching crops to perennial or nitrogen fixing varieties, to stabilise soil structures and enhance the introduction of carbon and nutrients into the soil.
- Precision agriculture technologies such as drones, sensors and smart tractors to optimise returns on farm inputs.
- Enhancing the use of technologies such as solar, wind and bioenergy on farmland to power farm machinery.
- Reducing emissions from animal husbandry including through increased grass feeding and slower growth methods.

Delivering these technologies in Wales will require:

- Incentivising farmers to use their land for carbon sequestration.
- Undertaking further research in plant breeding.
- Further research and investment in home-grown alternatives to soy for animal feed.
- Further R&D of technologies that utilise farm waste to generate bio-energy.
- Building a large, skilled workforce, through education at all levels including access to doctoral and post-doctoral research opportunities.

Data and digital technologies

Digital technologies hold promise to deliver substantial efficiency gains across a range of industries and make better use of existing data to support decision-making.

Sensors and an expected increase of computing power could improve efficient use of resources. Sensors are already commonplace in public spaces, buildings, vehicles, and farmland to monitor energy, fertilisers, or parking spaces. Developments in quantum technology present the potential of increasing the power of computing methods and further enhancing the use of this sensor data. Cardiff already uses the Smart Parking App with 3,000 parking sensors to help drivers find parking spaces to reduce traffic congestion and emissions.

Increasing infrastructure connectivity and sharing data more openly across sectors is crucial to maximise efficiency gains from these technologies. In the energy sector, smart grids use data to model energy demand and dynamically allocate energy across users. This, together with energy storage, enables the effective integration of intermittent renewable energy sources to the grid.

There nevertheless remain concerns about privacy loss and inequity. These could limit the ability to deploy these technologies if the risks of installing smart meters or appliances are perceived as higher than the resulting benefits.

Wales could facilitate the integration of these technologies by:

- Increasing transparency around the ways in which personal or commercial data is used, processed and stored by corporations and public authorities.
- Raising awareness of the potential contribution of digital technologies to a net-zero carbon future.
- Nurturing data skills across the whole population through schools and continuing education, particularly for those who might be most affected by the rise of digital technologies in Wales.
- Supporting cross-sectoral research, involving academia, private and public organisations, to identify specific policy needs and set research objectives.
- Developing schemes for retaining data scientists in Welsh companies, universities, and research centres.

Hydrogen and other carbon-free fuels

Carbon-free fuels have the potential to reduce emissions in hard-to-decarbonise sectors. For example, transport is the third largest contributor to Welsh greenhouse gas emissions (14%). This is only slightly decreased from the 1990 baseline level. Switching freight or public transport to hydrogen could reduce emissions while improving air quality.

Hydrogen is a potentially important carbon-free fuel, but low-carbon production is still in development. Hydrogen is typically produced by steam methane reforming of fossil fuels resulting in CO_2 emissions. Decarbonising this method would require carbon capture and storage technology. Alternative low-carbon production technologies, such as electrolysis of water, are being developed, but have not been deployed at large scale, in part due to higher costs.

The transport and storage of hydrogen also constitutes a challenge for a hydrogen-based economy. Its conversion to ammonia is being considered as a solution for which these challenges are reduced.

Carbon-free fuels like hydrogen and ammonia will play a part in a broader energy system, which will include renewable energy, changes in energy efficiency and the potential introduction of other energy sources all operating together. The Welsh public and businesses will need to be engaged in the development of this system to ensure success.

Whole system

Creating a circular economy in Wales would decouple growth from the consumption of finite resources, and simultaneously reduce emissions. Placing life cycle assessment at the heart of industrial and decision-making processes could enable reusing, repurposing or recycling of products to be planned for at the early stages of production. This could facilitate ongoing economic output and prosperity, while embedding low carbon resource use into the economy.

In parallel, increasing infrastructure connectivity could bring significant benefits. A modernised transport infrastructure, for instance, would facilitate access from rural areas to economic and industrial hubs where most people currently work whilst simultaneously reducing greenhouse gas emissions. This would require careful regional planning, and a change in focus and ambition from building infrastructure for peak demand (mainly roads and electricity grids) to infrastructure that enables demand shifting across sectors and places.

These transformations would bring about new forms of mobility and cultural change across society. In cities, better conditions for cycling, walking, and public transport services over private vehicles could facilitate the transition to a services-led system where individual ownership is no longer dominant. In organisations, enhanced digital connectivity would make teleworking easier and more socially acceptable.

Greenhouse gas removal and carbon capture and storage could play important roles in emissions reductions. Methods such as increased forestation, soil carbon sequestration or sustainable bioenergy with carbon capture and storage could play an important role for Wales, where the industrial and agricultural sectors together accounted for 41% of total greenhouse gas emissions in 2016.

Achieving these changes will also require social change. Engaging members of the public with the environmental impact of consumption and production patterns will be essential and could be achieved through education in schools, universities, continuing professional development, and public outreach activities.

Further reading

Prosperity for All: A Low Carbon Wales (March 2019). The Welsh Government. See: https://gweddill.gov.wales/docs/desh/publications/190321-prosperity-for-all-a-low-carbon-wales-en.pdf

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