HYDRO INTERNATIONAL SPEAKS TO PROF ED HILL, NATIONAL OCEANOGRAPHY CENTRE

From seafloor mapping to clean energy: hydrographyâ€™s key role in a sustainable world

Renewable energy and the pivotal role of hydrography in offshore development take centre stage in a captivating interview with Professor Ed Hill, chief executive of the National Oceanography Centre (NOC). Illuminating the immense opportunities in renewables, he discusses the role of hydrography in seafloor mapping, turbine siting and offshore infrastructure monitoring. Additionally, the interview addresses the contributions of hydrographers and ocean technologists in advancing sustainability and harnessing the potential of renewables and big data. Emphasizing the importance of public-private partnerships and the ocean's potential to provide climate change solutions, Professor Hill presents a compelling vision for a sustainable ocean economy.

Renewable energy is a trending topic in today's hydrography and oceanology industry. What do you regard as the key opportunities associated with it?

Renewable energy is an essential element of the clean energy transition – both onshore and offshore. Hydrography information is crucial to understanding the development of offshore forms of renewables, such as offshore wind, tidal power and, in due course, offshore waves. Key opportunities are related to the more effective mapping of the seafloor, for example to identify where the tidal stream energy might be concentrated. The power generated by offshore tidal turbines can be very sensitive to the location, and moving the turbines just a few hundred metres can lead to considerable differences in energy output, due to the way in which tidal streams can be focused, particularly by bathymetric conditions. Understanding this is crucial for siting turbines.

Also, as we build very large wind farm arrays, issues such as scouring and evolution of the seafloor and coastal morphology will need to be monitored. There is clearly a role for hydrography in both the siting and monitoring of these arrays and, eventually, the decommissioning of offshore infrastructures. This also applies to the cabled power infrastructure from offshore installations, whether tidal wave or wind, to shore-side locations.

Sustainability should be a crucial consideration for all industries, including hydrographic surveying. How do you think the industry can continue to improve in this area in the coming years?

To date, hydrographic surveying has been very dependent on offshore survey vessels and, as we know, shipping is a particularly hard sector to decarbonize. The carbon footprints of survey vessels can be significant, both individually and collectively, and are one of the major drivers of cost in offshore surveys. Consequently, opportunities exist in exploring suitable alternatives to the use of survey vessels. Some of these options may reduce the carbon footprint while also having cost benefits. These options include satellite measurements of seafloor bathymetry and the use of Lidar techniques in shallow waters, uncrewed surface vehicles with swath bathymetry suites installed and underwater autonomous vehicles. Uncrewed surface vehicles are particularly promising, as they can have a considerable range and endurance, which not only reduces the carbon footprint but also removes some of the other costs associated with hydrographic surveying, including the number of people at sea.

There will always be a role for hydrographic survey vessels, at least for the foreseeable future. The question is how to optimize and use them in appropriate circumstances, to minimize the carbon footprint and obtain the most efficient data return for the emissions incurred.

At this year's Ocean Business, you gave an opening keynote in which you stated that the ocean is not just a victim of climate change, but also a solution. Could you elaborate on this?

There are many ways in which the ocean offers solutions to a number of climate-related issues. The installation of offshore renewable energy systems is a clear example, and the UK is a leader in the installation of offshore wind, while it is growing in other regions too. Tidal power is less developed, but will come on stream and clearly has the ability to offset some of the known disadvantages of offshore wind.

Beyond renewable energy, there are a number of other areas where the ocean offers a solution. For example, trajectories to net zero emissions and moving to reduce future atmospheric CO_2 levels need mechanisms that can capture and sequester CO_2 in natural or artificial carbon sinks. Subsea carbon capture and storage is an area that is important to develop. Combined with biofuel reduction, this can lead to negative carbon emissions. Carbon capture and storage is certainly very high on the agenda and some of the first sites are being developed now.

Another area that is attracting considerable attention is marine nature-based solutions. The idea is that there are areas where protecting biodiversity, particularly in coastal habitats such as seagrass meadows, mangroves and salt marshes, not only benefits biodiversity (which is a major concern) but also improves the habitat's ability to act as a natural carbon sink. This is potentially a win-win situation: protecting biodiversity, protecting and even enhancing carbon sinks, thereby removing carbon from the atmosphere, and economic benefits ranging from tourism to benefits to local communities to providing natural flood protection.

There is also the question of the relative benefits of taking food from the sea (whether through wild fisheries or aquaculture) or producing food on agricultural land, and there are differences in the carbon trade-offs in doing this. Land-based agriculture is very energy- and water-intensive, whereas the water supply is clearly not an issue for marine food, which is potentially less energy-intensive too. There are however other concerns about the sustainability of aquaculture and wild fisheries. But, provided that sustainable approaches are developed, the use of marine food to supplement and complement energy- and water-intensive agriculture can provide important carbon and health benefits.

The High Level Panel for the Sustainable Ocean Economy produced a report looking specifically at the ocean as a source of climate solutions. Their estimate was that about 20% of the gap between current emissions and the CO_2 reductions needed to be on track for the Paris targets could be achieved by a mix of ocean-based solutions of the kinds I've just described.

What should be done to harness the enormous potential of renewables and the role of hydrographers and ocean technology professionals in it?

There is enormous potential for offshore renewables. There is a continuous need to upscale the use of renewable energy, including for offshore wind moving into deeper waters, because the further offshore one goes, the greater the available energy resource. Moving into deeper waters is therefore one area, but also expanding into other regions of the world with high levels of wind energy that are not yet being exploited at scale.

Another opportunity is to combine offshore renewables, including wind, with other activities to produce mutual synergies. For example, offshore wind arrays provide natural marine protected areas, given that it is not possible to fish intensively in these areas. More research is needed, but it is also important to monitor these areas to see if these co-benefits are being realized. These kinds of opportunities therefore combine an element of habitat and biodiversity surveying and traditional hydrographic surveying.

Big data is seen as a technology that can help solve the climate change challenge. What is your vision on this?

Traditionally, in terms of ocean observation, our problem has been gross undersampling in space and time, so that sparsity of data has been the challenge in interpreting change and variability. This is very much changing with the advent of new technologies that are capable of more continuous observation, both of the seafloor and of an increasing number of ecological and chemical variables.

Consequently, the big data revolution is hitting ocean science and hydrography, to the extent that vast datasets can now be generated. As a result of this technology innovation, it will be possible to obtain information about habitats and ecological systems on the seafloor as routinely as it has been for the more traditional variables. This opens up really important opportunities for forecasting how ecosystems will change in response to human activities.

Some of the artificial intelligence techniques that are now being developed will help to identify species and, in due course, to understand changes and which ecosystems are associated with which types of seabed morphology, as well as to potentially predict the physical and ecological impacts of offshore development. Even if it had been technologically possible to make these observations before AI, it would have been impossible to interpret them using human analysis alone. AI is therefore essential for handling vast quantities of data generated in this way, and is a huge opportunity. It means that our offshore surveys can now take these ecological and habitat dimensions into account, which will become integral to offshore surveying in many future applications.

Professor Ed Hill CBE is chief executive of the National Oceanography Centre (NOC), one of the worldâ€™s most innovative oceanographic institutions.

How do you envision the collaboration between public and private sector organizations in hydrographic surveying, in the light of climate change and the energy transition?

Hydrographic surveying has long involved public and private partnerships. Public bodies often set the requirements for data gathering, through hydrographic surveying programmes for civil or military use, and public bodies/regulators increasingly set the regulatory environments or conditions offshore, including for environmental impact assessments and the setting out and development of marine spatial plans and protected areas. The private sector's strength is being able to undertake the necessary surveys to inform these public

requirements and to enable other private sector actors to operate in compliance with them.

The private sector also plays a key role in innovating the application of new technology in hydrographic surveying. Research institutions such as my own have been important in pioneering the use of autonomous underwater and surface vehicles for scientific applications, very often in extreme and deepwater environments.

The commercialization of these technologies and their widespread upscaling and application is really the key role for the private sector. The scaling up is completely reliant on private sector investment and being able to respond to the demands set by public body regulators.

The transition towards renewable energy is fuelled by the desire to combat climate change. Are you optimistic about the path we are taking?

Fundamentally, yes, I am. I think there is little alternative but to be optimistic. The path to stabilizing CO_2 emissions and therefore levels in the atmosphere and indeed reducing them is an important one. All scientific evidence points to increasingly severe adverse impacts on human society and the ecology of the planet if the global temperature rise is allowed to exceed 2°C. We are seeking to minimize the impacts of this. It is a very significant challenge that involves a whole range of issues, which makes it highly complex.

Although it is technically feasible, it also involves significant economic impacts in the short term as part of the transition. It will also necessitate behavioural changes in society and imaginative policy options. It is important that the transition is a 'just' transition – in other words, we already know that those likely to be most adversely affected by climate change are some of the poorest in the world, but the costs of the transition to cleaner energy may also fall on the most disadvantaged and least able to afford it. If this transition is not managed in such a way as to continue to secure public and political consent, we risk making progress in achieving what is technically possible.

We therefore need a concrete set of plans for how to achieve these transitions, which will be different in different circumstances, but which have clear steps and timelines set out for how to achieve them and what the best options are. There is currently a high level of ambition, at the global, national and even regional and corporate levels, to set targets for these reductions, but these will run into trouble unless followed by clear, concrete and realistic plans. Of course, some sectors are more difficult to decarbonize than others, which is why, in the first instance, we are talking about achieving net zero emissions – where those sectors that are hard to decarbonize are compensated in other ways by reducing emissions elsewhere. However, these are by no means a substitute and can never get close to reducing emissions to the level that is actually needed and which demands the transition of fossil fuel energy sources.

I am therefore optimistic but realistic concerning the complexity and difficulty of the change, and aware that we need to move fast to a phase beyond aspirational to realizable and verifiable plans.

Are there any specific climate change measures in which the hydrography and oceanography profession can play a pivotal role, based on your knowledge as a scientist?

The quick answer is that the main thrust is in developing the offshore renewable sector and subsea carbon capture and storage options. There are also clear opportunities in the generation of hydrogen offshore as an energy store but also as a fuel. Although hydrogen is not the answer alone and comes with a number of challenges, these are the main areas to focus on in the short term.

Some scientists are pursuing research relating to the removal of CO_2 from the atmosphere through manipulation of the ocean chemical and biological carbon uptake processes using artificial means. While this is important to undertake, it is a hugely contentious area. The main risk is completely unintended consequences of large-scale manipulation of ocean systems' natural processes. It is therefore important to research, if only to identify the full scope of risks involved.

Is there anything else you want to share with the hydrographic community?

The role of the ocean in providing solutions to climate change, but also opportunities to develop a sustainable ocean economy, is considerable. It is an exciting time to be a hydrographer and oceanographer, as for a very long time we have operated behind the scenes without the recognition that we thought our work merited. The work of marine is moving centre stage and is pivotal in addressing the world's greatest challenges of today.

Professor Ed Hill CBE

Professor Ed Hill CBE is chief executive of the National Oceanography Centre (NOC), one of the world's most innovative oceanographic institutions. He has a research background in physical oceanography, specializing in the circulation of continental shelf seas, and has participated in over 20 research expeditions. Professor Hill received his MSc and PhD degrees in oceanography from Bangor University and his BSc in Applied Mathematics from the University of Sheffield. He was appointed Commander of the Most Excellent Order of the British Empire (CBE) in 2020 for services to environmental sciences. Professor Hill has served, and continues to serve, on numerous national and international advisory bodies.

Professor Ed Hill is known for his compelling vision for a sustainable ocean economy.