

Professor Eric Mackay

Hello. It's an honour to address you at the launch of the Petronas Global Technology Centre at Heriot-Watt University.

My message is that the Centre represents an excellent fit between Petronas and Heriot-Watt as they jointly address the urgent challenge of the energy transition. Over the next 10 minutes I will use some personal perspectives on the topic of carbon capture and storage to illustrate this fit between Petronas and Heriot-Watt.

Petronas's statement of purpose is to be a progressive energy and solutions partner enriching

lives for a sustainable future. These words chime very well with Heriot-Watt's ethos in research and training in energy engineering and its place in the world: leading hearts and minds in accelerating the energy transition. And if we look a little deeper at Petronas's sustainability targets for the period to 2024, we note that they align very strongly with Heriot-Watt's four-part strategic plan to 2025.

Heriot-Watt seeks to build flourishing communities. One of Petronas's sustainability targets

is to promote a circular economy, one which adopts a systemic community-based approach to benefit businesses, society and the environment and one which aims to gradually de-couple growth from the consumption of finite resources.

Secondly Heriot-Watt aims to excel in research and enterprise. Petronas is committed to capping greenhouse gas emissions to 49.5 million tons of CO² for their Malaysia operations by 2024. It has also pledged to step up its renewable energy capacity to three gigawatts in the same time frame. These targets speak to Heriot-Watt of the urgency with which the energy transition is being addressed by Petronas. This depends on excellent research and development and on an enterprise approach that delivers technology that can be applied in the field today.

Thirdly, Heriot-Watt University has and continues to be, pioneering in education. Petronas's strategy includes the nurturing of future leaders reaching over 24,000 beneficiaries through education programmes by 2024. Heriot-Watt's commitment is to offer a distinctive learning experience grounded in the needs of a rapidly changing world and to support Petronas in reaching its targets.

Finally, Heriot-Watt is a globally connected university. It goes without saying that Petronas is an energy company with a global footprint. Heriot-Watt has campuses in Edinburgh, Putrajaya and Dubai. The Institute of GeoEnergy Engineering has trained students from over half the countries of the world, remaining in active contact with many of them.

As we have just heard from the Principal and Vice-Chancellor, Heriot-Watt through the Global Technology Centre will partner in delivering R&D supplies Petronas with know-how technology enterprise and training these will enable Petronas to achieve its ambition to be a leading player in low-carbon energy provision. There is much that Petronas in Heriot-Watt share in common. Petronas was founded in 1974 and was a year later in 1975 that Heriot-Watt established its Department of Petroleum Engineering.

Petronas's roots were oil and gas, but it has evolved into a progressive people-centred energy company seeking a sustainable future. The Department of Petroleum Engineering has re-established itself as the Institute of GeoEnergy Engineering looking to a future in which the subsurface will play a rapidly increasing role in sustainable, secure, and just energy provision.

Knowledge transfer has been an important element of our engagement with partners across the world. There are those in academia who propose that universities should walk away from engagement with the oil and gas industry. This is precisely the wrong thing to do. This would hinder the drive to lower carbon emissions and fails to understand the urgency of the challenge we face. The best way to accelerate the energy transition is to win over the hearts of the next generation of energy engineers and train their minds so that they're equipped to deliver a trusted partnership between universities such as Heriot-Watt and national energy companies with a global footprint such as Petronas creates the best of all opportunities to deliver on the energy transition in the here and now.

This figure from the BP Energy Outlook for 2020 with data collated by Heriot-Watt illustrates that to meet emissions targets hydrocarbons will need to play a decreasing role in the overall energy mix. However, by 2050, they will still represent a significant component under all scenarios considered in this and indeed other studies. We need to work together to replace hydrocarbons in the energy mix but we also need to urgently address the emissions associated with hydrocarbons that will of necessity be produced before the transition is complete. Whilst it might capture a populist headline it would be grossly irresponsible for regulators, industry, and academia to walk away from this challenge thereby making the objectives of immediate reductions in emissions more difficult to achieve. This means two things. We need to urgently reduce emissions from hydrocarbons that will be produced, and we need to use subsurface assets infrastructure knowledge and expertise to provide alternatives to traditional hydrocarbon extraction.

A very good example is carbon capture and storage (CCS) which will help deliver both these objectives. Firstly, CO² associated with hydrocarbons can be stored in the subsurface from which it originally came. Secondly, CO² associated with hydrogen generation can also be stored permanently while another subsurface reservoir may act as a temporary store for the hydrogen itself. I wish to mention some of the CCS work we've undertaken at Heriot-Watt. In 2005, Heriot-Watt was a co-founder of Scottish Carbon Capture and Storage (SCCS), a partnership among Scottish universities and the British Geological Survey. I personally have been privileged to be involved from the outset and have led technical work that contributed to three major reports that were delivered to the Scottish Government. Here's a picture of one of the reports being presented to then Scottish Energy Minister, Jim Mather.

To date, the Oil and Gas Authority in the UK has licensed four CCS projects on the UK continental shelf. Together with colleagues we have been involved in technical work associated with all four projects:

- Assessing the risk of salt deposition and geochemical reactions in the bunter formation

- Calculating the risk of interference with other subsurface activities in the Goldeneye Field
- Evaluating storage capacity and ultimate destination of CO² for the Captain and East May Formations
- Investigating potential for pressure management by water extraction in the Hamilton Field.

Our work has focused on maintaining injection capacity, managing subsurface pressure to maximize storage capacity and security, and identifying the impact of unrecovered hydrocarbons on CO² migration and trapping. In the example shown here, note how dissolution of CO² in water contributes equally in both cases - the green bars - but that in the first case on the left residual trapping - the red bar - and the solution in oil - the purple bar - deliver over 50 percent of the remaining trapping. While in the second case on the right structural and residual trapping account for most of the remaining CO². In IGE we have undertaken research work in CCS that is funded by industry and by research councils and in partnership with many academic and industrial collaborators. We welcome the fact that Petronas now become a prominent partner in this initiative. Knowledge transfer will continue to be a key priority of ours that will be furthered through the Global Research Centre, through writing of our books, publication of papers in the peer-reviewed literature, and delivery of training. I personally have been involved in the supervision and co-supervision of these 15 PhD students working on aspects of CCS including in Petronas. The partnership between Petronas in Heriot-Watt is already delivering research that is helping to cap CO² emissions and is nurturing future leaders as well. I have set myself a career goal of being involved in projects that deliver 20 million tonnes of CO² storage. To date no CO² has been stored in the UK and, as someone with perhaps a decade left of their career, time is short, so for me there is some urgency about delivering research that industry can use now to usher in more sustainable energy future. However, the biggest impact I can have is to influence, motivate, energize and train the next generation of new energy leaders and to help equip them with the technological innovations that can deliver this more sustainable energy future. The Global Technology Centre provides an excellent opportunity for Petronas and Heriot-Watt to partner in this crucially important task and to deliver world-leading research and training of future leaders in the here and now.

Thank you and a hearty congratulations on the launch of the Petronas Global Technology Centre at Heriot-Watt University.