Getting to Net Zero: Lifetime and Avoided Emissions of Floating Wind & Marine Energy Systems

Iain Struthers, Dr Camilla Thomson, Prof Gareth Harrison

Wind & Marine Energy Systems CDT, Rm 3.36, Royal College Building
University of Strathclyde, 204 George Street, Glasgow, G1 1XW

Email: iain.struthers@ed.ac.uk | Twitter: @iastruthers

Climate Emergency?

- **Human actions are driving changes** in greenhouse gas emissions and global average temperature, at rates **unprecedented in Earth's history** [1].
- **Warming is proportional to cumulative emissions** [2] or 'carbon budgets'.
- The world has warmed by around 1.1°C since pre-industrial times (1850 – 1900) [1]. **Around 10 years remain for 1.5°C** warming at current rates [3].
- **Under the Paris Agreement**, there is only a **66% chance** that warming will be limited to **3°C by 2100** [4].
- Further anthropogenic global **warming can be halted by** stabilising greenhouse gas concentrations: the concept of **'Net Zero'** [1].
- **CO_2 and CH_4 are the largest contributors** to warming (around 68% and 18%) [4]. For CO_2: **fossil fuels and cement** (82%) and **deforestation** (18%) [5]. For CH_4: **agriculture and waste** (57%) and **fossil fuels** (34%) [6].
- Total annual emissions reductions **for 1.5°C** are **-7.6% per year** from 2020 to 2030. However, emissions increased **+1.3% per year** (2009-2019) [4].
- **Fossil CO_2 emissions increased +2.1% in 2018** and are expected to increase again, **+0.6%, in 2019** [5].
- The UK and Scottish Governments declared a **Climate Emergency** in 2019 and legislated to achieve **Net Zero in 2050; Scotland in 2045**.

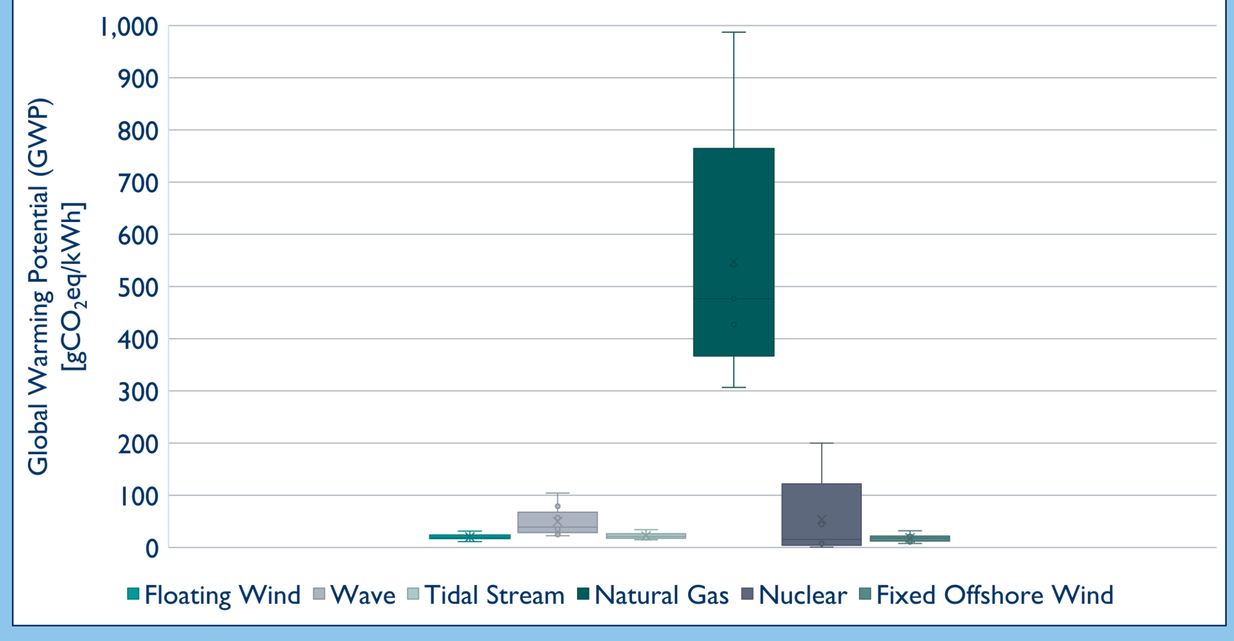
Mitigation and Getting to Net Zero

- **Decarbonising power**, **reducing demand**, and **electrifying energy end-use** are key mitigations in 1.5°C pathways [2].
- The UK and Scotland have been leaders in wind and marine energy technology development.
- Floating wind is predicted to deploy 10 GW out to 2050 [7], with wave and tidal around 5 GW and 2.5 GW [8].
- **Floating wind, wave and tidal are *not* currently involved in the Committee on Climate Change (CCC)** Core or Further Ambition **scenarios**, but are recognised as offering **further decarbonisation potential** for the UK [9].

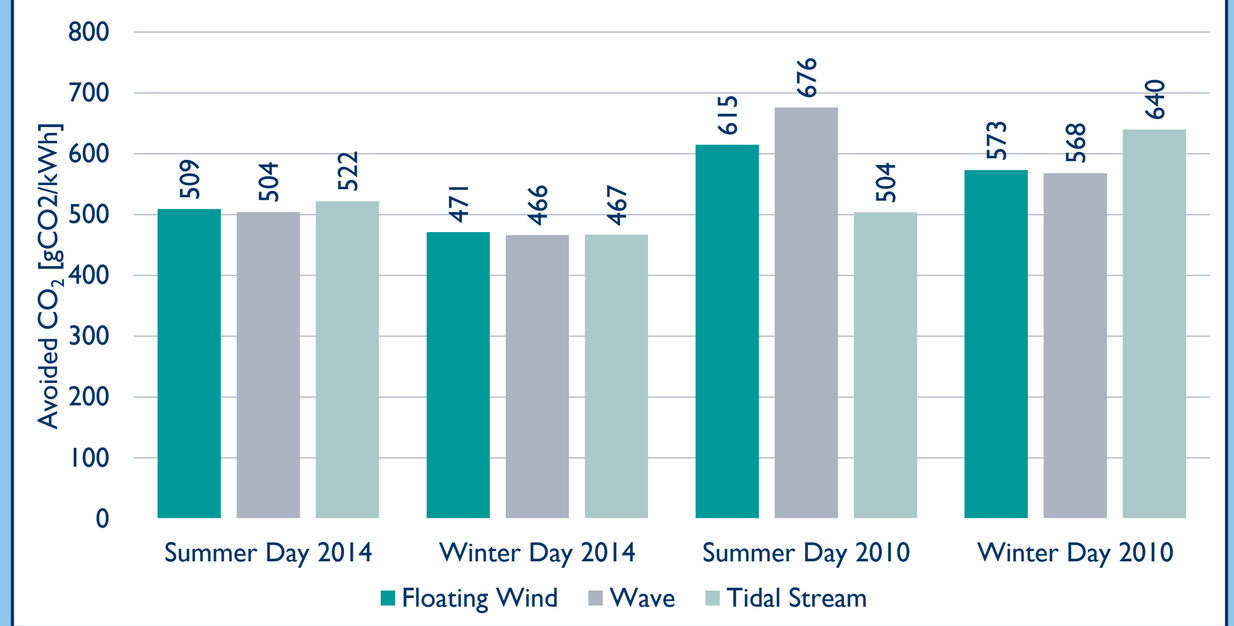
Research Questions of this PhD

- **What role can floating wind, wave and tidal energy play in achieving Net Zero?**
- What is the ecological footprint of these technologies at scale?
- **How do the lifetime "embodied" emissions relate to the "avoided" emissions?**
- Is there a novel way to consider carbon payback time (CPT)?
- **Which technologies, locations or strategies will be most effective at displacing fossil generators from the grid in the future?**

Lifetime Emissions from Literature Review



Avoided Emissions in Example Scenarios

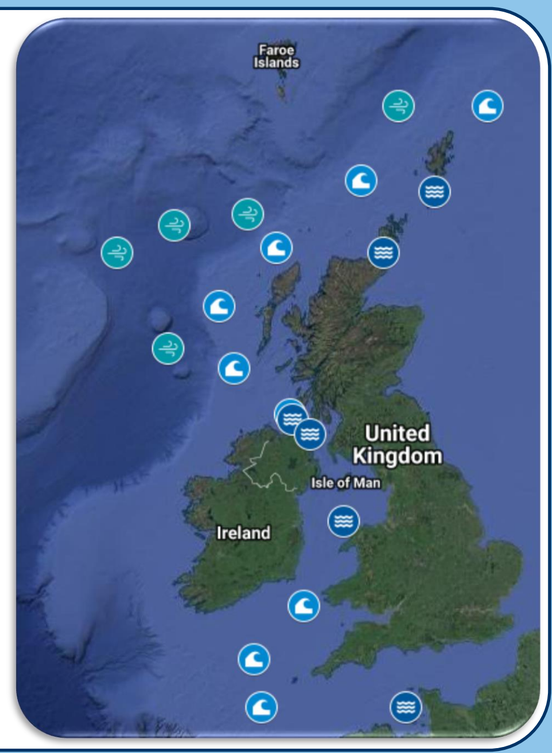


Results to Date

- **Materials & Manufacturing** typically largest contributor (>50%)
- O&M **underestimated**
- **Optimum technology varies** with location, demand and generation mix
- **CPT improves** with displacement

Current and Future Work

- Working with industrial partners on **novel device LCA** (Wind and Wave)
- Use **Energy Systems Modelling** for future deployment scenarios, to find **optimal displacement strategies**



References

1. Allen, M.R. et al. 2018: Framing and Context. In: Global Warming of 1.5°C. An IPCC Special Report.
2. Rogejl, J. et al. 2018: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: Global Warming of 1.5°C. An IPCC Special Report.
3. Global Carbon Project (2019) Carbon budget and trends 2019, https://www.globalcarbonproject.org/carbonbudget/19/visualisations.htm.
4. United Nations Environment Programme (2019). Emissions Gap Report 2019. UNEP, Nairobi.
5. Friedlingstein, P. et al 2019: Global Carbon Budget 2019
6. Saunois, M. et al. 2016: The global methane budget 2000–2012
7. ORE Catapult: Macroeconomic Benefits of Floating Offshore Wind in the UK 2018
8. Stegman, A. et al 2017 "Exploring marine energy potential in the UK using a whole systems modelling approach," Energies, vol. 10, no. 9, 2017
9. Stark, C. et al. 2019: Net Zero Technical Report