Tidal Energy potential of the Irish Sea:
(1) Background

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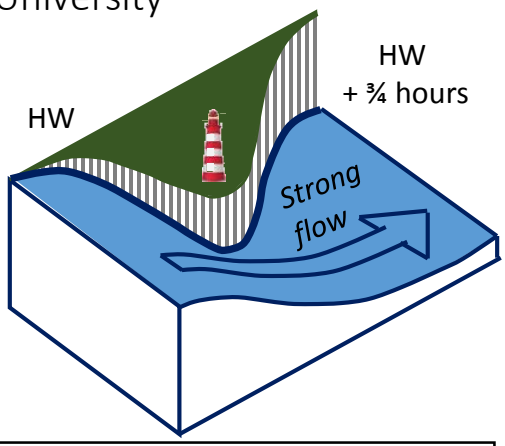
In the UK there are two high-waters (HW) a day, with ~6 hours between HW and LW (low-water) or *visa-versa*, with strong associated tidal currents. The time of HW varies around the coastline*. The regular, predictable nature of tides guarantee an excellent and firm renewable energy resource[1] that, with the correct strategy, could produce electricity around the clock[2].



*For example, Conwy HW is ¾ hours after Caernarfon due to the propagation of the tidal wave around Anglesey, which is enough to drive a 3m/s (6 knots) tidal flow through the Menai Strait.

Benefits

The UK has an excellent marine energy resource; 50% (27GW) of peak electricity demand is available from wave and tidal energy alone[3].

Tidal energy could provide energy security, contribute to CO_2 emission targets, and develop a high-tech UK economy worth between £1.4b - £4.3b to UK GDP[3] by 2050[3].

Tidal-stream energy has the biggest potential for global exports of all the marine renewable industries[3] with research from Bangor University showing the global resource may be under-predicted; hence the market even bigger than previously thought[1-6].

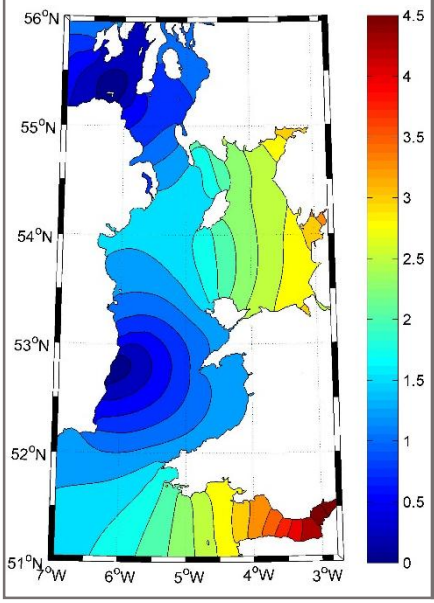
Current status of projects

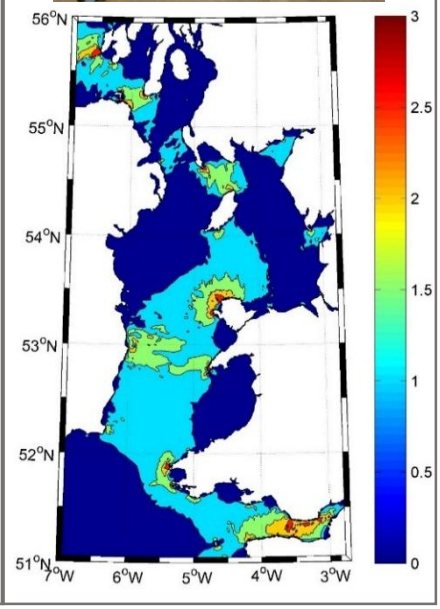
The TEL 400kW "demo device" is to be installed in Ramsey Sound by 2015, with plans for a 10MW array (enough for 10,000 homes). Atlantis and Minesto both have plans for 10MW arrays around Anglesey, close to the Crown Estate tidal-stream demo-zone. Cardiff and Conwy tidal lagoons are planned by Tidal Lagoon plc, who are currently awaiting approval for their 320MW Swansea Bay lagoon (enough for 155,000 homes).

Tidal energy resource and assessment

Tidal-range traps seawater behind a wall, controlling its release through turbines at optimal times (e.g. 320MW Swansea Bay lagoon).

Tidal-stream uses natural constrictions (e.g. straits) and high tidal flow sites (e.g. headlands) to drive turbines (e.g. TEL 400kW rated devices).





Numerical models are used to make resource assessments. Tidal-range resource is shown on left as the tidal amplitude (m) of the principle constituent[5]. The tidal-stream resource is shown as the peak spring tidal currents (m/s) on the right[1]. Orange-red colours indicate sites suitable for development using current technology, but not accounting for other factors[5,8].

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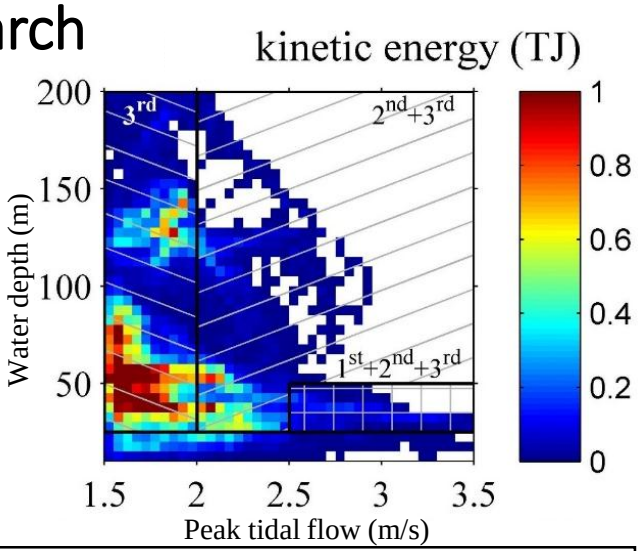
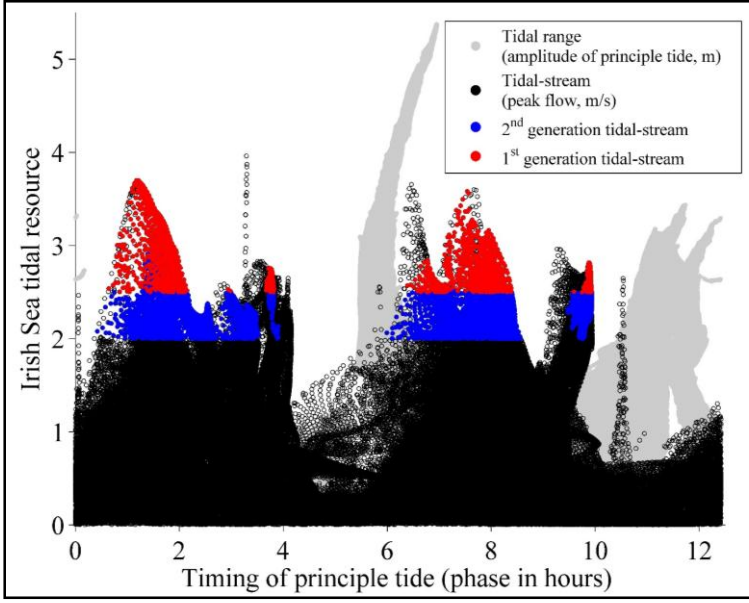
Tidal Energy potential of the Irish Sea:
(2) Research

Future development

- Irish Sea tidal-stream energy could meet 25% of the Welsh Government's target of 4GW of marine renewable energy by 2025[1,3].
- The available resource would increase 7 fold if technology was developed for deeper water sites and lower peak flow rated turbines designed[1].
- Devices require peak flows above 2.5m/s (5 knots) and water depths between 25 and 50m (so called 1st generation devices); where the distribution of the Irish Sea resource is limited (see right figure).





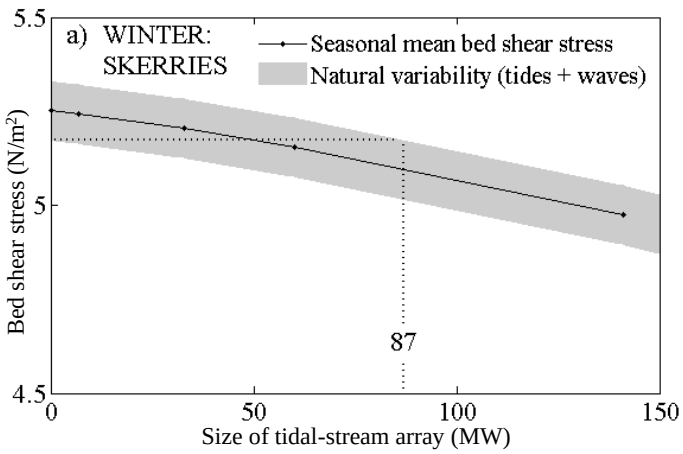
Firm electricity generation

- The timing of the tide (phase of HW or peak tidal current) varies around the Irish Sea.
- With the correct strategy, firm and constant electricity could be generated; however the development of both tidal-range and the development of "2nd generation" tidal-stream technologies would be required (2nd generation sites include peak flows above 2m/s and water depths greater than 50m).
- Although 2nd generation sites may have associated engineering difficulties (such as the effect of waves[8]), this development would allow a globally exportable industry.

Environmental impacts

The likely environmental impacts must be understood within the context of natural variability[7].

In the "Winter Skerries" example on the right, an 87MW tidal-stream energy array could be installed before the impact to local sediment mobility (bed shear stress) was above the natural effect of waves and storms (e.g. effects to sandbanks). Hence, the environmental impact may be lower at more offshore and wave exposed sites (e.g. 2nd generation sites).



Further research need on tidal lagoons

Concerns of tidal lagoons include high capital costs, unfeasibility of decommissioning, and environmental impacts[9].

More research is required on environmental impacts (e.g. sediment transport and effects to beaches/flood risk). Research also needed into reducing barriers to development (e.g. co-location of tidal lagoons with flood defences and aquaculture).

Further reading

[1] Lewis et al. 2015. dx.doi.org/10.1016/j.energy.2015.02.038
[2] Neill et al. 2014. dx.doi.org/10.1016/j.energy.2014.07.002
[3] Neill. 2014. www.youtube.com/watch?v=0Cg4uUdrA9s
[4] Neill and Hashemi, 2013. dx.doi.org/10.1016/j.apenergy.2013.01.026
[5] Robins et al., 2015. dx.doi.org/10.1016/j.apenergy.2015.03.045
[6] Neill et al. 2014. dx.doi.org/10.1016/j.renene.2014.01.052
[7] Robins et al. 2014. dx.doi.org/10.1016/j.renene.2014.07.037
[8] Lewis et al. 2014. dx.doi.org/10.1016/j.apenergy.2014.09.061
[9] O'Rourke et al. 2010. dx.doi.org/10.1016/j.apenergy.2009.08.014

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