Wave

Most of the wave power approaching Britain comes from the Atlantic. As the map shows, Britannia rules about 1 000 km of Atlantic coastline. The power of Atlantic waves is about 40 kW per metre of exposed coastline.

One of the leading offshore wave devices is the Pelamis (Figure 1), a 'sea snake' which floats in deep water and faces nose-on to the oncoming waves. The waves make the snake flex, and these motions are resisted by hydraulic generators. The peak power from one snake is 750 kW; in the best Atlantic location one snake would deliver 300 kW on average. One snake weighs 700 tons, including 350 tons of ballast. Other designs such as sea-bed-mounted wave machines are also in development.

Level 1

Level 1 assumes there is very little investment in wave power, with no wave machines deployed up to 2050.

Level 2

Level 2 assumes the UK deploys the equivalent of 300 km of Pelamis wave farms in the Atlantic by 2050. This requires a Pelamis every 40 metres over the 300 km stretch, totalling 8000 machines. The machines deliver 8 kW per metre of the wave farm (20% of the waves' raw power) with an availability of 90% (allowing time for maintenance). The total output of these wave farms is 19 TWh/y.

Level 3

Level 3 assumes that the UK deploys the equivalent of 16 000 Pelamis machines over 600 km of the Atlantic coastline by 2050, delivering the same power per machine as in level 2. 600 km is a little further than the distance between London and Glasgow. The total output of these wave farms is 38 TWh/y.

Level 4

Level 4 assumes that the UK deploys the equivalent of around 27 000 Pelamis machines over a 900 km stretch, involving installing the full capacity north of Ireland as well as some off the south-west tip of Cornwall (see Figure 2).These machines are also assumed to be more efficient, delivering 10 kW per metre (25% of the waves' raw power). With a 90% availability, the total output of such wave farms is 71 TWh/y.

Figure 1. A Pelamis wave energy converter is a 'sea snake' made of four sections, each the size of a railway locomotive. It faces nose-on towards the incoming waves. Photo © Pelamis wave power.

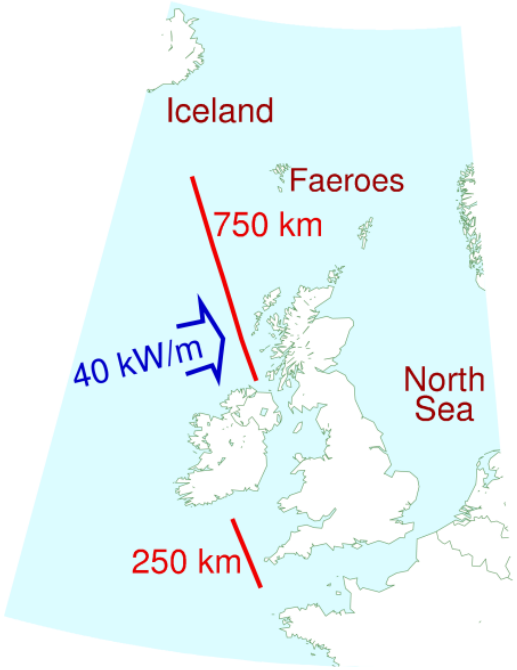
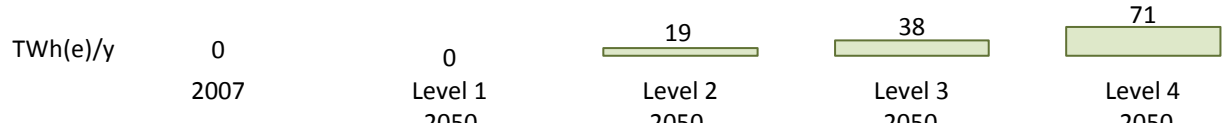


Figure 2. Map showing 1000 km of potential UK wave farm locations. Level 4 requires 900 km of wave farms.



Tidal range

In 2007 there were a few tidal range schemes in operation around the world, including the La Rance barrage in France, but there were none in the UK.

Level 1

Level 1 assumes that the UK does not exploit tidal range technology by 2050.

Level 2

Level 2 assumes the UK builds 1.7 GW of tidal range schemes by 2050, equivalent to seven schemes like La Rance in France (Figure 1) and requiring an enclosed water area of about 130 km^2. This is well within the scope of the potential sites available; the proposed Cardiff-Weston barrage on the Severn would be five times as big. The total electricity generated is 3 TWh/y in 2050.

Level 3

Level 3 assumes that the UK builds 13 GW of tidal range capacity by 2050 with an enclosed water area of around 900 km^2, about the size of 41 La Rance schemes. There are a number of possible options for achieving this level of ambition, including the proposed Cardiff-Weston barrage on the Severn which could generate 17 TWh/y. Other tidal range sites are also developed, for example at the Solway and Mersey. The total electricity generated is 26 TWh/y in 2050.

Level 4

Level 4 assumes that 20 GW of tidal range capacity is built by 2050 with an enclosed water area of around 1400 km^2, about the size of 64 La Rance schemes. This requires all of the UK's potential tidal range resource to be fully developed. The total electricity generated is 39 TWh/y in 2050.

Figure 1. The La Rance tidal barrage in Brittany, France, has been operating since 1966, with a peak generation of 240 MW.

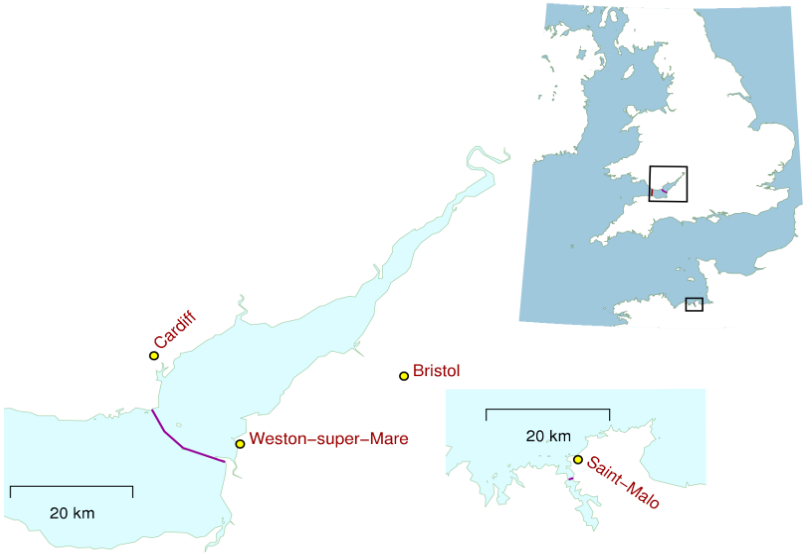
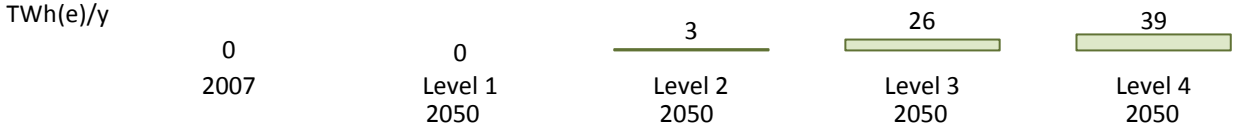


Figure 2. The La Rance Tidal Power Station (lowest map) plotted at the same scale as one of the options for a tidal range scheme in the Severn (on the left).



Tidal stream

Tidal stream technologies harness the energy from the tides using underwater turbines. In 2007 there were only experimental tidal stream machines in the UK. There remains considerable uncertainty about the tidal stream resource in British waters.

Level 1

Level 1 assumes that no tidal stream devices are installed by 2050.

Level 2

Level 2 assumes that tidal stream capacity grows to 1.9 GW by 2050, equivalent to roughly 000 2-MW tidal stream devices, larger than the 1.2-MW Seagen prototype shown in Figure 1. This capacity generates 6 TWh/y of electricity output.

Level 3

Level 3 assumes that tidal stream capacity grows to 9.5 GW by 2050, equivalent to 4700 2-MW devices. This generates 30 TWh/y of electricity output.

Level 4

Level 4 assumes that tidal stream capacity grows to 21.6 GW by 2050, equivalent to 10 600 2-MW devices. This generates 68 TWh/y of electricity output.

Figure 1. Seagen (Strangford Lough), the first grid-connected tidal stream device in the UK, with capacity of 1.2 MW. Photo by Dr. I.J. Stevenson.

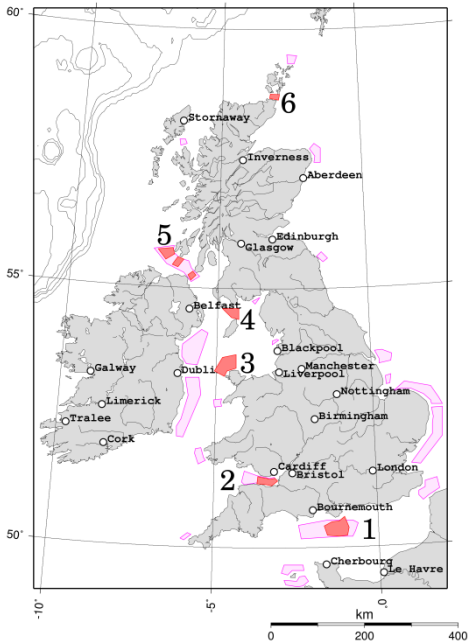


Figure 2. The six areas marked in red have peak tidal flows that exceed 1 m/s.