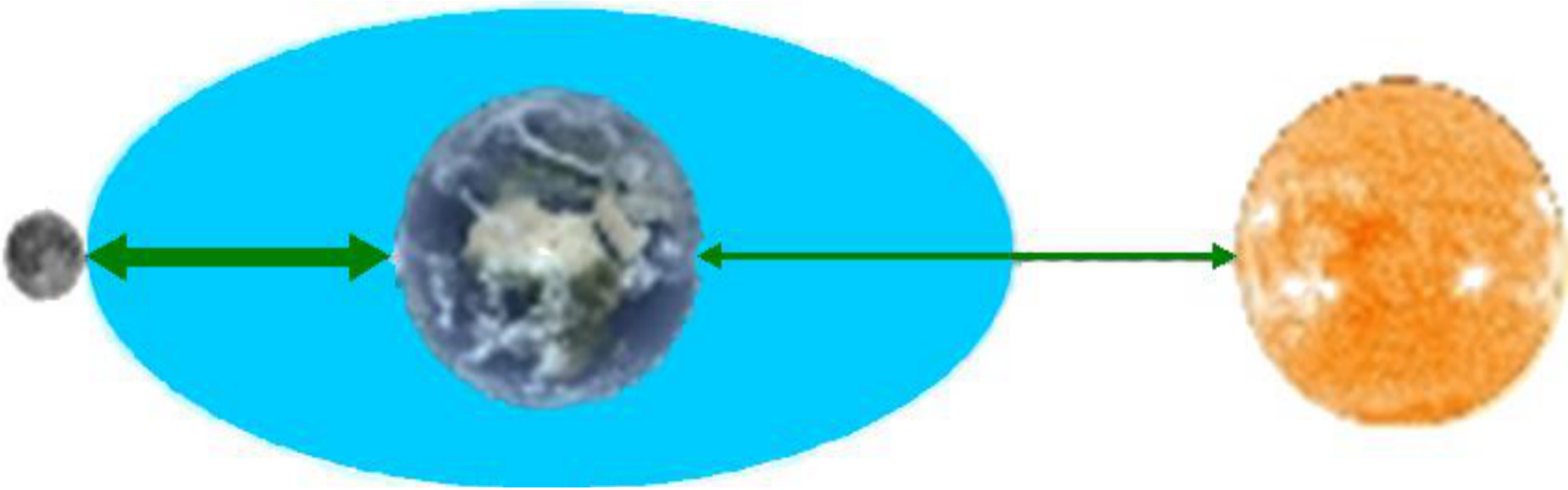
Tidal stream turbines



How tidal currents generate electricity

Harnessing tidal streams

- The tides drive the currents used by tidal turbines. Tidal timing and range can be predicted far in advance.
- At suitable sites in our region, the tides are mainly semi-diurnal. The current typically reverses four times per tidal day and often runs roughly parallel to the coast.
- Where the flood and ebb follow a consistent axis, a turbine designed to work in both directions can operate without a yaw mechanism. This can reduce construction and maintenance costs.

From moving water to electricity

Kinetic energy of the tidal stream › **Mechanical energy of the rotating shaft** › **Electrical energy from the generator**

- Most tidal stream turbines have a rotor aligned with the flow. Moving water turns the blades and drives a generator.
- Subsea cables carry the electricity ashore. Another possibility is to use it to produce hydrogen on site.
- Electrical, hydraulic or pneumatic storage can complement generation.

What determines turbine power?

$$P = \tfrac{1}{2} \times \rho \times C_p \times (\pi D^2/4) \times V^3$$

- ρ is seawater density (1,025 kg/m³). C_p is the power coefficient (about 0.25 in this example).
- The swept area, $\pi D^2/4$, increases with the square of the rotor diameter D.
- Below rated speed, with C_p held constant, power varies with the cube of current speed V.

Rated power and annual energy output

Rated power (MW)

A turbine reaches its rated power at its rated current speed. A 1 MW machine running continuously at that power for 365 days would generate 8,760 MWh (about 9,000 MWh).

Energy generated (MWh)

Tidal currents reverse and their speed rises and falls. In a simple model the speed follows a sinusoidal cycle, while power below rated speed varies with speed cubed. The spring–neap cycle also changes current strength (French tidal coefficients range from 20 to 120).

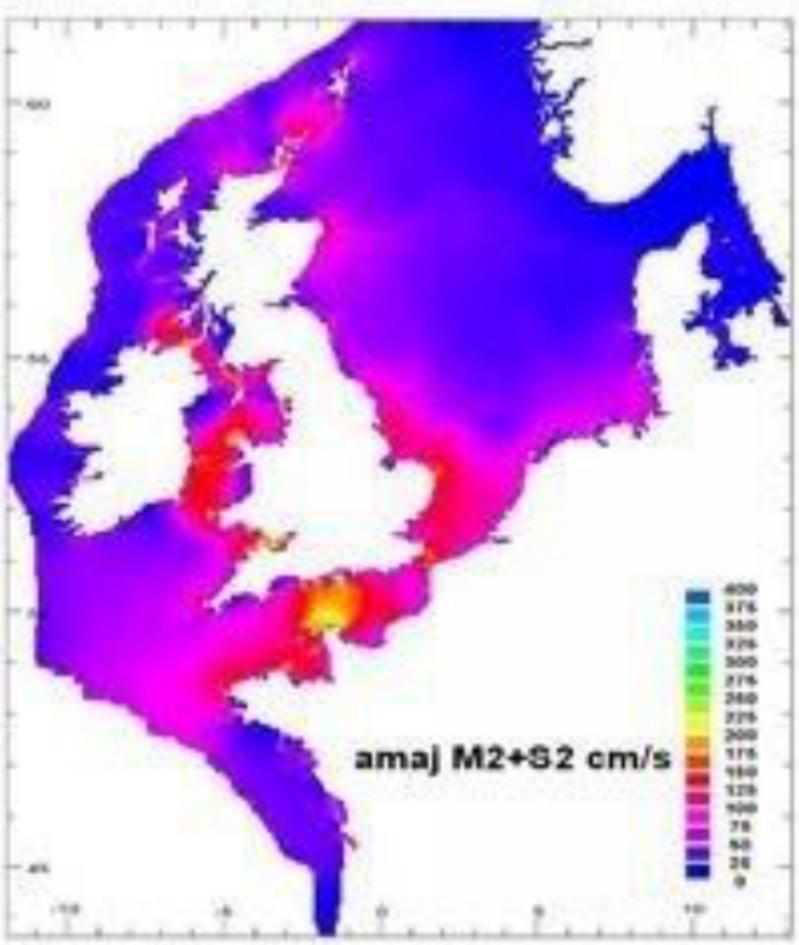
Illustrative annual output for a 1 MW turbine in the Alderney Race (Raz Blanchard): 2,000 MWh.

What determines project revenue?

The early estimates used an electricity price of €50/MWh. The French source also describes a near tenfold price rise after late 2021.

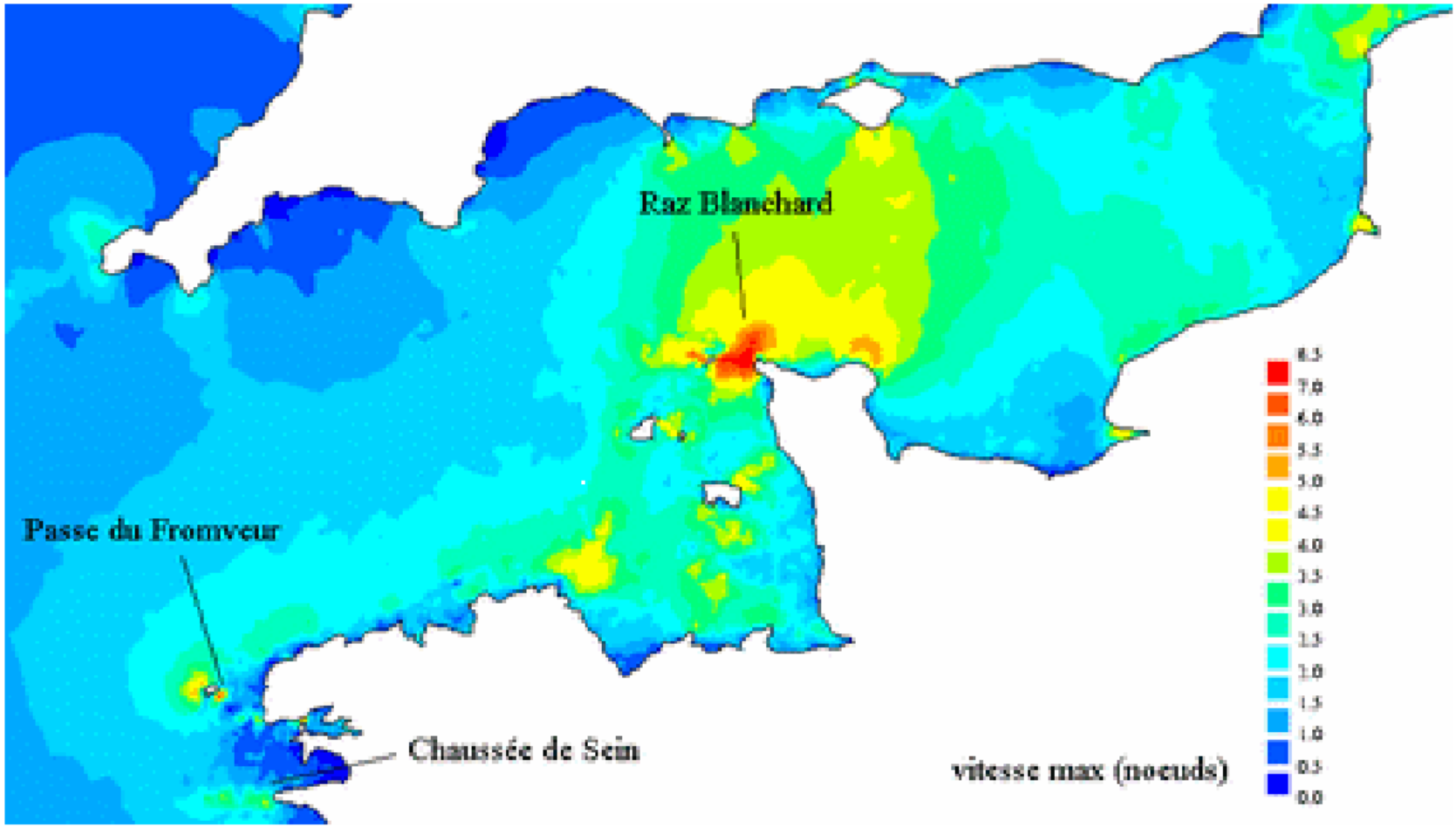
- Profitability depends on the initial investment, operating costs, actual energy yield and the price received for the electricity.
- For example, a 1 MW turbine generating 2,000 MWh a year at an average sale price of €150/MWh would earn €300,000 in annual revenue before costs.
- Predictable tides and a regular generation cycle help producers anticipate when electricity will be available.

Tidal currents in European waters



Map scale: current speed in centimetres per second (M2 + S2).

Tidal currents in the English Channel



Maximum speed in knots. Raz Blanchard is the French name for the Alderney Race.

Estimated European tidal stream potential

- A 1996 European study estimated that 12.5 GW of tidal stream capacity could be exploited in Europe, yielding 48 TWh of electricity a year.
- United Kingdom: 6 GW (source: EDF).
- France: 3 GW (source: EDF).

Tidal stream potential in Canada

Estimates by province and territory

Province or territory	Tidal stream potential (MW)	Number of sites	Mean power per site (MW)
Northwest Territories	35	4	9
British Columbia	4,015	89	45
Quebec	4,288	16	268
Nunavut	30,567	34	899
New Brunswick	636	14	45
Prince Edward Island	33	4	8
Nova Scotia	2,122	15	141
Newfoundland and Labrador	544	15	36
Total	**42,240**	**191**	**221**

Source: Bibliothèque et Archives nationales du Québec.

Does the current stop at high water?

Two observations from a quay

A tide gauge shows the water level in metres. A float drifting past the quay reveals a different movement: water flows horizontally, at a speed measured in knots or metres per second.

A float can still be drifting at high water.

At high water, the level on the gauge stops rising. The current may still be strong. The time between high water and minimum current speed varies from place to place. For a tidal turbine, the speed that matters is the current speed at the site itself.

How the tide travels along the Channel

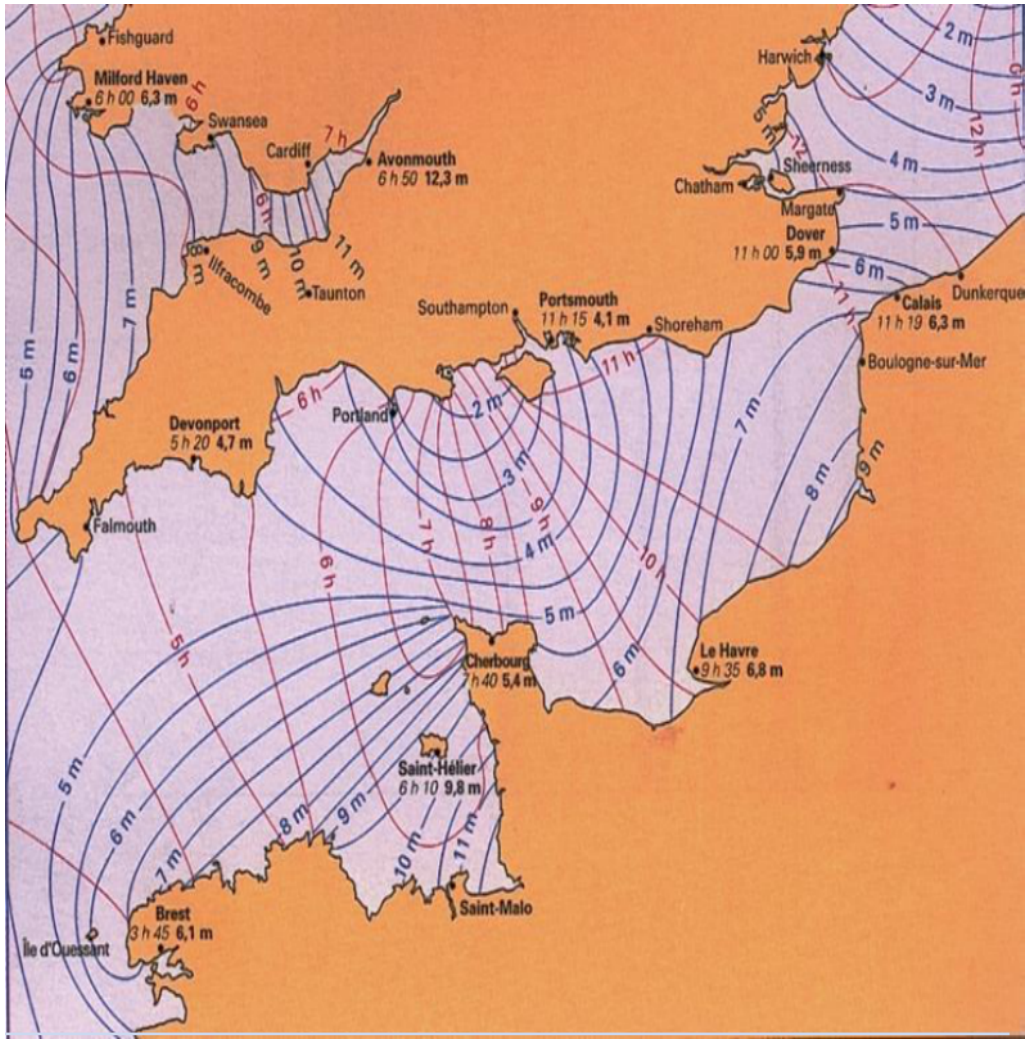
Red lines

These join places that reach high water at the same time.

Blue lines

These join places with the same tidal range: the height difference between high and low water. The map shows a French tidal coefficient of 95.

High water and minimum current speed have different timings. To find the lag between current minima at two sites, use slide 13.



Comparing currents in the Alderney Race (Raz Blanchard) and at Paimpol–Bréhat

When the current weakens at one site, is it still strong at the other?

1 Select “Stream speed V”. Select Alderney Race by name, choose “Keep only this site”, then tick Paimpol–Bréhat.

2 Find a trough on each curve. How far apart are they in time? Move the cursor to each trough to estimate the difference.

Open the HydreManche tidal stream map ›