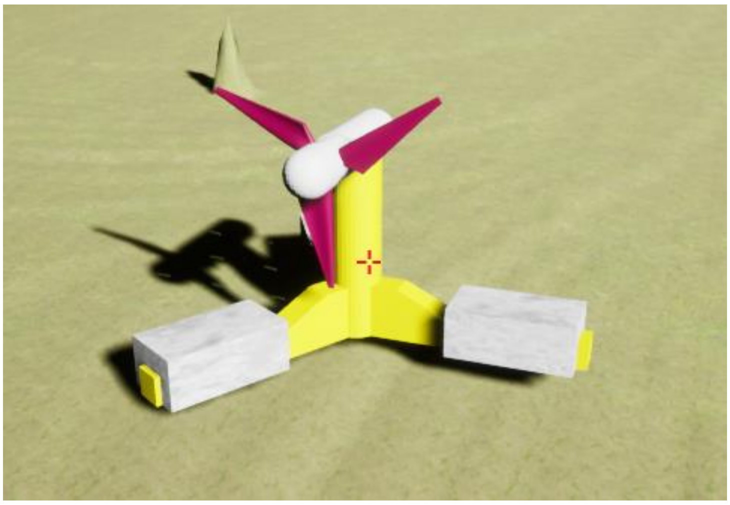
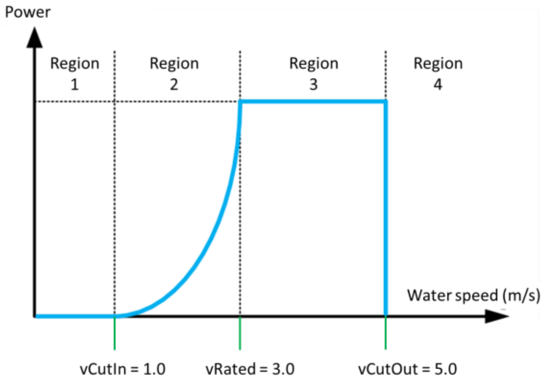


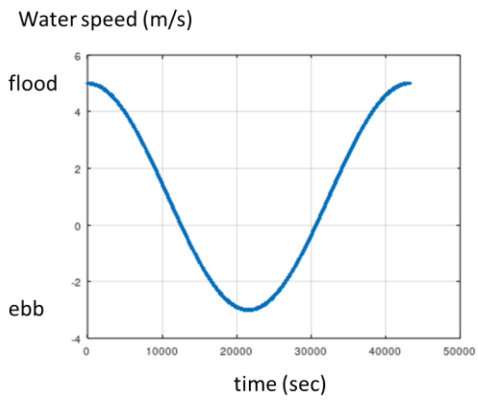
Ramsey Sound Tidal Hydro-Kinetic

Background. This is a real project located in Ramsey Sound, though it is currently being upgraded. Hydro-Kinetic turbines are located on the sea floor where there are strong tidal currents.

Hydro-kinetic turbines convert water flow into electricity; they have a distinct operating curve (right). Ours is modelled on the Simec-Atlantis AR1500, and is designed with a rated water speed of 3 m/s where it operates in region 3 at full power. At lower speeds in region 2 it extracts the maximum power possible, below 1 m/s it turns off, there is not enough power to overcome friction. Above 5 m/s it also turns off to prevent damage. In region 2 the blades do not pitch, this happens in region 3 to prevent the power exceeding the rated.

The tide has two phases, the flood and the ebb where the direction of flow changes (right). To handle this, the turbine yaws (rotates) so it is always facing incoming water. Note the maximum speeds are different for the flood and ebb phases.





Files and Levels:
Level **Ramsey Sound** from the **Main Menu** then the actor **MAS22_Hydro_Kinetic.**
Octave script **Ramsey_Sound_Data** where you can plot your data.

Parameters (Independent Variables) available

R radius of the turbine blades
waterV constant water speed
region3Kp, region3Kd parameters to control the blade pitch motion.
VFlood and **vEbb** flood and ebb velocities when the **"Series"** option is chosen.

Dependent Variables to observe:

HUD

waterV water speed when it is changing.
region current operating region (1,2,3,4)
beta pitch angle of turbine blades
rpm revs per minute.
power (in kWatt)

Octave file (as function of time) Tons of stuff.

Ideas to get started.

Study 1. Measure the **power** and **rpm** for a range of water speeds over all 4 regions of operation. You should also check that the blade pitch **beta** only increases for region 3. Your plot should look like the curve presented above.

Study 2. Here we shall apply real tidal flows for Ramsey Sound. Change the line in **MAS22_System.ini** (in the **Saved/Config** folder) to **waterTypeStr = "Series"** which will produce flood and ebb with given parameters. Keep an eye on the turbine motion, and let it reverse direction a couple of times before you stop. Keep an eye on the HUD values.

Open up the Octave script composed by the Engine, there's a huge amount of analysis you can do here. The red lines on some plots are the rated values for that variable. Use the **waterV** as your key to the other plots, you should see regions 1,2,3 here. Compare the power produced during flood and ebb tides. Try to understand when and why **beta** increases from zero.

Other Ideas.

1. Select a fixed water speed in the **.ini** file, and set this to a reasonable value. Now find out how the power produced depends on radius **R** of the blades.

2. Find out how the max values for **vFlood** and **vEbb** affect the power produced. You might like to look for other possible locations around the UK, possibly in the English Channel.

3. Theory predicts that $power \propto rpm^3$. You could check this out.

Hints for Roundup.

Reflect on the amount of power produced, how many homes could this supply? Could it supply a nearby town or city?

Would such a turbine deployed in the river Severn be able to power a significant part of the University? You will need to find out flow rates, depths etc.

What could be the major issues involved in deploying and maintaining such a turbine?

Are there any possible adverse effects on the undersea environment caused by the turbine?

Compare with wind turbines, what are the pros and cons?

Domestic electrical energy consumption per household per year (2023) is 2700 kWh, which means an average continuous power draw of 2700/(365*24) = 0.31kW.