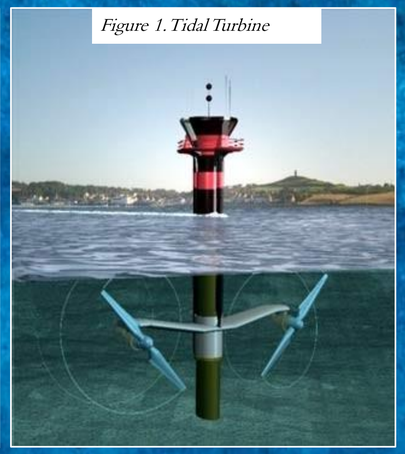
Tidal Energy Model Using Homer Pro

School of Computer Science and Electronic Engineering
By Eleanor Frost
PRIFYSGOL BANGOR UNIVERSITY

Aims

- Investigate the use of tidal turbines, figure 1, to generate electricity to power Holyhead and Anglesey and to use the surplus energy to produce hydrogen for fuelling vehicles.
- Modelling tidal turbines under various scenarios in Homer Pro:
  1. The number of turbines needed to power Holyhead.
  2. Use of generated hydrogen as stored energy.
  3. Use of generated hydrogen as fuel for HGVs.
  4. Way the efficiency can be increased for ferries.
  5. A realistic look at how we could use hydrogen to power 20 HGVs 4 times a day and how many turbines we would need.

Figure 1. Tidal Turbine



Introduction and Background

- Tidal energy is a very dependable and much needed source of renewable energy. With its predictability, the energy output it is a great option for energy production where there is a large tidal range.
- As you can see from figure 2, Anglesey is a prime area for harvesting energy using tidal turbines.
- The cyclic pattern of tides, figure 3, leads to variations throughout the year, where more energy is produced during spring tides and less during neaps.
- The use of renewable energy to power vehicles, (e.g. hydrogen) is increasing. Hyundai aiming to provide 1600 hydrogen powered HGVs by 2025 [1].
- The excess energy from the tidal turbine could be used to produce hydrogen , stored in a tank and used to fuel these HGVs.

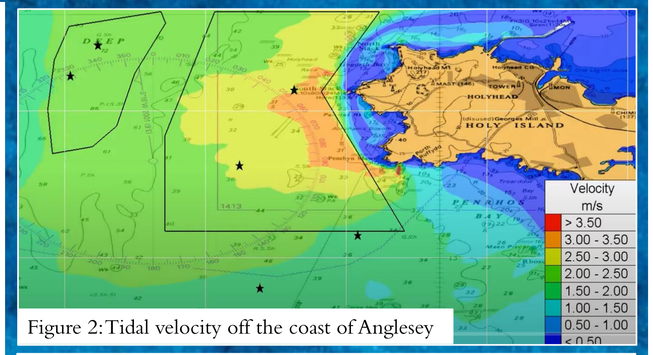


Figure 2: Tidal velocity off the coast of Anglesey

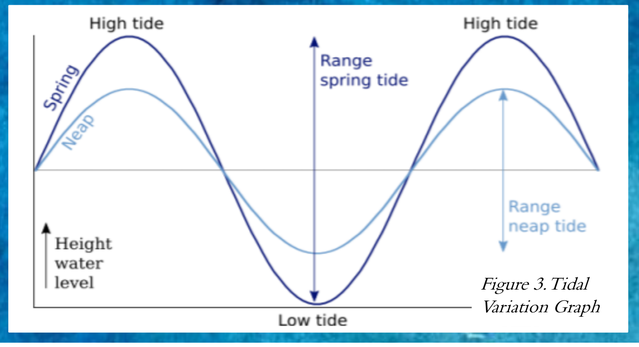


Figure 3. Tidal Variation Graph

Method and Approach

- Using Homer Pro to design and simulate the technical components for all scenarios. Using base data for the electrical demand and water velocity data provided by the school of ocean sciences to produce results for the turbine [2].
- The data will demonstrate how much energy is being imported from the grid when the turbine is under producing, and how much is being exported when the turbine is producing in excess.
- This variation in energy production is why the project will look at converting excess energy to hydrogen using an electrolyser and store it in a tank to produce a steady supply of energy.
- Figure 4, the design schematic, utilises the electrolyser, hydrogen tank and hydrogen load which are supplied by the turbine.

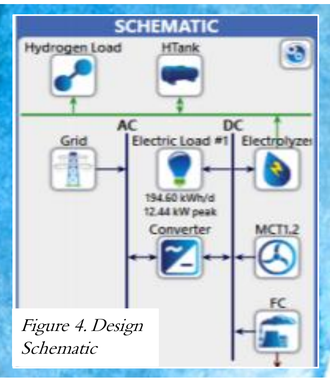


Figure 4. Design Schematic

Results & Discussion

- Figure 5 shows the flow of the tides and the energy produced by the turbine.
- The total output of energy for 1 turbine in 1 year is **4.36 GWh**, compared to the **66.7 GWh** that is needed to supply Holyhead with green energy.
- This means that more turbines are needed to meet the demand needed.
- Now looking at a realistic number of HGVs (60), refuelling and using the turbines excess energy provided, figure 6, shows that the turbine is producing enough energy, then turning into hydrogen which is filling the tank up.
- Figure 7 shows that the hydrogen tank is depleted 4 times a day in line with the ferry times in Holyhead.
- Figures 9 & 10 shows the amount of energy that is being imported and exported from the grid with 75 turbines. This scenario we are using the grid as a battery to demonstrate how this system could work.
- Preferably the excess energy would be stored and used as a battery. This would mean that we could run Anglesey completely independently of the grid.
- This would vastly decrease the carbon emissions produced by Anglesey, figure 10, shows how increasing the number of turbines decreases the amount of carbon emissions.

Figure 5. Hydrokinetic Output

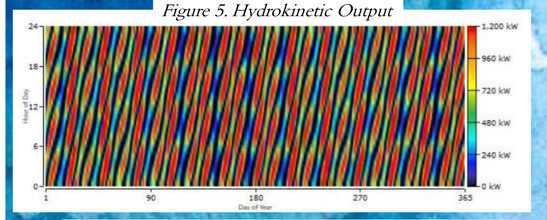


Figure 6 Tank Level No Staggering of Refuelling

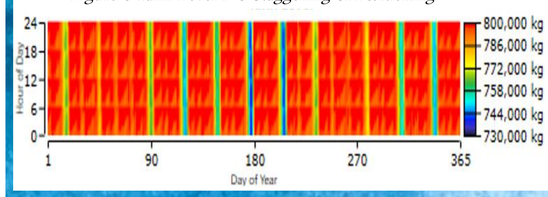


Figure 7. Tank Level With Staggering

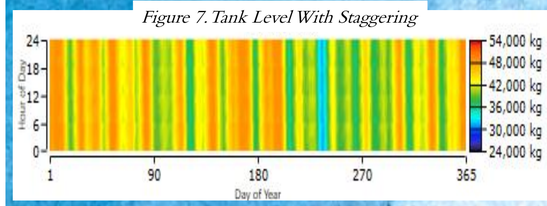


Figure 8. Energy Purchased from Grid

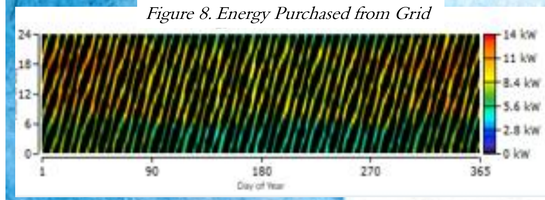


Figure 9. Energy Sold from Grid

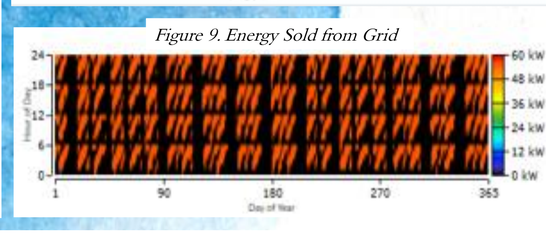
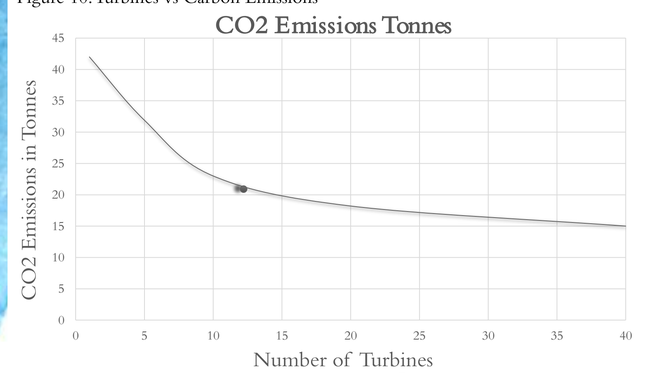


Figure 10. Turbines vs Carbon Emissions



Conclusions

- This leads that with 75 turbines supplying energy, converted into hydrogen, realistically supply 60 HGVs 4 times a day spread over 3 hours, assuming a 30kg tank size would reduce Anglesey's carbon footprint.
- This means that we can being to see how utilising the large tidal ranger across in Anglesey could make the area carbon neutral and help the current climate crisis we are facing.
- By using the natural energy sources available to us we can see how a green future is within our grasp and is attainable with an injection of funds to install and build the turbines.
- With further funds more turbines could be built, where in using this excess energy we could see Anglesey supplying energy to more parts of the UK.

References & Figures:
[1] https://www.driving.co.uk/news/hyundai-ships-first-units-hydrogen-powered-heavy-duty-lorry/ [2] Lewis, M., et al. "Resource assessment for future generations of tidal-stream energy arrays." Energy 83 (2015): 403-415
F1. https://www.sailingissues.com/navcourse6.html F2. aemstatic-ww2.azureedge.net/content/hydro/en/articles/2014/11/siemens-announces-plan-to-exit-marine-power-sector/_jcr_content/leftcolumn/article/headerimage.img.jpg/1416947501047.jpg F4. https://www.youtube.com/watch?v=7FtMP-7ua_E