Tidal Power: Still Expensive, Still Unlikely To Contribute Much

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Over the past several years, I've assessed numerous low-carbon generation technologies including the variants of **ocean energy**. Tidal energy might in some future provide up to 1% of total global energy demands per my estimates. That might seem small, but every percent of energy that comes from low-carbon sources is a percent that doesn't come from high-carbon sources. It continues to be worth doing, even though it isn't a major wedge.

Recently, the planned **Swansea Bay Tidal Lagoon** came to my attention. The private consortium behind it includes Atkins, General Electric, Andritz Hydro, Laing O'Rourke and Alun Griffiths Ltd. They've spent about $44 million USD on this planned generating station in Wales. They received consent to build it in 2015 and are hoping to start construction in 2018. They are serious about this.

So this begs some questions. How much electricity will it actually generate? At what price per KWH? And will it actually be a low-carbon source of electricity given all of the construction materials?

I spent some time recently looking at the numbers and doing some math.

Generation

It's a 320 megawatt (MW) capacity generator, but that doesn't mean it generates all the time. The tide goes in and out daily but the generators won't always be running. Per their **statistics site**, they estimate that it will generate about 530 GWH per year. That turns out to be about a 19% capacity factor which is better than solar and worse than wind, but also irrelevant if the electricity is cheap. That means that it will generate about 1,450 MWH per day, which is pretty good if true.

This of course assumes that it keeps working at the expected levels without undue failures or maintenance. Both of those are unlikely to be true given the harsh marine environment. Sea water is hard on human-made things. It's more likely to be below that number, perhaps as low as 15%, but let's take the claim at face value for the calculations.

Cost

It's estimated to cost about $1.66 billion USD, which puts it into the range of a mega project. By definition, mega projects are much more likely to go over schedule and budget, but once again let's assume they hit their targets. It's supposed to last for 120 years, also a rather interesting and unlikely number. Expect major rebuilds to achieve that which aren't included in the $1.66 billion.

No one is going to amortize debt for 120 years, so it has to amortize over a shorter period. Let's assume they'll get 40 year financing and use that as the basis for amortization. What about the cost of operation and refurbishment? Let's be generous and say 2% annual costs and a major refurbishment costing 20% of initial capital cost every 20 years, with two refurbishments included in the 40-year amortization period.

That suggests an amortized annual cost of around $105 million USD. That in turn indicates a cost of electricity of around $197 per MWH or about 19.7 cents USD per KWH. That's more expensive than the Hinkley nuclear plant which is projected to be up around **15 cents USD per KWH** if it goes forward. It also excludes financing costs, which are likely to be considerable, so the end cost will be over 20 cents USD per KWH.

To their credit, they acknowledge that it's going to be expensive, but claim that this is a small test site that will become much cheaper at larger scales. I'm sure the various companies involved would love to do a few more multi-billion dollar projects over the next twenty years.

However, onshore wind in the UK a couple of years ago was well under 10 cents USD per KWH and offshore wind was trending toward 10 cents USD per KWH. The price of both continues to fall. It's hard to justify two to three times the cost per KWH for this tidal project.

Carbon Dioxide

Also on the stats page they claim 236,000 tonnes of CO_2 will be saved annually. They don't make clear their basis for calculation.

As of **September 2016**, the UK grid had become much cleaner due to slashing coal use, averaging 0.26 tonnes of CO_2 per MWh. Lots of wind

energy in that mix, by the way. Given annual generation, that would suggest around 138,000 tonnes of CO2 diverted. That doesn't appear to be their basis for calculation.

If they were assuming that they were displacing coal generation with its average one tonne of CO2 per MWH, that would give about 530,000 tonnes of CO2 per year. That's obviously not how they were calculating carbon savings. This suggests their calculation was for displacing natural gas generation which emits about 0.5 tonnes of CO2 per MWH.

But now the final bit. How much CO2 to build the thing? Well, they don't mention the tons of concrete which will be required but they do mention steel, 100,000 tonnes of it. Also, 5 million tons of rock. We can approximate CO2 from those numbers.

Making a tonne of steel emits about **2 tonnes of CO2**. Let's assume only 5% additional CO2 emissions for transportation and the like. That's about 210,000 tonnes of CO2 for the steel.

What about the rock? Obviously no CO2 is expended making the rock, but digging up and transporting 5 million tons of anything is pretty carbon intensive these days. This **assessment** suggests 5 kg per tonne including all processing and shipment for coastal construction. At 5 million tons, that suggest 25,000,000 kilograms of CO2 or 25,000 tonnes.

So roughly speaking the CO2 debt of construction is around 235,000 tonnes and the annual savings of CO2 are projected to be 236,000 tonnes. Even if generation is at a 15% capacity factor and the total CO2 debt is 50% more, it's still only a couple of years before the total carbon debt is paid off. That's pretty reasonable for multi-decade generation, and a lot better than hydro dams in areas with heavy vegetation.

They claim about 530 GWH per year, but it will probably average closer to 420 GWH per year over its lifetime at the probably more realistic 15% capacity factor. The CO2 used in building it looks to be around 235,000 tonnes plus or minus 20%. Generation from the plant will pay off that carbon debt in one to two years. The cost of electricity will be above 20 cents USD per KWH when amortized over 40 years. If it lasts a lot longer, and they claim it will last 120 years, then the cost of electricity for the remaining years would be lower.

Is it going to be a game changer? No. Is it likely to get funding for the $1.66 billion USD capital outlay? Normally I'd say it doesn't have a chance, but very odd decisions are being made in the UK regarding electrical generation these days. It might very well end up being built. And if it does, it will help provide quite lot of low-carbon electricity to the UK.

Tags: co2 emissions, Electricity, Energy, Europe, GE, general electric, ocean energy, UK

About the Author

Michael Barnard Mike works with startups, existing businesses and investors to identify opportunities for significant bottom line growth in the transforming low-carbon economy. He regularly publishes analyses of low-carbon technology and policy in sites including Newsweek, Slate, Forbes, Huffington Post, Quartz, CleanTechnica and RenewEconomy, with some of his work included in textbooks. Third-party articles on his analyses and interviews have been published in dozens of news sites globally and have

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