James Conway ENV-2E02 Energy Resources Presentation

24th February 2005

THE TIDE AS A RESOURCE:

- On a global scope, the tides are a one meter high bulge in the level of the ocean that moves across the globe every 24 hours and 50 minutes
- This bulge changes amplitude as it nears land and hits sea beds: tidal ranges can be as small as 6 inches and as large as 60 feet
- Broad-mouthed estuaries create the largest tidal ranges and long straight coastlines tend to have the smallest
- The power available (per unit area) in any specific location is a function of the square of the tidal range and thus the largest tidal ranges are the most attractive areas for tidal power generation
- Worldwide, approximately 3000 GW of energy is continuously available from the action of tides although there are insufficient suitable sites to harness this fully.

A RESOURCE IN THE UK:

- The UK has one of the world's best tidal energy resources
- The tide moves a huge amount of water twice each day, and harnessing it could provide a great deal of energy - around 20% of Britain's needs (DTI)

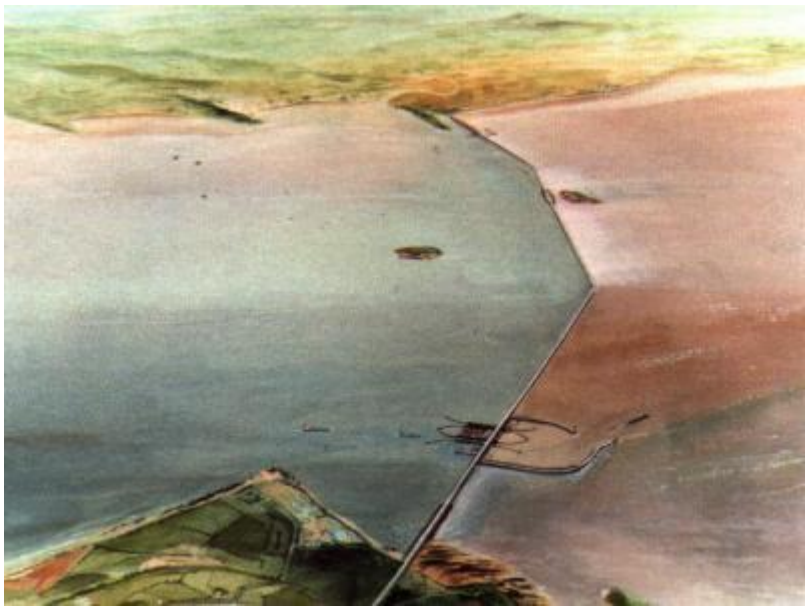
MARINE TURBINES - SEAFLOW/SEAGEN:

- Whilst the potential is certainly there for Scotland and the UK as a whole to develop, there are a number of factors holding back growth
- These factors are principally financial, with a lack of funding available to companies that wish to diversify, but also knowledge-based
- Technology is still in the experimental stage
- The phased development of grid-connected farms within six years is viable after which the industry would enter into a commercial phase
- However, it will not be feasible to contribute significantly to electricity supply economically for the next couple of decades

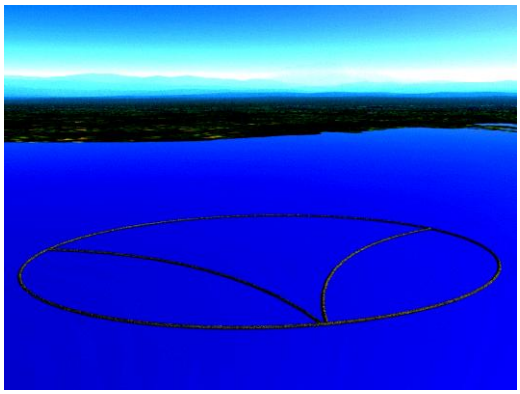
- Any money invested at this stage would be for design and research

TIDAL BARRAGE:

- Plans to build a tidal barrage on the Severn Estuary have been around since the 1980s
- It may have over 200 large turbines, and provide over 8,000 Megawatts of power (that's over 12 nuclear power station's worth). It would take 7 years to build, and could provide 7% of the energy needs for England and Wales
- Although locks would be built into the barrage, shipping would be hampered
- Originally cost estimated at £10-12 billion. Engineering improvement has bought it down to £8 billion. Still uneconomical
- Would offer electricity at about 5.5p/KWh – Not particularly competitive.
- Environmental implication: The Severn Estuary is being proposed for a special area of conservation. It is used by 50,000 water vole on major migration routes
- The barrage would operate with a low load factor but a very high maximum output (nearly 9.5 GW), so heavy improvement to local grid connection needed.



TIDAL LAGOONS:



- Offshore tidal power generation resolves the environmental and economic problems of the barrage system

- completely self-contained and independent of the shoreline (visualize a circular dam, built on the seabed

- Turbines are situated in a powerhouse that is contained in the impoundment structure and is always underwater

- Power is transmitted to shore via underground/underwater cables and connected to the grid

- optimal site is one that is as shallow as possible, thereby minimizing the cost of building the impoundment wall

Building a complete impoundment structure offshore may seem to be more expensive than building a relatively short barrage but the cost per unit output of the offshore tidal power generator is less than that of the barrage:

- Depth: The impoundment structure is built on near-shore tidal flats proximal to the low tide level and avoids deeper areas. In contrast, the barrage must span an estuary and must cope with whatever depths exist on the site.
- Load Factor: Barrages must generate primarily in one direction (on the ebb tide) in order to minimize disruption and silting up of the head pond. The offshore tidal power generator is free to utilize both the ebb and the flood tides.

- While offshore tidal power generation must be considered “new,” it cannot be considered “experimental.”

- AEA Technology has affirmed the general economic and mechanical practicality of the offshore tidal lagoon technology

FEASIBILITY STUDY FOR A TIDAL LAGOON IN SWANSEA BAY:

- An impoundment of total area of approximately 5Km2 predominantly in water depth of 1-5 metres at mean low water springs

- Bi-directional generation turbines
- Installed hydro-turbine capacity of 60MW
- It is anticipated that the generators will operate at a voltage of 11kV and that this will be stepped up to 132KV for the export line to shore.

- It was concluded that it was practical to install 24 turbines of 2.5MW capacity with runner diameter in the region of 3.3 metres. The annual output of the scheme (from hydro-turbines with a mean efficiency of 85%) will be circa 187,000MWh/year for a 5Km2 impoundment.

- Implementation timescales have been considered and a 36 month construction programme looks practical

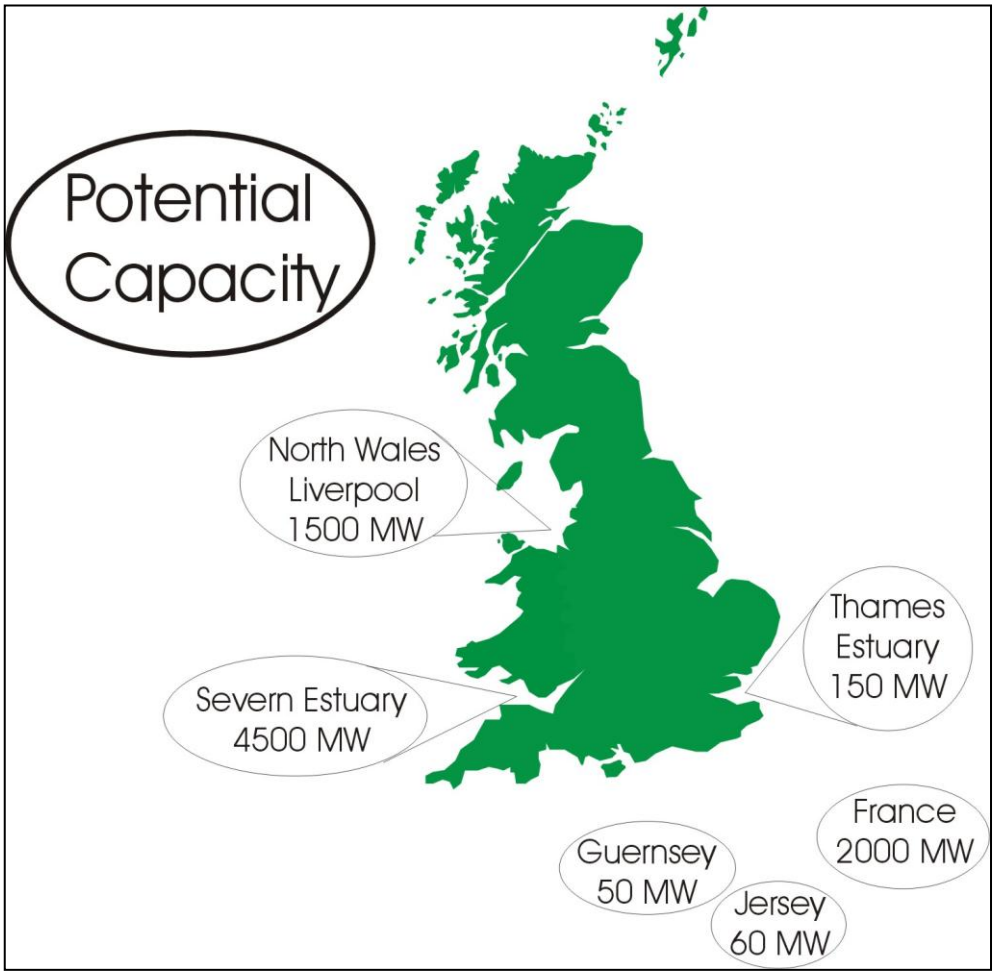
- The intent would be to run the power plant as a remote, unmanned station.
- Final de-commissioning presents no particular technical problems

Capacity (MW)	60
Load factor	36%
Costs:	£m
Impoundment	48.5
Turbine Hall structure	12.7
Turbine Plant and equipment	14.1
Maintenance equipment	0.1
Electrical Connections	3.0
Access Jetty	0.5
Navigation lights	0.1
Total	**£79m**
Cost / installed MW capacity	£1.32m

- Life expectancy of at least 120 years.

- The generation cost of the Swansea Bay scheme is 3.4 p/KWh

SUITABLE TIDAL LAGOON SITES IN THE UK:



- A total potential capacity of around 6000MW
- Translates to over 3.5 GW of average electrical output
- Suitable sites are all near built up areas
- Predicable output as tides are regular
- Therefore storage and transmission problems are minimal
- Lagoons can even be used as storage systems by the addition of pumps

TIDAL LAGOON IN THE SEVERN ESTUARY

- An optimum area of 300 km2
- Overall wall length of 150 km2
- Installed capacity of 4.5 GW
- Average output of 2.75 GW
- Estimated cost of £3.2 billion
- Generation cost of 2 – 2.5p/KWh
- Could be built in stages
- Could be built by 2010

TIDAL LAGOON NEAR LIVERPOOL:

- An optimum area of 120 km2
- Overall wall length of 90 km2
- Installed capacity of 1.5 GW
- Average output of 0.75 GW
- Estimated cost of £1.6 billion
- Generation cost of 3-3.5p/KWh
- Could be built in stages
- Could be built by 2010

THAMES ESTUARY:

- An optimum area of 20 km2
- Overall wall length of 20 km2
- Installed capacity of 150 MW
- Average output of 60 MW
- Estimated cost of £100-300 million
- Generation cost of 3-5.5p/KWh
- Could be built in stages
- Could be built by 2010