Commentary for Public Presentation for Community Hydro Power on the Tefii 25/11/13

1. [Introduction by Tom Cowcher, chairman Llandysul & Pont Tyweli Ymlaen]

[SLIDES 1-11]

2. [Introduction to feasibility study for Archimedes screws by Paul Thomas, Zero Carbon Future, Menter Cwm Gwendraeth]

[SLIDE 12]

3. My name is Greg Parker, I run The Solutions Factory, a software development business in Pont Tyweli. I am interested in renewable energy, and have a solar power system myself. So, when Llandysul and Pont Tyweli Ymlaen raised the idea of having a hydro-electric energy project on the river Teifi I was pleased to join a small group of volunteers to investigate the feasibility. We are only volunteers and have no vested interest in the scheme save that we think it is a damn good idea and would like to invest in it if it goes ahead.

4. This is only a feasibility study at this stage. Various options have been investigated, but nothing has been decided.

5. I would like to explain why we are looking into this. What benefit it will bring to the community. Then look at a few options. Then would greatly appreciate feedback to see if there is any wider interest and whether it is worth proceeding further.

6. The slides I will show, together with the MannPower report and a draft proposal are available for download on the Llandysul & Pont Tyweli Ymlaen website that is at www.llandysul-ponttyweli.co.uk – there is a link for Hydro in the left hand menu.

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7. So what are the reasons for setting up such a project?

8. There is a historical precedent - Llandysul & Pont Tyweli were originally powered by electricity from water turbines here at the Powerhouse, between then 1920s and 1940s. There were 3 generators generating up to 100kW of power. This fell into disuse when the national grid reached the area and electricity generated by cheap at the time fossil fuels. Our initial intention was to largely re-instate the historical scheme, but bringing it up to date.

9. Ironically, it is the national grid which now allows renewable energy projects like this to easily export power that cannot be used locally and to balance generation and demand over the whole country.

10. Energy security: While we have had cheap fossil fuels for many years now. We have now seen the global implications of this with pollution and global warming. So fossil fuels are now expensive. And those which produce additional pollution such as coal can no longer be used in power stations, so many of the UK's coal fire power stations are closing. There are long term projects such as more nuclear power stations, but these are very long term. There is huge demand on national grid already, so blackouts are quite possible. And local energy security is vital.

11. Energy policy: It is UK law to provide 15% of all energy by renewables by 2020. It is going to happen with our without us. The government does not itself build power stations, it can only encourage groups like us or companies to build those power stations by giving incentives such as the feed in tariff. This is going to happen whether we like it or not, and I would say that it is better to be involved and benefit from the feed in tariff rather than simply paying it in a our tax money or energy bills to foreign companies who are prepared to make the investments.

12. While we are on this point, a topical question is whether the feed in tariff is likely to continue.

13. We know how fickle politicians are and how they keep changing policies just to get more popularity. It was a month or so ago that Ed Miliband announced that if Labour got into power they would force energy companies to freeze prices for 2 years. This resulted in all the energy companies raising their prices immediately by 10% to compensate for that just in case. Which prompted David Cameron to say that he may roll back the green taxes that form part of electricity bills. So would the feed in tariff be affected?

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14. Just in case you don't know, the feed in tariff was introduced in 2010 to encourage people to invest in renewable electricity generation equipment. An amount is paid for each kWh of energy generated.

15. There are lots of different ranges but we would probably be looking at a hydro system in the range 15 to 100 kW or 100 to 500kW of peak power. That would give 20.21 p or 15.5p per kWh.

16. For comparison you can see the prices paid for solar and wind, depending on the size of the system.

17. Plus if you export the power rather than use it yourself you can chose to either sell the power to an energy company and negotiate a rate, or get a fixed Export Tariff of 4.64 pence per kWh.

18. Once you start generating the rate is set and will increase in line with inflation for the next 20 years. After that time you will not get any feed in tariff, but you will still be exporting electricity to energy companies at a rate similar to the Export tariff, plus inflation plus expected huge increases to energy prices in general far above inflation. With a hydro scheme you would expect it to operate for at least 50 years, even up to 100 years, so you will still be getting a good return on investment for many years.

19. The initial prices you see here decrease each year. To give you an idea, the starting price paid for solar systems was 40p per kWh and now it has been reduced to 14p. So the longer we delay with such a project, the less return we will get. These prices are valid up to March 2014. They will fall after this.

20. So do we have security that these tariffs will continue to be paid? Two years ago the government saw that more people were taking up large solar systems than expected so decided to cut the feed in tariff for solar giving only 2 months' notice, despite having guaranteed a price up to the end of the year. Schemes can take a year or more in planning and

a lot of investment before generation can begin, so giving 2 months' notice of a change was ridiculous. Indeed it was later proved illegal in court and so the original tariff was honoured. Based on this even if the government wanted to stop paying the feed in tariff it would likely be illegal for them to do so.

[SLIDE 15]

21. So what are these Green Taxes on our electricity bill that David Cameron has said he will review? Taking an average electricity bill of £576. We can see that 37% of this goes to pay wholesale energy costs – the cost of the fuel to generate the electricity. 23% to the distribution network – the national grid. 21% on other supplier costs and profit margin. 5% on VAT. Leaving these 13% of so called Green Taxes. Of these 5% go to paying people on low incomes to install additional insulation in their homes. 4% on the Renewables Obligation Support which requires electricity companies to purchase a specified proportion from renewable sources. 1% on EU Carbon Trading Scheme where large organisations have to pay for the CO2 they generate. A small amount on smart meters. Leaving only 1% of the electricity bill going to pay the Feed In Tariffs.

22. This is tiny proportion and if cut it would not make a significant difference to the general public's electricity bills, considering they are raised 10% year on year anyway by the energy companies. And if necessary, the government have said that this could be paid from general taxation.

[SLIDE 16]

23. Continuing with our reasons for the project. I believe Hydro power is a better alternative to the other methods available:

24. Hydro is a better alternative than wind, nuclear power and gas fracking. In terms of both visual impact and environmental impact.

25. Wind turbines produce intermittent power that has to be backed up by conventional fossil fuel power stations. While the power produced by the hydro-electric plant is steady and can be relied upon to produce a base supply into the national grid.

26. The peak power required by wind turbines is higher than a hydro system to generate the same amount of energy over the year. To give a comparison, to produce 1GWh of electricity you would need 500kW wind turbine at 77m tall. While you only need a 160kW hydro system.

27. So you need a large electricity pylon network to hold the 132kV power lines, while a hydro-power system such as we are investigating can connect to the existing small overhead 3-phase power lines adjacent to the site.

28. Wind turbines and the associated electricity pylons required have a huge visual impact over tens of miles. While the hydro-electric power system has a very localised visual impact.

29. Wind turbines have an expected safe life of only 20 years due to mechanical fatigue. The hydro systems we are looking at are likely to operate for well over a hundred years (the

generator and electrical components may need to be replaced before then, but these are relatively low power and a small proportion of the costs).

30. Nuclear Power is green from a carbon dioxide point of view, but is definitely not green from an environmental point of view and you have to securely handle the radioactive waste for tens of thousands of years. Additionally Nuclear Power plants only have a design life time of 50 years at most after which they are decommissioned.

31. Gas Fracking is a possibility now. Some sites have been tested in the UK and are likely to be used soon. But this is still a fossil fuel and contributes to Global Warming which causes Environmental changes to rivers and fish migration.

32. Gas Fracking is used extensively in the United States and there are many cases of severe pollution to ground water at these sites.

[SLIDE 17]

33. We would like this to be a community led project to help benefit the local community. One of the main benefits will be to give local people the chance to invest. Depending on the scheme that is chosen the return on investment would be from 3% to 11% per year. So looking at the best returns, if you invested £100 you would get back £11 per year. If you invested £6,000 you would get back sufficient to pay the average annual electricity bill. So you would never have to pay for electricity again. This would be an ongoing return, not limited to 20 years as a wind turbine scheme would be.

34. I would like to see this having no minimum investment, so we could even encourage participation by the school, getting kids to invest a few pounds of their pocket money which will teach them about renewable energy, the environment and finance. These small investments no matter how small will show that the whole community is supporting and participating in the scheme. And getting the school children involved will help encourage the next generation of Llandysul & Ponttyweli to respect and care for the environment.

35. Additional we aim to have enough income to offer a Community fund for local projects of up to £30k per year depending on the scheme.

36. This could for example be used by the Anglers to fund projects to clear the banks of the river of Himalayan Balsam, or by the Paddlers to help run events, or the help keep events like the Tysul Country Fair running, or to re-invest in further renewable energy projects such as solar power.

37. A quick search of the internet showed several other successful community hydro projects. Stockport hydro £650,000 investment, Harlaw £350,000 investment, Halton, Lancaster £1m investment.

38. There are different ways of arranging the company and shares, and possibilities of tax free investments, which will need to be research further. One interesting very successful project is Brighton Energy Cooperative which allows people to collectively invest in a range of

renewable energy projects, so far they have generated enough investment to build 3 solar systems totalling 80kWp. More and more systems can be built as more people invest.

39. You may think that there is no way that our small community could raise the required investment. But if we don't raise it all, we simply open up investment to the rest of the country. This has been successfully done to create a 5MW solar and wind project in Oxfordshire, Westmill Solar with over 1600 members, which raised 12 million pounds of investment.

40. From a purely financial point of view this is a very good investment. If you have savings you are lucky to get 1 or 2 % interest on them at the moment. This project would give up to 11% and that rate would be guaranteed for at least 50 years. So there should be no shortage of investors.

41. The important thing though is to give the local community priority and the opportunity to invest in their own project.

[SLIDE 19]

42. Coming back to our reasons for the project, the final point number 7. Is that it is also a benefit for the Environment: Reducing CO_2 so reducing climate change. Which should help keep the environment of the river and the fish population stable.

43. When we presented this at the Llandysul & Pont Tyweli Ymlaen AGM, one argument raised against it was that climate change does not exist. I was a bit surprised that this view is still held.

[SLIDE 20]

44. So I did a quick internet search for "Does Climate Change Exist?" and came up with this startling graph from the National Oceanic & Atmospheric Administration Centre which shows it undeniably with physical evidence. This shows the carbon dioxide content of ice cores dating back to 650,000 years ago. We can see the levels change over time as the climate naturally changes, but in the last 50 years the level has shot up to double the maximum level at any time in the last 650,000 years. This is clearly a man made and unprecedented change.

[SLIDE 21]

45. If the climate changes will that affect us? Yes absolutely and perhaps greatly. Our climate is kept temperate by the North Atlantic Conveyor, an ocean current that brings warm water from the equator up past the UK, together with plankton and the fish that go along with it.

46. As the Arctic ice cap is melting so much it is dumping huge amounts of fresh water into the salt water ocean. The fresh water floats above the salt water which then prevents it sinking down. This then prevents the cold water returning and after a while the current may simply stop flowing or at the very least change position.

47. Bearing in mind that we are around the same latitude as Moscow and Canada which routinely experience -40 Celsius temperatures in the winter, when we lose the warming effect of the

North Atlantic Conveyor and perversely while the average temperature of the planet is increasing, we will be plunged into an ice age. And it could happen very quickly within the next 20 years.

48. So will our hydro scheme stop this? Not on its own, but if lots of community groups around the world get together to do similar schemes then most definitely we can all benefit from the luxuries of electricity without further increasing climate change.

[SLIDE 22]

49. As Paul has said we had a grant for a feasibility study. Which we commissioned Mannpower to proceed with.

[SLIDE 23]

50. They concentrated on Archimedes screws. As you can see from the photo it is literally a large screw which water flows down and as it flows down it turns the screw which turns a generator to generate electrical power. The amount of power is proportional to the difference in height from the top of the screw to the bottom (which is called the head) and the volume of water flowing per second.

[SLIDE 24]

51. To get the difference in height from the top to bottom, generally you have to take water from somewhere up river, and channel it down to a lower part of the river. In one of the MannPower examples we take water from up in the parks and return it by the Powerhouse. So you are taking water out from the normal river channel and causing an environmental impact on this stretch of the river. This stretch of the river is called the depleted reach. So in any such scheme you have to weigh up the pros and cons. And Natural Resources Wales, who are responsible for maintaining the rivers in Wales, have to approve any such scheme, and they take a very strict view on the environment. Their policy is for projects to achieve no-impact or a positive impact. This is why the planning approval process for a hydro scheme is lengthy and expensive.

52. Now that is the way most hydro power systems work. But I am going to show you two other possible schemes that work in quite a different manner, that and have no such problem and as far as I know have not been used in the UK yet.

53. Mannpower investigated 4 main options. The first options 1a and 1b are re-instating the route of the water as per the original power house scheme in the 1920s. Water is taken from the river past the paddlers lake and piped under the road to a location near the power house. A photo montage is shown how the Archimedes screw may look in place just in front of the power house.

54. Option 1a uses a similar amount of water to the historic scheme. Option 1b doubles the volume of water to generate more power.

[SLIDE 25]

55. Option 2 takes the water from the same place, but does not have the complication of crossing the road, so is lower cost.

56. The photo shows a sample of how the intake point may look, and the screw at the exit point on the paddlers lake side of the road bridge.

57. All of these options involve building a new weir at the site of the old weir which is very expensive and not liked by Natural Resources Wales.

[SLIDE 26]

58. Option 3 uses an existing very small weir at this location – as you can see from the photo – it may in fact be just be a sewage pipe, but it acts as a weir and should hopefully be sufficient for our needs. The water is taken from there are returned near the paddlers barbeque area.

[SLIDE 27]

59. MannPower sent the feasibility document to Natural Resources Wales. Their reply was a firm negative. But Elizabeth James and a colleague from Natural Resources Wales came down for a meeting with us in September, so we started a good dialogue., Their main concerns are:

60. Fish population: The main issue here is the depleted reach which gets less water flowing through it. If there is less water, then there is an environmental change to the river no matter how small. It could, for example, make it harder for the fish to swim up river at certain times of the year.

61. Additionally there is the impact of a weir if this is needed. This could make it harder for fish to swim up river, although this is generally mitigated by putting in a fish pass at the weir.

62. There is also a rare moss which grows on the banks of the river from the road bridge down towards the power house. This may be affected by the depleted reach as the water levels would be lower in this part of the river.

63. Flooding we know happens on the river from time to time. If we go ahead with these schemes we would have to prove there would be no additional impact caused by installing the weir and leat.

64. The river is a Special Area of Conservation (SAC) and a Site of Special Scientific Interest (SSSI). There may be impact on other life along the river banks as part of the works.

65. Other water users such as the Anglers and Paddlers may be affected.

66. And Abstraction & Impoundment Licences would be required to take the water out of the river and hold it temporarily.

67. Other issues that we have to consider as a project are Feasibilty – we need funding to build the scheme. People are only likely to invest significant amounts if there is a reasonable return on their investment.

68. Visual impact to the general public using the parks and footpath.

69. Tourism – I can only see that being improved by any of the schemes.

70. Now all of the schemes proposed by Mannpower came out with uneconomical returns on investment of at most 3% per year. Additionally all of the options caused an environmental impact which was not liked by Natural Resources Wales.

71. So I started looking at alternatives.

[SLIDE 28]

72. The hydro electric barrel is a plastic barrel with ridges on it, floating on the water. As the water flows past, it turns the barrel which turns an electrical generator. The barrel is supported on an arm which can pivot up and down as the level of the water changes and the barrel just floats on the surface.

73. As far as I can tell this has no negative environmental impact. I showed the people from NRW but they had never seen one so could not comment.

74. With this there is no depleted reach.

75. No impact on fish. At the last meeting an argument was raised that "*ALL* hydro projects kill around 10% of fish" – it is doubtful this is true, but even if it were, what we are proposing here is *unlike* all other hydro projects this is something new. Never been implemented on a large scale in the UK. And Llandysul and Pont Tyweli could be the pioneers of hydro barrels. There is no way that fish can be killed or even disturbed by these barrels floating on the surface.

76. No impact on moss.

77. No impact on flooding.

78. No abstraction & impoundment

[SLIDE 29]

79. The only issue I see is the visual impact. These are large barrels 2m in diameter, and each will generate at most 5kW. So to get a reasonable power you would need at least 10 of them at locations along the river.

80. [MOVIE START] We can see here a little movie of a prototype which does look a bit ugly. But then so does an Archimedes screw and intake house. To improve the look I think that you could have the barrel simply anchored to the bed of the river by a cable either side as per this diagram, so you would only see the barrel above the river.

81. Someone suggested at the last meeting that we could even have an art project to paint each of them with different designs.

[SLIDE 30]

82. Another issue raised at our last meeting was that the barrels may get damaged by fallen trees or even the odd cow passing down the river at times of flood. I don't think that is a great problem. You either make the posts in-front of the barrel sturdy enough to withstand the impact and divert the object around the barrel. Or if we use the cable idea, a tree coming down river here, will probably cause the barrel to submerge and pass over it.

[SLIDE 31]

83. Another issue is that to get most power we need a fast flowing river. The river is fastest flowing where it is narrowest. We would need to do some surveying to investigate the best locations for the barrels and I don't have a firm idea of where there would be best located at the moment.

84. But for example a good location would be where the Tyweli joins the Teifi – it is in a very narrow concrete channel so there could be no environmental or river user issues.

85. Perhaps a couple over the small weir which naturally increases the speed of water flow.

86. But we can see clearly see from the map the main narrow part along here is the popular bit for canoeing.

87. The barrels could be additional fun obstacles for the paddlers? But if they do get in the way it should be possible to find a way to have them move out of the way when that part of the river is in use by the paddlers.

[SLIDE 32]

A bit of a wild idea illustrated here. We already have cables and gates across the river for the paddlers. So we could suspend the barrel on a cable **[SLIDE 33]** which can be winched up when access is required **[SLIDE 34]**.

88. Of course we can also look at putting the barrels along the Tyweli which has fewer users. But we do need to consider the electrical cabling. If the barrels are a long way from an existing power line they need big cables to avoid the power loss and these are expensive.

[SLIDE 35]

89. Now at the meeting with NRW they said that our proposed scheme was too small to be considered of significant public benefit. So I found a way to make the scheme much bigger and much more significant for public benefit by using the whole flow of the river, but having none of the negative impact of the Archimedes screw systems.

90. [MOVIE START] This is a Gravitational Water Vortex. Water is fed into a circular tank, and it rotates and falls out of the bottom like water going down a plug hole. This turns a generator as you can see in the middle to generate electrical power.

91. This has the same benefits of the hydro barrel: No depleted reach. No impact on fish – and studies have been carried out to verify that. No impact on moss –as we would not be placing

the vortex at the sites where the rare moss is found. No impact on flooding – as the existing river bed remains as it is and although there does need to be a weir it will be mechanical and can be fully opened at times of flood. There is also no abstraction & impoundment.

92. It does however have a visual impact. We would need 13 of these 5.5m diameter tanks to generate a good amount of power. And I have also calculated an option using 20 tanks.

93. The tanks need to be constructed along the banks of the river, so there will be 55m of bank that will be disturbed, which could be an environmental impact depending on where we locate it.

[SLIDE 36]

94. This gives a plan of the scheme. A moveable weir is put across the river. This directs all the flow through the tanks. The water enters rotates and exits from the bottom. Fish can easily navigate through the tanks as the complete flow of the river is used and at a slow speed, which makes it much easier to pass both up and down river than a conventional fish pass. Most other fish passes only allow fish to pass up river, not down. Indeed these vortexes have been used as fish passes themselves.

[SLIDE 37]

95. An example setup is shown superimposed over a river in Austria.

[SLIDE 38]

96. Photo of a tank next to a moveable weir. It looks a bit crude but I'm sure we can design something a bit better.

[SLIDE 39]

97. As for location I suggest here or may be better here as more difference in height of the river. But I know the paddlers use this part of the river at times. This should not be a problem because the weir could simply be opened on those days.

[SLIDE 40]

98. Various tests have been carried out to prove that the Gravitational Water Vortex is fish friendly and they show that fish can pass freely up and down stream through the vortex. It makes sense because it is a simply a large body of slowly rotating water so the fish cannot be harmed. There is no risk of damage near the turbine in the middle as the fish are moving at the same speed as the turbine and are free to simply swim past it. Indeed the GWV has been used in some places next to an existing hydro power scheme as a fish pass itself.

99. With other hydro schemes you need a fish pass to ensure that fish can pass freely. You can see a photo of an Archimedes screw with a fish ladder to the right of it.

100. With the Gravitational Water Vortex the fish easily find entry to GWV as ALL water passes through GWV unlike traditional fish passes which only has a small part of the flow, so confuses the fish.

101. GWV is a bio-reactor generating microbes which are food for fish, which lure them into the tank so they can pass freely. These also act as an additional food source, and clean the water.

[SLIDE 41]

102. Maximum speed of water is lower than 1m/s. While a traditional fish ladder can be up to 1.8m/s.

103. The power density is 120W/m3 as opposed to 150W/m3 for fish ladder.

104. The entry speed to the GWV is less than 0.5m/s so there is no danger to fish at all.

105. Fish can pass both up and down stream. Fish ladder only works up stream.

106. Fish only have to pass one door with GWV. With fish ladder there could be 20 or more basins and doorways.

107. The GWV needs no additional fish ladder so there is no additional building required.

108. The GWV aerates the water so improving the quality.

109. So as far as I can see – the standard environmental and fish preservation arguments against hydro power are not applicable to the hydro barrel or gravitational vortex system. If there are any objections on these grounds they should not be the standard ones used for other hydro schemes.

[SLIDE 42]

110. I have prepared a cost benefit analysis of all of the schemes to see which may be feasible.

111. The schemes are along the top – the options for the Archimedes screw, the Hydro Barrel and Vortex, and for comparison a 500kW wind turbine 67m tall and a 1MW solar park taking up 2 acres of land.

112. The costs are at the top ranging from 2.3 million pounds down to £300,000. The bottom line figure is the Return on investment highlighted in yellow. This is the percentage the investors will get back on their investment per year.

113. The returns for the Archimedes screws look too small to attract investors. I did have a further look at Mannpower's option 3 to see if we could reduce costs. We can if we go for a plastic Archimedes screw or a Kaplan turbine. So that brings the return up a little. But you still have the environmental impact of the depleted reach.

114. Moving on we can see the best return is given by the Hydro Barrels. But it is also reasonable for the Vortex systems. We can see that the return for wind power is much better. But a wind turbine must be dismantled after 25 years, so you lose your investment. With a hydro scheme it could potentially operate for 100 years.

115. Additionally have a look at the row in orange this indicates the number of houses that could be powered by the scheme as an average over a year. These are actual houses in the vicinity

that will be powered, through the national grid – electricity will be consumed by the nearest house first before passing on to further houses on the grid.

116. This ranges up to providing the complete annual electricity requirements for 182 houses for the large Vortex scheme.

117. But by comparison the wind and solar generate much more energy.

118. Although if we wanted to generate more energy we could add more hydro barrels or vortex tanks, you could simply keep adding more along the river to increase the power.

119. I have also summarised the impact of each of the schemes. Red indicates a negative impact. Green indicates no impact or a positive impact. We can see that the least impacting scheme is the hydro barrel with the only concern being the visual impact, and the vortex scheme coming a close second.

[SLIDE 43]

120. So what do we do now?

121. First of all I wanted to get feedback from people here to see what initial reactions are to any of the schemes. There is a feedback page on www.llandysul-ponttyweli.co.uk where we would welcome both positive comments and objections so that concerns may be addressed. There is a menu on the left hand side for Hydro. Additionally if you are at all interested in investing then please enter the amount you may wish to invest. There is no minimum or maximum amount.

122. This is by no means a commitment, but it would be very useful for us to gauge how much investment we may be able to generate and adjust the scheme accordingly. We will publish comments, but we will keep your personal details and the proposed investment details confidential.

123. So please do go to the site and register your support.

[SLIDE 44]

124. If the feedback suggests that it is worth going ahead. The next step will be draft a proposal to NRW – get their feedback. I have already drafted one which is available on the website also for comment. But that is subject to change.

125. Ofgem have to approve specific equipment to get the Feed In Tariff. The hydro barrel and vortex are not yet approved so we will have to find out what is involved.

126. Detailed plan of river and best locations for Hydro Barrel & Vortex

127. Land owner agreements

128. Investigating becoming an electricity supply company??

129. Public presentation, website, publicity

130. Share offer to public – register support
131. Detailed construction plans & costs
132. Planning permission
133. Additional funding if required
134. Build
135. Sit back and enjoy 100+ years of renewable energy.