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Memo

To: Prakash Rao, Jing Luo, Mike Gritzuk, James Doyle, John Sherlock, Jerry Bish, Larry Sawicki

From: Lon W. House, Ph.D. (530.409.9702) www.waterandenergyconsulting.com

Date: April 27, 2015

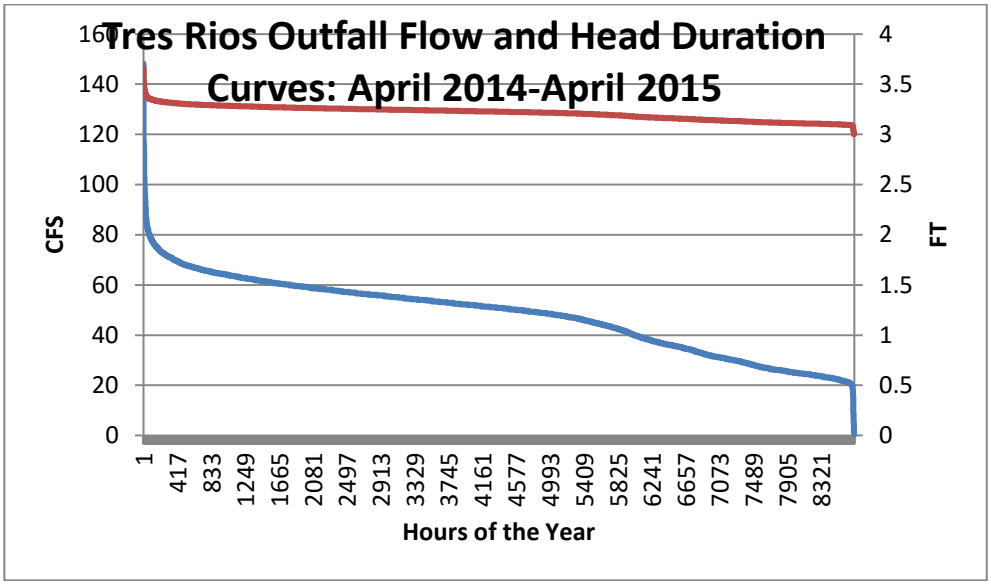
Re: Initial Tres Rios Hydro Analysis

Data

Larry provided hourly outflow data from April 2014 through April 2015. Data was generally good. There were a couple days (March 11th and March 15th) where the data was missing or bad. Normally I just interpolate between good data points on either side of the bad/missing data but these hours were so few that I just decided to ignore them and exclude them from the analysis.

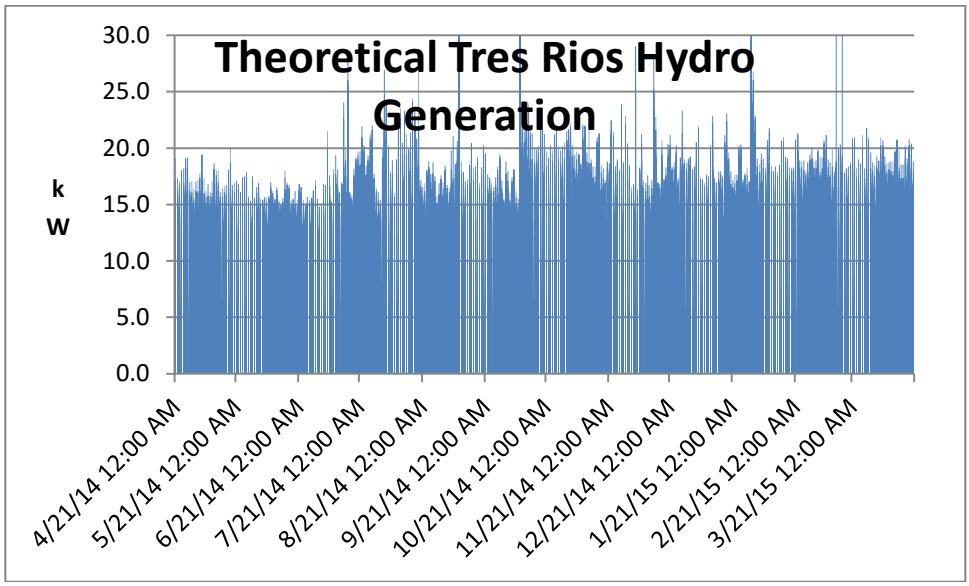
Larry also provided hourly flume level heights. But what I need are outfall pipe levels. As you remember from your college hydraulics class, you cannot calculate the fluid level in an open channel pipe directly, you have to iterate in order to get the exact level. I did a couple iterations on various flow levels and found the variation was only a couple inches difference from the initial calculation to the final. So, I am only doing the initial pipe level calculation here, to save lots of computation time. This should be adequate, we'll see if the manufacturers want more precise elevational levels. Note – I am assuming a drop of 3 feet exactly between the bottom lip of the outfall pipe and the water level in the riverbed splash basin.

The following graph shows the flow and elevation levels for the year. These are called flow duration curves, and are used by the manufacturers/developers to determine the optimal size of their hydro generator to install.



Initial Results

The following graph shows the theoretical power (kW) available at this site over the course of a year. This is optimistic, it is the theoretical power (100% efficiency) available at the site.



Actual generation will vary considerably from this figure, depending upon the size of the generator we install, and the efficiency curve of that generator.

Doing a rough estimate assuming a 75% water to wire generator efficiency and a flat generation curve (optimistic assumptions but screws can operate over a wide range of flows compared to other hydro generator types) this project could generate about 85,000 kWh per year. At a retail value of 8 cents/kWh, this is about $6,800 per year.

If we assume an all-in cost installation cost of about $250,000 (it should be less) we get a simple payback of over 30 years. Of course, any grants and incentives will reduce final costs, and we'll have more precise costs as we progress through this evaluation.

Next Steps

The next steps in the process are to:

- Contact the various manufacturers with this data and get quotes from them on the cost of their generation technology, its efficiency curve (used to determine actual kWh generation) and installation requirements;
- Talk with TEP to determine what interconnection requirements they will require, and likely configuration and costs;
- Determine initial generation site configuration and expected costs;
- From the above parameters, determine expected electricity generation and paypack period.

Additional information

As we discussed, I've been called back to California to work on the drought, so I won't be available for on-site meetings for some indeterminate time. But, this should not delay this project, I can still work on it there. I am an email or a phone call away.

If you have any question or comments, please provide them to me.

I am available for a conference call to go over these initial results if that would be helpful.

Thanks.

Signed:

Lon W. House, Ph.D.

April 27, 2015