COMMENTS: Geothermal Workshop

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The main problem with the workshop was that it was focused on achieving an important goal – the flexibility needed to balance the grid when a large percentage of the generation is in the form of intermittent wind and solar – but using the wrong tool to generate flexibility. Geothermal has some great virtues as a baseload resource with high availability rates. But when the approach of "flexible operation" has been tried, even with the clean, steam resources of the Geysers, the best conclusion that Calpine could reach, after considering decades of "flexible operation," was that the jury is still out. There is, however, little doubt, given that the Salton Sea area has much larger and even hotter resources than the Geysers. CalEnergy made the point that, as set forth in slide 39 of the presentations, "Each production well has the life expectancy of 25 thermal cycling events, whether one week or 20 years." Cycling on a daily basis would not last very long. Fortunately, there is a good tool to achieve the needed flexibility for balancing the grid. It is electrolysis. NREL has been exploring the use of electrolysis for balancing the grid, and has demonstrated that electrolysis can ramp up and down in a matter of seconds. Electrolysis using proton exchange membranes is particularly flexible.

The problem is not that geothermal is not needed. Although there is more than enough wind and solar to supply the grid some of the time, there are times when there is not enough to balance the grid and geothermal could be an excellent source of capacity for that purpose. The question is, what do we do with the energy when it is not needed for balancing the grid? Note that the other major problem expressed by the speaker for CalEnergy, as set forth (in italics) at the bottom of slide 47 of the presentation, is that it "*Lacks a market to deliver geothermal power*." The answer is that, with the extra energy during off-peak hours, we supply the need for clean transportation and heating fuels. Geothermal can sell capacity to the grid, and still sell most of the energy for transportation.

The most attractive possibility for a transportation fuel that does not include carbon is hydrogen. The greatest problem with hydrogen is that 94% of hydrogen fuel is produced by steam reformation of methane or other methods which produce greenhouse gases. Up until now electrolysis, which is the "green" method of producing hydrogen, has been too inefficient and therefore too costly to compete in the marketplace. The solution to the low efficiency and high cost is to use supercritical water for the electrolysis. Researchers demonstrated 45 years ago that certain properties of water in a supercritical state are much different than those properties in liquid water, differences that make electrolysis much more efficient, but nobody has actually used this information to advance electrolysis towards the market. Unfortunately, NREL's model ties electrolysis to wind power as the renewable resource providing the energy. Wind power is not only intermittent, but unpredictable. Moreover, it will not supply the heat necessary for supercritical electrolysis. Given the high capital cost of efficient electrolysis, operation at close to maximum capacity for long periods of time would be optimal, which is exactly the kind of operation that would tend to result from pairing electrolysis with geothermal energy. The optimal resource for this solution is the baseload, supercritical geothermal energy in the ocean rift zones around the world. A copy of a paper delivered at the World Geothermal Congress last spring explaining this concept is attached for your review. We have commenced the necessary research into electrolysis, and it looks promising in terms of being able to compete commercially with fossil fuels.

If we need a very large amount of hydrogen to provide clean transportation fuels to replace carbon fuels, then electrolysis would be the ideal tool for managing whether the renewable energy remains as electricity to balance the grid or is converted into hydrogen to put into the inventory of transportation fuels. In addition, electrolysis can operate efficiently at as little as 5% of its maximum capacity, so it can be used to dispatch almost all of the energy as electricity, as fuels, or anywhere in between. The calculation of the capacity charge for the geothermal electricity that will be available to balance the grid should include an amount to compensate the electrolysis system for its unused capacity during those periods when the electrolysis is turned down because of balancing. Geothermal systems not only lose efficiency in "flexible mode," they are actually degraded to some extent, depending on the system. The electrolysis system is not harmed by being turned up and down (although you generally don't want to turn it down below 5% of capacity because it is difficult to start back up) and it doesn't even lose much in the way of efficiency, it just doesn't earn enough to compensate for its capital cost, and that compensation should therefore be paid through the capacity charge for balancing the grid. We should also float the cost of the energy actually used to balance the grid at a level high enough to incentivize the owner of the grid to use other available sources of power first and only use the balancing power when actually needed for balancing, so that the geothermal power is left, as much as possible, for the production of hydrogen.

While the ocean rift zones are the primary location for such resources, one of the few places where such rift zones intrude under the land is in the Salton Sea area. That is the ideal area for the research and development of the techniques needed to harness the resources to produce green hydrogen. The Salton Sea area is the greatest known geothermal resource area in the United States. The research and development (hopefully initially supported in part by grants from California's cap-and-trade funds) and production of large amounts of inexpensive hydrogen could significantly improve the economy of Imperial County, particularly because the volumes of greenhouse gases produced, and the severity of the air pollution problems, in the neighboring Riverside, San Bernardino, Los Angeles and Orange Counties would make them ideal markets for such hydrogen. Once the techniques for producing clean hydrogen have been developed around the Salton Sea, they can be used offshore in the ocean rift zones, like the Gorda rift zone just off the coast of Northern California and other rift zones all around the world.