The Economics of an HIF SPRFD Fusion System in a Desert Region

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The economics of the FPC SPRFD fusion power system have been discussed previously by Helsley and Burke (2014) in a general model that was based on marketing of electricity and the production of synthetic fuel from the excess generating capacity. The SPRFD system can produce electricity at a price between US$0.04 to US$0.06 per kWh and synthetic fuel at about US$3 per US Gallon. Desert regions not only need electricity and fuel for their development but they also need water. Since electric generators and synfuel production both produce low temperature waste heat, we examine the value of producing water from the waste heat using multieffect distillation(MED) processes. We will focus on the energy and water needs of Iran as a site specific model.

Iran's population has grown 8-fold in the past 100 years and continues to grow at more than 1 percent per year. Water shortages are common and per capita consumption is between 180 liters and 250 liters per day depending on location. Expanding industrial and agricultural needs are also present. Thus water becomes a limiting resource for economic development.

A typical SPRFD system produces 100 GigaJoules of heat. Unless direct electrical conversion process are implemented, approximately 50 percent of this heat is captured during the conversion to electricity and the production of synfuels. The other 50 percent is either lost to the environment by radiation from hot surfaces or is discharged via cooling towers or cooling water. Using the analysis provided by SIDEM, a major multi-effect distillation (MED) system supplier, we find that the maximum heat desired is 75 degrees C. and that the waste heat from a 2.7 GW combined cycle gas turbine plant, assumed to be about 60 percent efficient, can deliver 800,000 m3 per day (SIDEM Video on Marfaiq Jubail facility - http://www.sidemdesalination.com/medias/multimedia/?playId=42491) simply by use of the spent steam to heat seawater for low pressure evaporation.

A fully developed SPRFD facility can produce about 20 times as much electricity as the Jubail facility and thus it should be able to produce 20 times as much fresh water. Cost information supplied by SIDEM indicate that the water making portion of the facility with an output of 15 Million m3 per day would cost about US$16 Billion. Burke and Helsley (2014) estimated that the SPRFD system including a modest synfuel making facility would cost US$80 Billion. Thus for a combined cost of US$100 Billion one could get 50 GigaWatts of electricity (continuous capacity), 15 million m3 of distilled water per day, and the ability to produce at least 100,000 barrels of carbon-neutral synthetic liquid fuel per day.

Most of the populated areas of Iran are above 1000 meters but less than 2000 meters. There are major land areas that could be irrigated at less than 500 meters in essentially undeveloped areas. Pumping costs can be estimated to be 6kWh per m3 for a lift of 1800 meters and the fully amortized horizontal transport of water can be as low as US$0.09 cents per hundred kilometers (UN Publication E/ESCWA/SDPD/2009/4). But the challenge in Iran will be the high mountains between the Persian Gulf and interior use areas. If a SPRFD system were built near Bandar Abbas, a delivery route exists at elevations less than 2000 meters that could deliver water to central areas such as Rafsanjan and continue on to the vicinity of Tehran – a total distance of about 1500 km.

Water produced by MED systems has a fully amortized cost of about US$0.50 per m3 produced. Pumping cost to the high elevations of central Iran would add an additional US$0.24 per m3 and long distance transportation in pipe and canals would add an additional US$0.09 per hundred kilometers of transport. Thus for a cost of approximately US$1.00 to $2.00 per cubic meter water could be delivered anywhere in central Iran at elevations less than 1800 meters.

The combined income from electricity, synfuel and water from a SPRFD system may be a viable option for industrial and economic growth of Iran. A system could be 'in place' in a decades time.