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Economic Viability of Large-scale Fusion Systems

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The utility industry has conditioned us to think in term of power generation facilities having capacities of about 1 Gigawatt (GW). This works for fossil fuel plants and for most fission facilities for it is large enough to support the sophisticated generation infrastructure but still small enough to be accommodated by most utility grid systems. The size of a fusion power system demands a different paradigm. The compression and heating of the fusion fuel for ignition requires a large driver even if it is necessary for only a few microseconds or nanoseconds per energy pulse. The economics of large systems, that can effectively use more of the driver capacity, need to be examined.

Large output systems provide a problem for electrical grids for no grid node in the US can accept more that about 6 GW, yet the ideal duty cycle for a large driver, such as the Single RF Driver (SPRFD) system of FPC, is most economical when the output is large, say 30 GWe or more. This is incompatible with most regional grid structures and thus requires either grid reconstruction or some other means of using the large output. We have examined several cases in our financial models. One is a simple 'all electric model' and another is an electricity plus synthetic liquid fuel model. Each can produce potable water by multi-effect distillation (MED) processes where water is in high demand and a non-potable source of water is available. Other models might include major electricity users in the immediate vicinity, users such as smelters, metal refiners, etc.

The assumptions used in our models are specific for the SPRFD process but could be generalized for any system. We assume that the accelerator is the most expensive element of the facility and estimate its cost to be $20Billion.Chambersandfuelhandlingfacilitiesareprojectedtocost1.5$ Billion each with up to 10 to be serviced by one accelerator. We have taken data from the literature for the cost of electrical generation facilities and synthetic liquid fuel production costs have been estimated in the Green Freedom report produced by LANL. The water maker costs come from IDE Technologies and Veolia's experiences in Bahrain and, although capable of paying for itself at irrigation rates, water generally contributes little to the overall profit of the facility. But it may be necessary to produce water as a means of utilizing the 'waste heat' in a way that minimizes environmental impact.

Using these assumptions and data, we conclude that a fully utilized HIF system will produce marketable energy at roughly one half the cost of our current means of generating an equivalent amount of energy from conventional fossil fuel and/or fission systems. Even fractionally utilized systems –i.e. systems used at 25 percent of capacity, can be cost effective in many cases. Our conclusion is that SPRFD systems can be scaled to a size and configuration that can be economically viable and very competitive in today's energy market.

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