POWERSAT UNIT 1 ECONOMIC & COMPETETIVE ANALYSIS

ECONOMIC COMPARISON OF EXISTING GENERATION TECHNOLOGIES AND THE PSU-1 MODEL

William E. Maness
Janet Hendrickson

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INTRODUCTION

The PowerSat, or Solar Power Satellite is an electrical generation system that consists of solar collectors in orbit, a wireless power transmission system and a receiving station on the ground. This document presents an economic comparison of the proposed PSU-1 system and traditional generation. The physical details of the PSU-1 system are presented in the companion document, "PowerSat Unit 1 Baseline Physical Performance Model." The PSU-1 physical document should be reviewed by those unfamiliar with the proposed design, as this analysis draws heavily on the PSU-1 computational results and assumptions.

SCOPE

This document has been developed to provide a theoretical model of the economic aspects of the PSU-1 system, and to place it competitively within the commercial power generation marketplace. The modeling has been done in Excel, with assumptions and equations from various sources. Where possible, hyperlinks or footnotes are provided to the sources cited.

The purpose of this document is to provide a reference for business planning and feasibility analysis.

DOMESTIC WHOLESALE ELECTRICAL GENERATION MARKET SUMMARY

The demand for electricity in the US varies up to 60% with the time of day, and the season. There are also a variety of energy sources that are used to generate electricity to meet these demands. To best understand how a PowerSat compares with traditional generation, a brief review of power plant types and fuels is in order.

POWER PLANT UTILIZATION

Because the demand for electricity is so variable, it doesn't make sense to have fuel-burning power plants running at full capacity all the time. This would merely waste fuel. There are two ways in which power plants are used, baseload and peaking. A baseload power plant runs twenty-four hours a day, seven days a week except for scheduled outages for maintenance. The peaking plant however is only started when demand exceeds the baseload capacity, and is then shutdown again once the excess demand recedes.

Different energy sources are better suited to the differing plant types. Nuclear and coal fired plants provide 71% of the baseload power in the US. Oil and gas fired plants are easier to start and stop and provide peaking capacity. As a PowerSat is available 24/7, it's use and loading will be similar to a nuclear baseload power plant.

This differing utilization of the power plant's generation ability is called the capacity factor, and is expressed as a percentage. If a plant were to be fully loaded, and run 24/7 for a year, its capacity factor would be 100%. Baseload plants typically run a 60-90% capacity factor, with peaking plants running around 30%.

The table below shows the capacity factor and fuel-base of generation in the US[1].

PSU-1 Economic Model Generation Technology Capacity Factors & Usage			
Generation Technology	Typical CF	Typical Usage	% of US Supply
Coal	69%	Baseload	51.81%
Nuclear	90%	Baseload	19.88%
Gas	30%	Peaking	16.12%
Hydroelectric*	45%	Both	7.24%
Oil	31%	Peaking	2.87%
Biomass	30%	Peaking	1.69%
Other	Varies	Varies	0.24%
Wind*	30%	Peaking	0.13%
Terrestrial Solar*	20%	Peaking	0.02%
*Environmentaly Friendly			100.00%

With a low fuel cost, and constant availability, a nuclear plants capacity factor is the closest likely equivalent to how a PowerSat would be used. Thus, for the purpose of computing the PSU-1 revenue stream, we'll use the same capacity factor as a typical US nuclear baseload plant.

WHOLESALE ELECTRICITY PRICES

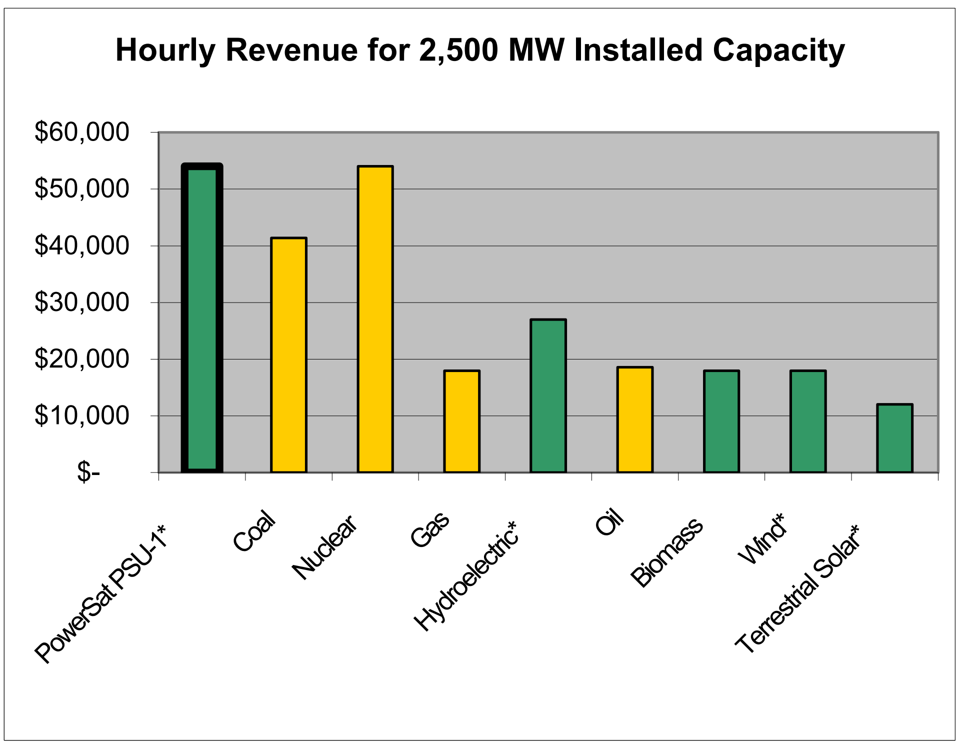
In general, power plants sell their electricity to utility companies, or are owned by utility companies which distribute the power to end users. The end users pay retail power prices, while the utilities pay wholesale prices. These wholesale prices can vary dramatically depending on the season, how far in advance the delivery contract is arranged, etc. Spot wholesale prices are the highest, with advance contract pricing a fraction of the spot price.

We will use a typical advance delivery contract wholesale price of $24.00 per megawatt/hour [2]for the basis of our PSU-1 revenue calculations.

SIMPLIFIED REVENUE MODEL

To keep the comparisons valid, we will also assume that we're comparing similar installed capacity, 2,500 MW. The following table shows the revenue for each plant type, based on their capacity factor.

PSU-1 Economic Model			
Revenue			
Revenue per Megawatt hour (2001 Avg. Wholesale price)			$24.00
Plant Type	Hourly	Yearly	
PowerSat PSU-1*	$ 54,000	$ 473,040,000	
Coal	$ 41,400	$ 362,664,000	
Nuclear	$ 54,000	$ 473,040,000	
Gas	$ 18,000	$ 157,680,000	
Hydroelectric*	$ 27,000	$ 236,520,000	
Oil	$ 18,600	$ 162,936,000	
Biomass	$ 18,000	$ 157,680,000	
Wind*	$ 18,000	$ 157,680,000	
Terrestrial Solar*	$ 12,000	$ 105,120,000	
*Environmentaly Friendly			



FUEL COST / WASTE MGMT. COST

While the PSU-1 system does not consume any fuel, more than 90% of current electricity generation in the US does. This fuel cost, and in the case of nuclear power, waste management costs are primary drivers of electricity cost today. The following table details these costs by technology, per megawatt hour of power delivered. Data from various sources[3].

PSU-1 Economic Model Fuel and Waste Mgmt. Cost per Megawatt Hour Delivered Generation Technology	Fuel	Waste	Total
PowerSat PSU-1*	$ -	$ -	$ -
Coal	$ 4.30	(recycled ash)	$ 4.30
Nuclear	$ 4.70	$ 0.76	$ 5.46
Gas	$ 8.10	$ -	$ 8.10
Hydroelectric*	$ -	$ -	$ -
Oil	$ 7.30	$ -	$ 7.30
Biomass	$ 6.40	$ -	$ 6.40
Wind*	$ -	$ -	$ -
Terrestrial Solar*	$ -	$ -	$ -
*Environmentaly Friendly			

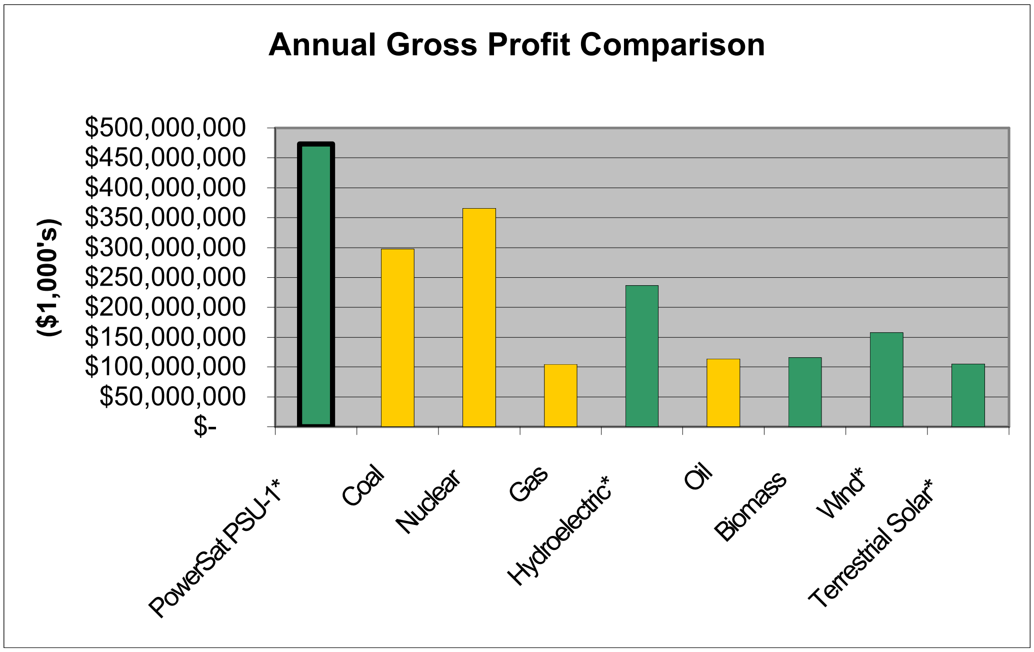
Coal produces various types of ash, but the cost of disposal is largely recovered by revenue obtained by recycling some of the ash into building products. The nuclear waste figure does not include plant decommissioning / clean up costs. These costs are treated as capital items, as they do not recur.

With this cost information, and the revenue stream, we can compare gross operating margins.

ANNUALIZED PROFIT / LOSS STATEMENT

As the table below shows, the PowerSat is a clear winner in terms of annual gross revenue. This is due to a combination of high load factor, and zero fuel cost. Nuclear power and coal also have strong earnings potential. This is what one would expect, as coal and nuclear power comprise the bulk of current generation.

PSU-1 Economic Model Annualized Gross Profit by Technology	Revenue	Expense	Gross Profit	Margin
PowerSat PSU-1*	**$ 473,040,000**	**$ -**	**$ 473,040,000**	**100%**
Coal	$ 362,664,000	$ 64,977,300	$ 297,686,700	82%
Nuclear	$ 473,040,000	$ 107,616,600	$ 365,423,400	77%
Gas	$ 157,680,000	$ 53,217,000	$ 104,463,000	66%
Hydroelectric*	$ 236,520,000	$ -	$ 236,520,000	100%
Oil	$ 162,936,000	$ 49,559,700	$ 113,376,300	70%
Biomass	$ 157,680,000	$ 42,048,000	$ 115,632,000	73%
Wind*	$ 157,680,000	$ -	$ 157,680,000	100%
Terrestrial Solar*	$ 105,120,000	$ -	$ 105,120,000	100%
*Environmentaly Friendly				

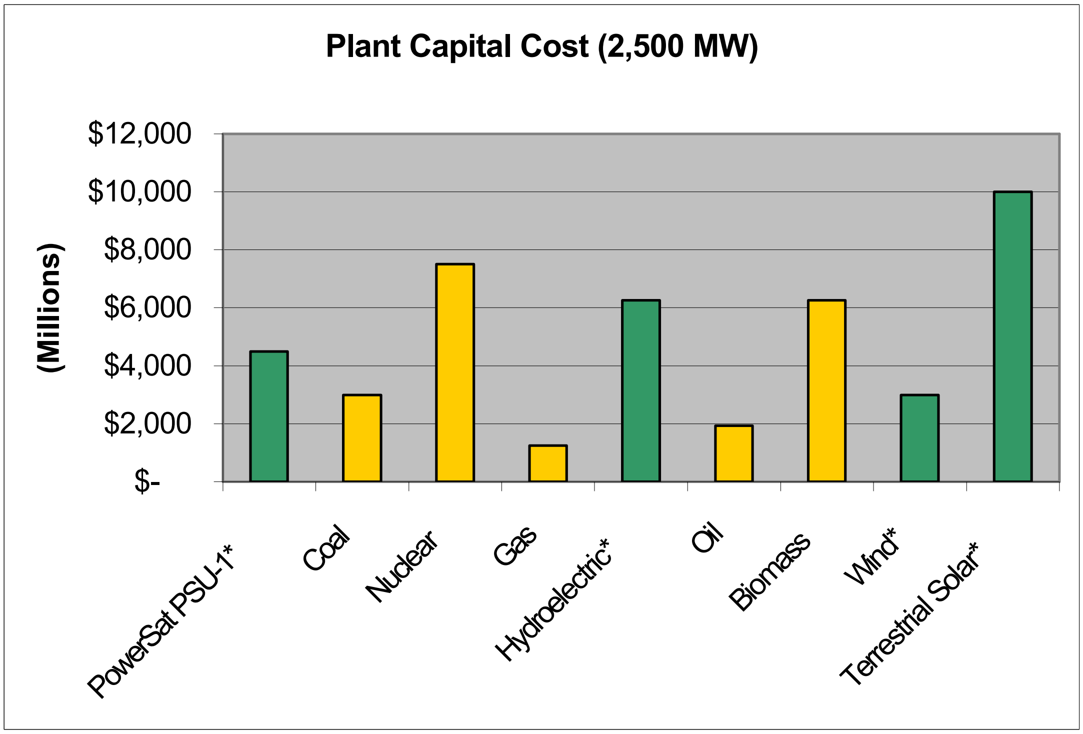


If the gross profit from operations were the only consideration, the PowerSat is a clear winner. However, the other key element in power generation is plant capitalization. In the case of nuclear power, this also includes plant decommissioning and cleanup. Next, the capitalization of these plants will be evaluated, and the cost of capital added to the profitability model.

POWER PLANT CAPITALIZATION

Power plants are large and expensive installations. Generally, the operating company or utility funds them by the issuance of utility bonds on the public bond market. We can use current utility bond rates as a basis for our cost-of-capital. We will use historic data to compute a capital-cost per installed megawatt of capacity. Because the technology varies so widely, the cost of the plant also shows a wide variance. The following table estimates capital costs for a 2,500 megawatt capacity plant using the various technologies. Data from various sources[4].

PSU-1 Economic Model				
	Capital Cost			
Generation Technology	Per MW (mil.)		Total (mil.)	
PowerSat PSU-1*	$	1.800	$	4,500
Coal	$	1.200	$	3,000
Nuclear	$	3.000	$	7,500
Gas	$	0.500	$	1,250
Hydroelectric*	$	2.500	$	6,250
Oil	$	0.774	$	1,935
Biomass	$	2.500	$	6,250
Wind*	$	1.200	$	3,000
Terrestrial Solar*	$	4.000	$	10,000
*Environmentaly Friendly				



Actual capital costs for nuclear technologies show substantial overruns relative to their budgeted cost. The figure cited for nuclear power is a midrange of the actual historical reactor and plant cost. The terrestrial solar data is based on smaller installations made to date; it would likely be reduced in a large-scale plant.

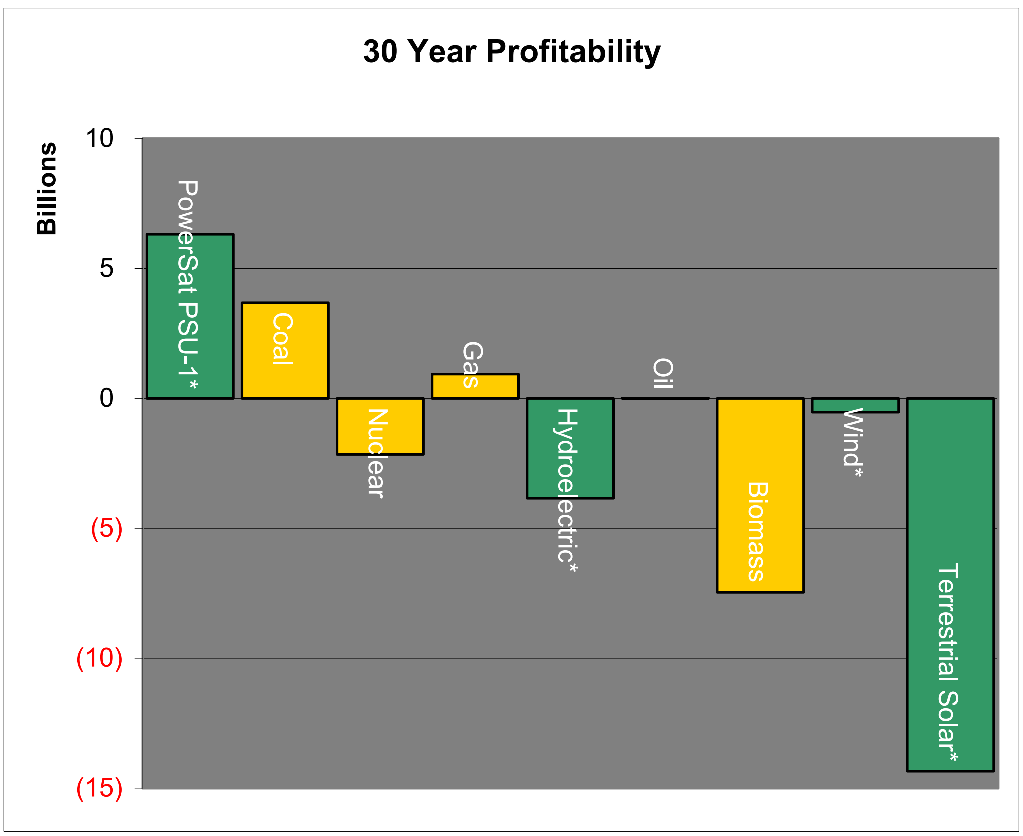
Now that we have established the capital outlay required for new generation, and the operational revenue stream each generation technology provides, we can analyze the profitability of each technology over its economic life.

POWER PLANT IDEALIZED PROFITABILITY

To place all of the competing generation options on an equal economic footing, the following analysis assumes 100% bond financing, with an annual 5% coupon, and a maturity of 15 years. It is interesting to note that some technologies do not show profitability within the 30-year economic lifetime used for new generation analysis. Surprisingly we were unable to find *any* nuclear installation actual cost that showed profitability using a straight bond-financing model. We must assume that these plants either sell their electricity at a rate substantially above the national average, or receive other subsidy to remain solvent.

PSU-1 Economic Model			
30 Year Profitability, by Generation Technology			
Assumes: Bond Rate 5%		Economic Life (Years) 30	
Bond Maturity (Years) 15			
Generation Technology	Total Investment (Capital + Bond)	Total Operational Profit	Lifetime Profit after Bond Ret.
PowerSat PSU-1*	$ 7,875,000,000	$ 14,191,200,000	$ 6,316,200,000
Coal	$ 5,250,000,000	$ 8,930,601,000	$ 3,680,601,000
Nuclear	$ 13,125,000,000	$ 10,962,702,000	$ (2,162,298,000)
Gas	$ 2,187,500,000	$ 3,133,890,000	$ 946,390,000
Hydroelectric*	$ 10,937,500,000	$ 7,095,600,000	$ (3,841,900,000)
Oil	$ 3,386,250,000	$ 3,401,289,000	$ 15,039,000
Biomass	$ 10,937,500,000	$ 3,468,960,000	$ (7,468,540,000)
Wind*	$ 5,250,000,000	$ 4,730,400,000	$ (519,600,000)
Terrestrial Solar*	$ 17,500,000,000	$ 3,153,600,000	$ (14,346,400,000)
*Environmentaly Friendly			

Not surprisingly, hydroelectric power shows considerable loss given the extremely high capital cost of such installations, however hydro projects are not usually constructed for the sole purpose of generation, so their capital cost is absorbed by many reservoir users. The economic situation regarding biomass, wind and terrestrial solar generation illustrates why such technologies are not in wide use.



SUMMARY

While powersats represent a high initial capital investment when compared to fossil fuel plants, they still generate the greatest profitability for investors over the long term. It is important to note, that when compared on an equal economic footing, nuclear, and all green power alternatives fail to return profits at all.

NOTES AND REFERENCES

[1] Department of Energy, Annual Energy Review, Table 8.2 (Y2000 data) [http://www.eia.doe.gov/emeu/aer/elect.html]

[2] Power Marketers Spot and Contract Prices. [http://www.powermarketers.com/]

[3] Fossil Fuels; FERC data [http://www.ecoworld.com/energy/EcoWorld_Energy_Resid_KWH_Prices.cfm], Nuclear; Nuclear Energy Agency, Economics of the Nuclear Fuel Cycle [http://www.nea.fr/html/ndd/reports/efc/]

[4] Biomass; Bioenergy information network [http://bioenergy.ornl.gov/faqs/], Coal; National Renewable Energy Laboratory report [http://www.nrel.gov/analysis/emaa/pubs/ceed/ceed.html], Wind, Solar, Hydro; NREL report [http://www.nrel.gov/documents/profiles.html]