THE NEXT 100 MW POWER PLANT FOR OAHU

Gabriel A. El-Swaify, MSCE and Panos D. Prevedouros, PhD
Department of Civil and Environmental Engineering, University of Hawaii at Manoa

Some electricity production units on Oahu are several decades old and need replacement within the next ten years. What type of plant should generate the next 100 megawatt (MW) on Oahu? Are there cost-effective alternatives that reduce dependence on fossil fuels? Our study investigated nine different energy sources including coal, oil, natural gas, geothermal, hydroelectric, photovoltaic solar, on-shore wind, waste-to-energy (WtE), and nuclear to provide answers.

U.S. Energy Information Administration (EIA) data show that in 2012 Hawaii had the 4th lowest average residential monthly electricity consumption in the nation (585 kilowatt-hours), but has the highest residential monthly electricity bill in the nation ($203), nearly two times that of the national average. Therefore the cost-effectiveness of future power plant installations is imperative.

The study took a holistic view of costs including plant design and construction, land needed and its cost, operation, maintenance and fuel costs over 30 years. Power plants are not equal. A major differentiating factor is the “capacity factor”. For example a 100 MW coal plant has a high capacity factor of 0.88 which means that over its design life it provides power 88% of the time. On the other hand, a 100 MW solar farm has a capacity factor of 25%. To make an apples-to-apples comparison at the level of 100 MW, each plant was outfitted with standby power in order to arrive at its true costs of consistently delivering 90% of 100 MW. Natural gas power plants were used for standby power.

EIA provided data necessary to conduct the 30 year power plant comparison analysis such as capacity factors, costs of fuel, megawatt-hours (MWh) generated per unit of fuel used, etc. EIA, the U.S. Department of Energy, and the National Renewable Energy Laboratory provided information for energy source profiles and national energy trends. Plant construction costs were equalized to 2012

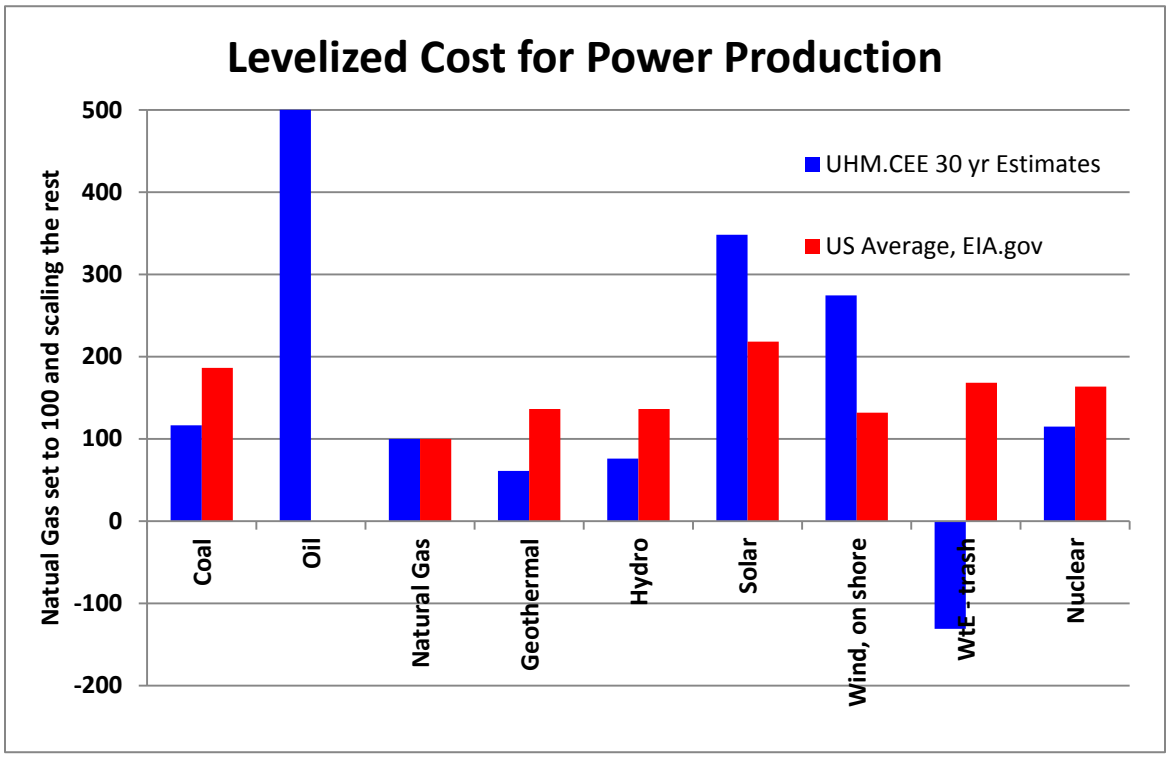
dollars using historical Construction Cost Indices (CCI). The table below is the bottom line of the analysis. It shows the net profit or loss after the plant operates at a 90% capacity over 30 years assuming that power is sold at 10 cents per KWh, and the cost of fuel is constant at the 2012 level.

	Electricity Generating Power Plant by Type of Fuel								
	Coal	Oil	Natural Gas	Nuclear	Solar PV	Wind	WtE - trash	Geo-thermal	Hydro
30 year net (in Million 2012 US $)	$ 1,286	$ (2,481)	$ 1,454	$ 1,319	$ (808)	$ (136)	$ 3,559	$ 1,809	$ 1,673

Waste to energy is superior to any other technology in the long term. Ranking 2nd and 3rd are geothermal and hydro technologies, respectively, but these resources do not exist on Oahu. Ranking 4th is natural gas, and although LNG is not a renewable energy source, it is much cleaner fossil than oil and abundant in the US thanks to advances in hydraulic fracturing (fracking.) Ranking 5th is coal, but use of coal produces the most pollution of all fossil fuels. Ranking 6th is nuclear, but nuclear plants do not come with capacities of 100 MW; the typical capacity of nuclear power plants in the EIA data is 2,000 MW; one of them would be much too large for Oahu. Additionally, approval for nuclear power generation in Hawaii is a long and intensive process that will take years to approve, if ever pursued. Ranking 7th and 8th is wind and solar, respectively. High costs for construction and standby energy are associated with their low capacity factors. Wind turbines have a life of about ten years. Ranking last at 9th is oil, which is unfortunate because oil-fired power plants currently generate about 75% of Oahu's electricity.

The following chart provides a relative scaling of the cost of these power plants. There are some differences with national data. Basically only Hawaii uses oil for power production; no national data are available for a comparison. Solar and wind cost estimates are higher for Hawaii due to higher land costs. Solar can be cheaper if all of it is on (free) rooftops. WtE actually has a negative cost because the tipping fee or value of a truckload of refuse is $81 per ton which is comparable to the 2012 average tipping fee of $73 for east coast states (the west

coast has much cheaper landfills.) In other words, all other plants examined have to buy fuel or get it for free from nature. WtE plants are paid to receive the fuel!



Given these results and the fact that Oahu already has a 3-boiler installation of WtE that takes full advantage of the municipal solid waste production on the island, the best choice for the next 100 MW of electricity production is a liquefied natural gas (LNG) power plant.

Another alternative or addition to this recommendation is to expand Oahu's WtE by another 50 MW and develop a "trash-trade" with the outer islands. The Big Island, Kauai and Maui can significantly reduce their landfill pressures by shipping their trash to Oahu and then receive back ash. In this way there is more electric power on Oahu where it's needed the most, the volume of municipal waste dumped on the outer island landfills is reduced by about two thirds, and Oahu's Waimanalo Gulch landfill can be closed but remain at a hiatus that enables it to temporarily receive wastes should H-Power experience a major problem.