Photovoltaic Electricity in Hawaii

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House Resolution No. 159 (HR 159), "Requesting the Department of Business, Economic Development, and Tourism (DBEDT) to Conduct a Study on the Future of Photovoltaic Electricity in Hawaii," was adopted by the House of Representatives of the Twenty-Third State Legislature of the State of Hawaii, Regular Session of 2005. This report is DBEDT's response to HR 159.

Photovoltaic Electricity in Hawaii

This report has been prepared in response to House Resolution 159, Requesting the Department of Business, Economic Development, and Tourism (DBEDT) to Conduct a Study on the Future of Photovoltaic Electricity in Hawaii. HR 159 was adopted in 2005 by the Hawaii State House of Representatives.

As a state with both abundant sunshine and higher than average electric utility prices, Hawaii is well suited to adopt photovoltaic (PV) and other solar technologies. Hawaii is already known to have more solar water heaters per capita than any other state. Although hard data are not available, it is believed that the County of Hawaii has thousands of photovoltaic systems, mostly in remote subdivisions not serviced by the electric utility, more than any other comparable area in the U.S. The U.S. Department of Energy (USDOE) notes that Hawaii is among the best five markets for PV in the nation.

Data on photovoltaic costs and performance in Hawaii are very limited. In Hawaii, only a relatively few PV systems, primarily but not exclusively those installed with electric utility sponsorship, have been monitored to document their electricity output. Similarly, since most PV systems are privately owned, total installed cost data are not readily publicly available. This report utilizes data which have been publicly reported, as well as limited information provided by local solar businesses.

In some applications, photovoltaic-generated electricity is already competitive with utility power in Hawaii. These competitive applications include certain grid-tied residential and commercial installations as well as remote applications such as highway call boxes and warning signs. Although PV electricity prices may not drop significantly in the near future, rising prices for petroleum products will cause conventional utility-generated electricity to climb, making the comparison even more favorable for PV.

Photovoltaics Performance and Price Data Insufficient to Define a Trend

Although photovoltaics have been used in some remote, off-grid residential applications in Hawaii since the early 1970s, it has only been relatively recently that residential and commercial photovoltaics have been installed as grid-connected systems with performance data collected.

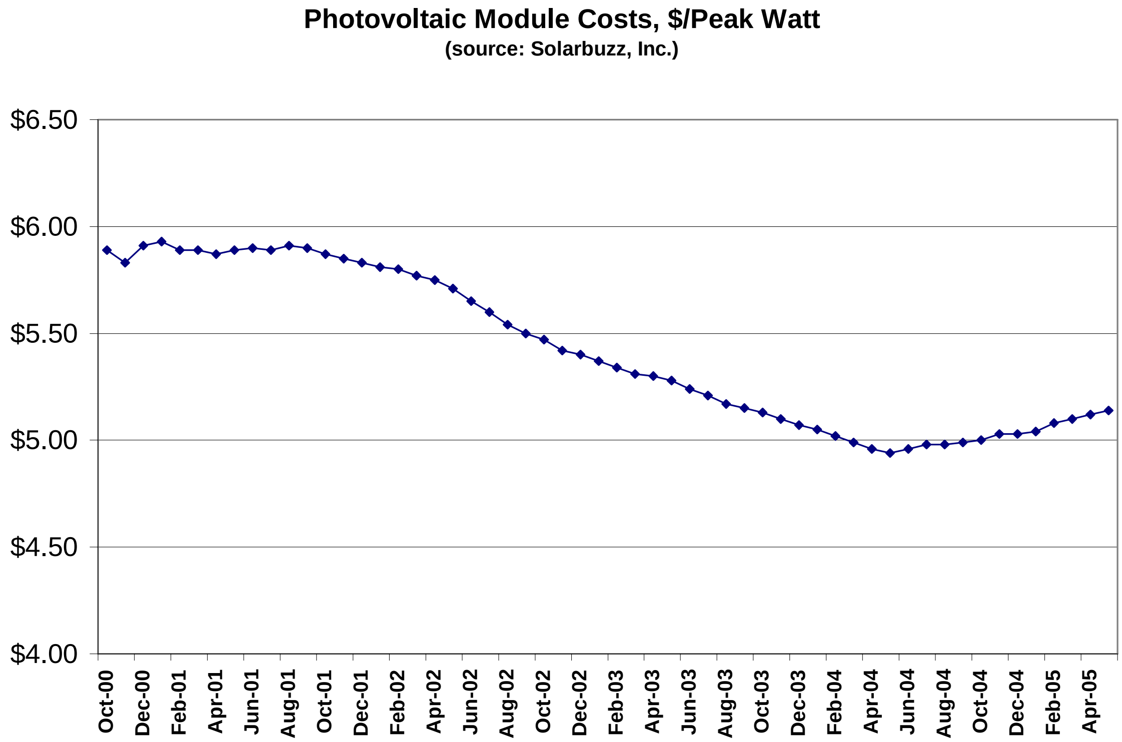
For instance, one company specializing in commercial installations has performance data for several systems; the earliest data are only from 1998. The oldest system installed under Sun Power for Schools, a utility-sponsored program, only has performance data dating from 1997, and there were only 14 “residential scale” systems installed statewide under that program at the end of 2004.

Thus, the locally available performance and price data are insufficient to define a trend for photovoltaics in Hawaii. National data are also insufficient to define a trend, for similar reasons. Some “snapshots” of installed costs and calculations of solar electricity prices have been reported, often with no detail on the assumptions which went into the calculations.

However, even the limited data can be instructive.

PV Module Prices are Rising

A major component of PV system equipment costs is the modules themselves—the “panels” containing solar electric cells. Since the mid-1970s, when a typical module cost approximately $30 per peak watt on the world market, the price has dropped dramatically to less than $5 per watt[1]. One major Hawaii solar supplier notes that its first module sold, in 1980, cost over $34 per watt; in 2005, modules were selling for $5.20 per watt. This industry-wide reduction in prices was the result of both increased demand, which led to an increase in manufacturing capacity, and improvements in cell and module manufacturing technology, and was further stimulated by rising oil and utility costs.



However, during the past several years this trend of declining module prices has flattened and reversed: module prices have actually increased since 2004, the result of supply constraints and accelerating demand. Several sources of data show

[1] U.S. Department of Energy, Energy Information Administration, 2005; www.eia.doe.gov/cneaf/solar.renewables/rea_issues/fig1s.html

the same reversal. A private industry analyst states that, "there is no doubt about the consistency of the upward price trend.[2]"

Modules are not only getting more expensive but also harder to obtain as unprecedented volumes are being sold. Demand is particularly high in Germany and Japan, where government incentives have resulted in burgeoning markets for photovoltaics. Module prices are not expected to decline during the next few years due to the serious shortage of product.

Although the production of photovoltaic cells has increased steadily during the past five years, new facilities are expected to be needed. Industry analysts, however, are not expecting that additional supply will immediately translate to lower module prices.

The industry is also concerned about the limited availability of semiconductor silicon, the material from which most solar cells are manufactured. An annual report for 2004 from one market analyst provides a world PV market forecast for 2005-06, and secondarily for 2007-2010. The report concludes that there is insufficient silicon feedstock to meet the planned cell manufacturing capacity announcements, restricting overall PV market growth[3].

Photovoltaic modules are a significant percentage of a system's installed cost. As long as module costs remain high, solar electricity prices may not drop significantly. Modules are typically between 30% and 60% of the total cost of a system, although the percentage can be even higher in some residential grid-tied systems. A study by Global Energy Partners for DBEDT estimates modules to be approximately 47% of the total installed cost of 5-megawatt (MW) central station PV systems[4].

Local Data on Photovoltaic Installed Costs

In Hawaii, the only photovoltaic program for which total installed costs and electrical output data are publicly available is Sun Power for Schools (SPS)[5]. Offered by Hawaiian Electric, Maui Electric, and Hawaii Electric Light Company and supported in part by voluntary donations from these utilities' customers, this program resulted in 14 installations of 1- and 2-kilowatt grid-tied PV systems on public schools on Oahu, Maui and the Big Island by the end of 2004, as well as some smaller solar-powered campus lighting projects.

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[2] Solarbuzz, Inc., 2005; www.solarbuzz.com/ModulePrices.htm

[3] Solarbuzz, Inc., 2006. "2004 World PV Market Highlights." www.solarbuzz.com

[4] Global Energy Concepts, July 2004; *Select Hawaii Renewable Energy Project Cost and Performance Estimates, 2004.* Prepared for: State of Hawaii Department of Business, Economic Development & Tourism, Energy Division.

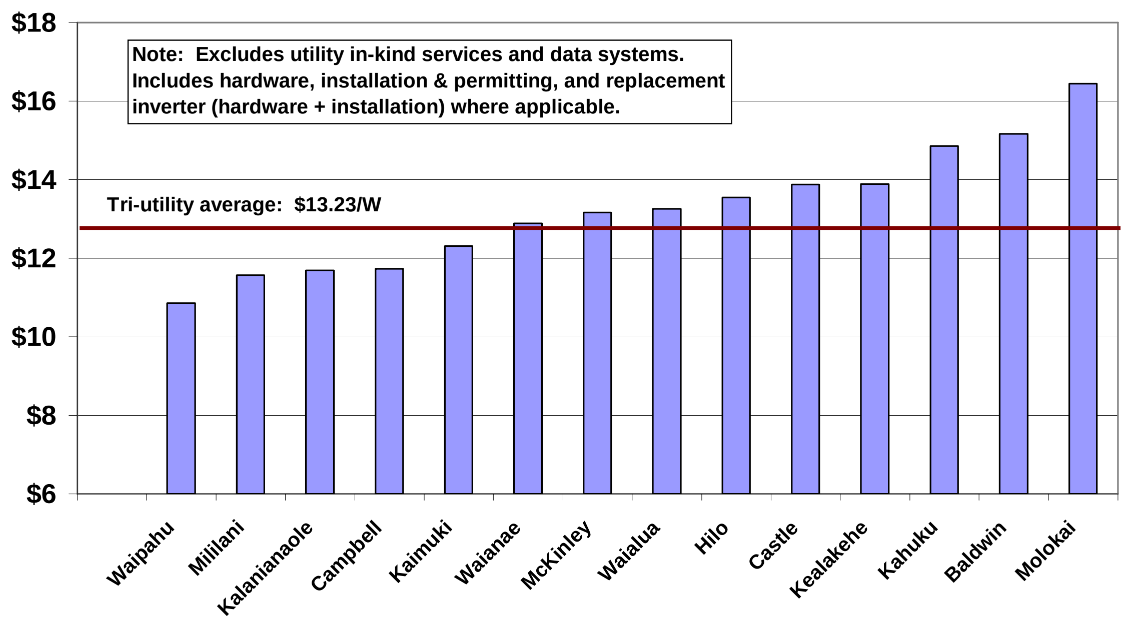
[5] Hawaiian Electric Company, Inc.; Hawaii Electric Light Company, Inc.; and Maui Electric Company, Limited; 2004. *Sun Power for Schools Status Report as of December 31, 2004.* Prepared for Hawaii Public Utilities Commission.

Being relatively small systems, the Sun Power for Schools installations do not benefit from any economies of scale. Further, the cost of in-kind services attributable to utility management of the program adds to the installed cost. Even when discounting the in-kind costs and the special expenses of data collection, the SPS systems are generally significantly more expensive than those installed on privately owned facilities by the commercial solar industry. The costs are also higher than the current average costs reported for PV installations elsewhere.

The tri-island average installed cost for the Sun Power for Schools 1- and 2-kilowatt PV systems is $13.23 per watt, when the utilities' in-kind services and data collection expenses are not included. Systems installed on Oahu averaged $12.72 per installed watt; those on the Big Island averaged $13.04 per installed watt; and those of Maui averaged $15.80 per installed watt.

When in-kind services, data collection and—in some cases—replacement costs for inverters are included, the total installed costs for Sun Power for Schools systems range from $20 to $33 per watt.

Sun Power for Schools PV Costs per Installed Watt
(1 kW & 2 kW Grid-tied Systems)



In contrast, over a dozen net-metered systems installed by a private sector PV design and installation company that were completed between 2001 and 2005 cost between $7.16 to $11.18 per installed watt, with an average cost of $9. These systems ranged in size from 1.7 kilowatts (kW) to 11.5 kW. One statewide supplier estimates an average 2- to 3-kilowatt residential system would cost around $10 per watt, installed. A recent proposal by a different company for a 400 kW system on a public school estimated an installed cost of $7 per watt.

National and International Data on Photovoltaic Prices

The national Photovoltaics Roadmap, prepared in 2004 by the U.S. photovoltaic industry to provide guidance and goals for the industry and policymakers, suggested that the best system selling cost nationally in 2003 was $6.10 per watt, based on the price of the ten lowest-cost commercial systems[6]. This included modules, inverters, the mounting system and electrical system, plus engineering and installation.

The same document cites the cost of solar-generated electricity from such an installation at $0.18 per kilowatt-hour. Calculation assumptions included the federal 10% investment tax credit, accelerated depreciation, a 7% real discount rate, and O&M costs per inverter manufacturers' recommendations over a 25-year life.

In states such as California, many photovoltaic systems have been installed under the aegis of various incentive programs. However, most of these systems have been installed too recently for a reliable trend to be computed. For instance, California has promoted its "Emerging Renewables Buydown Program," which provides rebates for grid-connected photovoltaics and other "emerging" technologies. Five years' worth of data on installed costs for PV systems are available, although most of the 2,000 systems were installed after 2001, making the study period even shorter. Median prices for small PV systems fluctuated between $9.50 and $10 per watt for the period of 1999 through 2003[7].

Under this program, it appears that economies of scale do apply: larger PV systems were somewhat less expensive. Installed costs ranged between $7 and $12 per peak watt for 1 kW systems, and between $6 and $9 per watt for 10 kW systems. For 2004, an industry analyst reported that average system prices in California were $9.54 per watt for systems smaller than 5 kW, and $7.34 per watt for systems 500 kW and larger.

The "Emerging Renewables" program is not the only California initiative which provides incentives for photovoltaics. A recent analysis of nearly 19,000 grid-connected PV systems in California, totaling 254 MW (AC), notes that the average pre-rebate total installed costs have declined substantially since 1998[8]. Much of the

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[6] Solar Energy Industries Association, September 2004; *Our Solar Power Future: The U.S. Photovoltaics Industry Roadmap Through 2030 and Beyond.*

[7] Trenschel, Dale; California Energy Commission. "Emerging Renewables Program: Workshop to Consider Changes to the Rebate Level, December 11, 2003." PowerPoint presentation online at www.energy.ca.gov/2005publications/CEC-999-2005-009/CEC-999-2005-009.pdf.

[8] Wiser, Ryan et al, January 2006*; Letting the Sun Shine on Solar Costs: An Empirical Investigation of Photovoltaic Cost Trends in California.* LBNL-59282, NREL/TP-620-39300. http://eetd.lbl.gov/EA/EMP.

overall cost reduction has come from improvements in installation and balance of system costs.

Also, the study confirmed that average system costs fall substantially for larger systems, providing economies of scale. Interestingly, the analysis also showed that systems installed in large new home developments and in affordable housing projects had lower costs of approximately $1.2 per watt (AC) on the average, compared to the general retrofit market.

New Jersey, which has an aggressive photovoltaic program, has increased its installed PV capacity from 9 kW in 2001 to over 4,000 kW in 2005, and installations are getting larger. A typical 10 kW system reportedly has installed costs around $7.75 per peak watt.

Calculations of photovoltaic-generated electricity costs in other states have not been published, but the U.S. Department of Energy's Energy Information Administration (EIA) gives a "current installed cost" of photovoltaic electricity at between $0.20 and $0.50 per kilowatt-hour[9]. No year or assumptions such as system size, O&M, or level of insolation are provided, nor is a geographic area specified. Preliminary work at Sandia National Laboratories suggests a benchmark of approximately $0.30 per kilowatt-hour for residential systems, based on photovoltaics actually installed in three mainland states.

Several sources provide information on photovoltaic electricity and module costs worldwide. One industry analyst charts the decline of photovoltaic electricity costs from $2 per kilowatt-hour in 1976 to approximately $0.21 in 2003[10]. The decline is not a smooth one, however; the cost per kilowatt-hour was halved during the first four years, reaching $1 per kilowatt-hour in 1980, and then followed a more gradual curve to approximately $0.25 in 1994. The system size is not specified. The curve during the last decade has been notably flatter. The cost per kilowatt-hour was linked to the volume, in megawatts, of modules shipped; as more modules are manufactured, the price drops.

According to another analyst, photovoltaic electricity worldwide since the summer of the year 2000 has been averaging between $0.39 and $0.41 per kilowatt-hour for residential systems. Commercial systems have been producing solar electricity for between $0.26 and $0.30 per kilowatt-hour, while industrial systems' electricity costs are between $0.20 and $0.22 per kilowatt-hour[11]. These values have been fairly flat in recent years, with a steady rise in 2005 reflecting the increased price of modules. Note that most systems installed worldwide are in Germany and Japan, countries which have lower average insolation than Hawaii, which makes the electricity generated from photovoltaics in those nations more expensive.

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[9] U.S. Department of Energy, Energy Information Administration. www.eia.doe.gov/cneaf/solar.renewables/rea_issues/fig1s.html
[10] Maycock, Paul. *PV News*. February, 2004; Vol. 23, No. 2
[11] Solarbuzz, Inc., 2005. www.solarbuzz.com

The major difference between residential, commercial and industrial systems is the size, that is, the generating capacity of the system. Industrial systems are the largest and residential the smallest. The lower average cost of industrial systems can be attributed to economies of scale.

Calculating Photovoltaic Electricity Prices for Hawaii

It is a straightforward matter to determine the cost per peak watt of a photovoltaic module, since module prices are reported by the industry. It is also fairly simple to determine the cost per watt of a system, as long as the system size (in peak watts of capacity) and the costs of hardware, installation, permitting, etc. are known: simply divide the total installed cost in dollars by the number of watts to determine the price per peak watt.

On the other hand, the calculation of photovoltaic electricity prices necessarily involves a number of assumptions, since no PV system for which cost and electricity production data are available has yet reached the end of its useful life. Among the information which is not yet documented is the cost of operations and maintenance (O&M) for the life of the system. In addition, the output of the system will vary according to a number of factors, including weather and climatic conditions as well as the system's state of repair and the rate of degradation of the photovoltaic cells themselves.

For the purposes of this analysis, certain assumptions were made to facilitate the calculation of electricity prices from installations in Hawaii. They are:

1) System life. Currently, photovoltaic modules carry 25-year warranties. Thus, 25 years was selected as the system life. It should be noted, however, that PV systems are expected to have useful lives well beyond 25 years and the longer the system life, the lower the cost of electricity from the system. No "salvage value" was assumed for the purpose of this report; that is, for purposes of simplicity, the value of the photovoltaic system is assumed to be zero at the end of its 25-year life.
2) Electricity output. The amount of sunlight falling on photovoltaics will obviously dictate the electrical output of the system. The insolation (incoming solar radiation) will be affected by daily and seasonal weather changes, longer term climatic changes, and such maintenance practices as washing the module surfaces. For the systems—i.e., the Sun Power for Schools installations—for which electrical output has been documented, actual data were used to calculate the annual average kilowatt-hours generated. For other systems, estimates provided by the National Renewable Energy Laboratory's interactive Clean Power Estimator were used according to the location (zip code) of the installations.
3) Operations and maintenance costs. O&M is the biggest unknown cost at this time and final calculations are heavily influenced by these costs. A

conservative assumption would be that the inverters would need to be replaced at the end of their 10-year extended warranty period, or twice during the assumed 25-year system life. Inverter replacement was assumed to be $1 per watt of capacity. Documenting actual O&M costs, which may be significantly lower than this assumption, would increase the accuracy of the calculated estimated electricity prices.

4) Cell degradation. Photovoltaic cells lose some efficiency over time. The amount of this degradation will vary with the type of semiconductor material used to manufacture the cells. For the purposes of this study, a 0.5% per year degradation in output was assumed. This figure has less of an impact on the final electricity price calculation than the above assumptions, however.
5) Utility-connected systems. All PV systems analyzed in this study are connected to the electric utility grid and do not include battery storage. Batteries and other balance-of-system equipment, including backup generators and the fuel they use, would increase the installed cost significantly and would also impact the O&M costs.
6) No financial incentives. Although tax credits and other incentives can significantly lower the final system cost to the consumer, they have not been included in the calculation. The method of payment, including interest rates, can also impact final costs; these also have been ignored for the purpose of this analysis.

The 14 SPS systems have the most complete data publicly available: total installed costs, including in-kind services, and kilowatt-hour per month output for each system. As noted above, however, the SPS systems had significantly higher installed costs than similarly sized, privately financed PV systems. Also, the SPS systems were only one- and two-kilowatts of peak capacity, a relatively small "residential" installation. Larger systems could exhibit economies of scale.

A range of estimated electricity prices was calculated for the SPS installations. At the most conservative end of the range, the O&M and cell degradation assumptions listed above were applied. At the other end of the range, it was assumed that there would be no O&M costs, although cell output would degrade.

The results of the calculations were:

Overall, Sun Power for Schools systems statewide are expected to produce electricity at between $0.34 and $0.57 per kilowatt-hour over their 25-year assumed life. The Oahu SPS installations will produce the least expensive electricity, ranging from $0.34 to $0.40 per kilowatt-hour depending on the assumptions above. The Maui SPS installations will produce the most expensive electricity between $0.51 and $0.57 per kilowatt-hour, while the Big Island SPS systems will produce electricity between $0.45 and $0.52 per kilowatt-hour.

Data from the Hawaii solar electric industry indicate that private-sector PV installations have lower installed costs per peak watt and thus can be expected to produce less expensive electricity than the Sun Power for Schools systems, given the same assumptions.

For example, for over a dozen net-metered photovoltaic systems ranging between 2 kilowatts and 11.5 kilowatts peak capacity, the cost per peak watt ranges from $7.16 to $11.18, with an average of $9, compared to the average for the SPS installations, which was $13.23. The cost of electricity for these net-metered systems, calculated using the Clean Power Estimator, ranges from $0.20 to $0.29 per kilowatt-hour if O&M costs are assumed to be zero, and from $0.26 to $0.36 per kilowatt-hour including O&M. It should be noted that the Clean Power Estimator estimates the annual energy output based on zip code, and in some cases the system capacity was required to be rounded up to the nearest whole kilowatt, which can result in lower calculated electricity costs. Nevertheless, the photovoltaic electricity produced by some of these net-metered systems appears to be competitive with current utility rates, even without financial incentives.

Similarly, several commercial and industrial sized systems for which actual kilowatt-hour generation has been documented show even lower electricity prices over an assumed 25-year life. These systems, which range from 20 kW to 250 kW peak, are generating solar electricity at $0.21 to $0.25 per kilowatt-hour, as calculated by the installer. Note that the assumptions behind this calculation may not match those listed above.

Forecasts of Photovoltaic Electricity Prices

Under contract to DBEDT, the consultant Global Energy Partners (GEP) calculated likely future photovoltaic electricity costs in several scenarios. GEP envisioned centralized, 5-MW PV plants located in North Kohala and the Pearl Harbor area, rather than distributed residential and commercial/industrial systems such as those outlined above.

GEP's analysis contained assumptions different from those used above. O&M ranged from 5% to 7.6% of capital costs over a presumed 30-year life. It was assumed that module costs would remain around 48% of total capital costs, including engineering, overhead and contingency. Module prices were assumed to be $2.60 per watt (AC) in 2004; this is significantly below prices for smaller installations. Further, module costs were expected to continue a modest decrease. Calculations excluded the costs of leasing land or upgrading transmission lines. The efficiency in AC output from the systems was assumed to increase from 10.5% to 15% by the year 2020. This takes into account expected improvements in balance of systems efficiencies.

Note that central station PVs are competing with utilities' avoided costs of production, rather than with retail residential electricity rates. The avoided costs on the island of Hawaii during the third quarter of 2005 were $0.17 per kilowatt-hour for electricity delivered during peak periods, and $0.14 per kilowatt-hour off peak. During the same period on Oahu, they were $0.12 per kilowatt-hour for on-peak electricity and $0.09 off peak.

The cost of electricity calculated by GEP for a 5 megawatt plant in North Kohala was $0.22 in 2004, dropping to $0.13 in 2020. For a similar PV installation at Pearl Harbor, the 2004 cost of electricity was $0.26 per kilowatt-hour, dropping to $0.15 by 2020. These calculations were based on the Technology Assessment Guide method promulgated by the Electric Power Research Institute.

Similar optimism regarding decreases in PV costs is exhibited by the EIA in its Annual Energy Outlook 2005 forecast. The capital cost of distributed generation installations is expected to drop by 13% every time the number of units shipped to the residential and commercial buildings sectors doubles; this reflects a "learning curve" of improved practices for the industry. Service life of the PV systems is assumed to be 30 years.

EIA reports the installed cost per watt for 2 kilowatt systems is expected to drop from the reported $9 in 2000 and the projected $8.20 in 2005 to $6.20 in 2010, $4.53 in 2015 and $3.18 in 2025.

For 25 kilowatt commercial systems, the same efficiency improvements and improved practices are assumed. The cost per watt in 2002 was reported as $6.50, and estimated as $6.00 in 2005. The cost is projected to drop from $4.75 per watt in 2010 to $3.78 in 2015, $3.18 in 2020 and $2.65 in 2025.

Some national industry analysts have concluded that installed PV system costs need to drop from today's approximately $8 to $10 per peak watt to $3 per peak watt to bring electricity costs from approximately $0.30 per kilowatt-hour to $0.10 per kilowatt-hour, or below[12]. The U.S. Department of Energy concurs, stating that, "In the longer term, it will take a combination of a wholesale system price below $3 per peak watt and larger volume dealers for PV to be cost-effective in the residential grid-connected market."[13]

If the EIA projections are accurate, this could happen nationally within the next ten to twenty years.

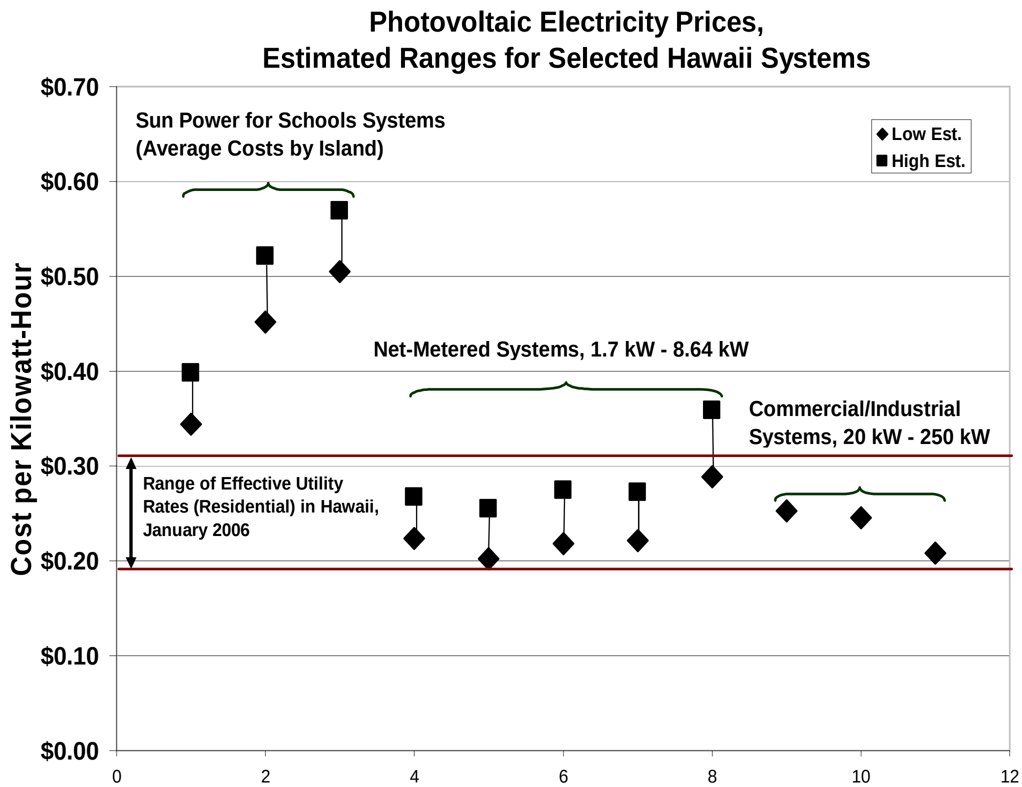
Solar Electricity Already Competitive in Hawaii

Projections aside, the U.S. Department of Energy, in one of its publications, asserts that photovoltaics are cost-effective in Hawaii today: if utility electricity rates

[12] Solarbuzz, Inc. www.Solarbuzz.com/StatsCosts.htm
[13] Holihan, Peter. "Technology, Manufacturing, and Market Trends in the U.S. and International Photovoltaics Industry." www.eia.doe.gov/cneaf/solar.renewables/rea_issues/solar.html

are $0.20 per kilowatt-hour, the breakeven PV price is given as $9.70 per watt[14]. Residential electricity rates are already above that level on all islands except Oahu, and the typical installed cost of a residential grid-tied PV system appear to be near or below the USDOE's breakeven point.

The previously-described analysis of installed costs for several private net-metered systems demonstrates that net-metered photovoltaic systems are already cost-effective in parts of Hawaii. As of January 1, 2006, effective residential utility rates ranged from $0.19 per kilowatt-hour on Oahu to $0.31 per kilowatt-hour on Molokai. The estimated cost of electricity for the residential-scale net-metered PV systems described above ranged between $0.20 and $0.36 per kilowatt-hour, depending on the assumptions, particularly O&M costs. In many parts of the state, therefore, photovoltaics can be considered to be cost-competitive today.



However, it is the nature of renewable energy systems, such as photovoltaics, to require significant up-front expenditures for equipment. Although these expenditures are balanced by "free" fuel costs, it is difficult for many residents and businesses to finance the installation. State incentives to accelerate the adoption of solar electric technologies will be very helpful in reducing this barrier, particularly on Oahu where rates are lower than they are on the other islands. Raising the ceiling for

[14] National Renewable Energy Laboratory, March 1997. "Customer-Sited Photovoltaics: Focusing on Markets that Really Shine. A Study Highlighting the Best Markets in the United States for Grid-Connected Photovoltaic Systems." Prepared for the U.S. Department of Energy.

photovoltaic tax credits will make this incentive more meaningful, given typical installation costs for both residential and commercial systems.

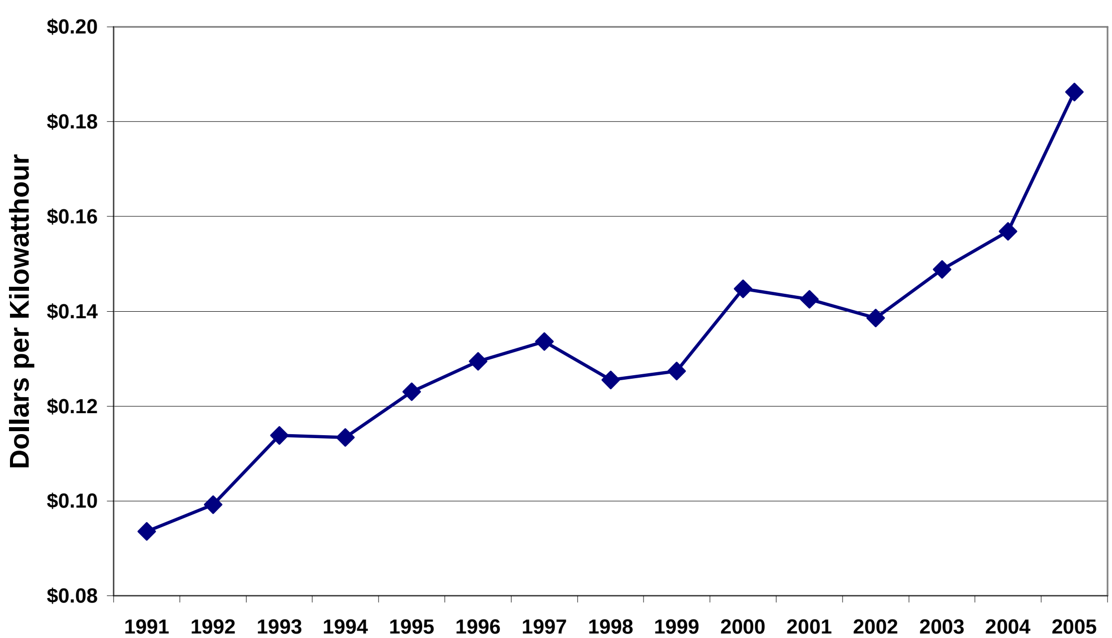
Hawaii's Utility Electricity Price Trends

The price paid by utility customers for electricity has been trending upward in Hawaii, as it has elsewhere. The rise in petroleum prices is a major contributor to the rise in electricity costs, since fuel cost adjustments are added to the rate set periodically by the Public Utilities Commission.

Residential customers on Oahu paid $0.09 per kilowatt-hour in 1991; that has risen to $0.19 as of January 1, 2006. Maui residential customers are paying an effective rate of $0.25. Customers on the islands of Hawaii and Kauai pay an effective rate of $0.29, while customers on Lanai and Molokai pay $0.30 and $0.31, respectively.

In the years between 1990 and 2004, Hawaiian Electric's average utility rates rose 67%, compared to the U.S. average rates which rose 15%. During the same period, the Consumer Price Index in Honolulu rose 38% and that of the U.S. as a whole rose 45%. It's clear that the cost of utility electricity in Hawaii is rising steeply.

Average Residential Electric Utility Rates on Oahu: 1991 to 2005



Neither DBEDT nor the Hawaiian Electric Company produces electricity rate forecasts. However, the upward trend is expected to continue, with both rates and fuel costs projected to increase in future years.

The EIA does produce petroleum price forecasts. However, the forecasts published in 2005 are not useful for this analysis since they are far below the actual world oil prices, which were approximately $60 per barrel in December 2005. Projections prepared for planning purposes—which are not to be considered formal forecasts—by the Hawaii Electric Light Company's Integrated Resource Planning Advisory Group anticipate that medium sulfur fuel oil used on the Big Island is expected to rise from slightly above $34 per barrel in 2004 to more than $105 per barrel in 2025. Diesel fuel used on the Big Island is expected to rise similarly, from more than $57 in 2004 to nearly $147 per barrel in 2025.

As long as Hawaii's utilities remain primarily dependent on petroleum-based fuels, their customers' electricity rates are expected to rise. As a non-renewable fuel which is seeing strong increases in demand worldwide, notably from developing countries, oil is expected to react to international market pressures by remaining high in price.

Fuel Costs for Electricity Generation in Hawaiian Islands: 1990 - 2004; and Projected, 2005 - 2025