The value of solar PV and PVBB systems to Hawaiian utilities

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Introduction -- There has been a recent rise in publications on “grid defection,” grid-tied PVs and on opinions that this would unfairly raise kWh-costs for non-PV rate-payers. Examples:

- "... grid defection raises social equity concerns. With widespread defection, utilities operating under legacy business models would be forced to significantly raise retail electricity prices to recover costs of grid infrastructure;"[1]
- "The middle class and poor are increasingly footing the bill for Hawaii Island’s electric grid when wealthier homeowners, businesses and government agencies opt out by installing photovoltaic systems, the county energy coordinator said”.[2] ...
- “The low-income population is really taking the hardest hit on this, Rolston said,"[2]
- "Utilities have complained that paying the retail rate, under a policy known as net metering, amounts to an unfair subsidy for customers that own solar panels at the expense of those who don’t. Meanwhile, solar advocates say the retail rate underestimates the value of solar panels to the grid and society."[3]

It is therefore refreshing news that some analysts have taken on the task of clarifying and quantifying the above contentions/concerns via analyses of the value of solar (VOS)[4,5] to the involved utilities. I had previously tried to find out whether the fixed “Customer Charge” or “Minimum Monthly Charge” (MMC, $20.50/month in Hawaii County) some of us PV-owners pay, would suffice to cover grid capital and maintenance costs (~$5/month would suffice), as well as prudent installation of on-site or grid-level PV-backup storage[6]. I assumed that the fixed generation costs would remain negligible as no-longer-needed plants would be closed. The very comprehensive analysis and methodology or ref.[4] does account for those fixed and variable utility generation costs. But it stopped short, in its one numerical example, of adding quantitative estimates for the (most likely) negative contributions to VOS due to "Added Voltage Control Cost" and "Added Solar Integration Cost," in Table (Fig.3, p.42[4]) on "VOS Levelized Calculation Chart," indicating that they may not be needed as long as the PV penetration is very low. In Hawaii and maybe in other locations like Germany, CA and AZ, that is no longer true.

Analysis -- So, I took a stab at estimating that missing info for “plain” PV systems as well as for PVBB (PV with on-site battery backup) systems, by adding appropriate columns to represent their VOS by assuming (see Table 1 below) that:

1. The original example in Fig.3 of ref.[4] did not consider battery back-up with the PV installations. I added two columns to represent PVBBs, which should feature a higher VOS to the utility
2. For “Added Voltage Control Cost,” the utility needs to add and invest in storage for plain PV systems as PV penetration grows, rather than wait until voltage control becomes difficult or unreliable. The assumed cost associated with each installed grid-storage kWh (storage + battery inverter/charger, etc) is 1000 $/kWh (incl. O&M). This battery is cycled at least once per day for 25 years so that the levelized cost is 1000/(25*365) = 0.1096 $/kWh, of which ≤60% needs to be stored for use after sunset (the other 40% PV output gets used on-site as it is generated). For on-site PVBBs no extra storage or voltage control cost is incurred by the utility. The LMFs are therefore 60 and 0% for PVs and PVBBs, respectively.
3. Similarly, the “Added Solar Integration Cost” is lower for PVBB than for PV installations, and taken as the $2500/kW now demanded by HELCO for new PV installations. The LMFs are therefore 100 and 10% for PVs and PVBBs, respectively. (However and in the interim, HELCO is also demanding that same fee for new PVBBs, because such new systems would reduce the sub-grid load and cause more energy “back-flow” in existing overloaded sub-grids caused by existing PVs without proper storage backup. Such backup should have been installed in proportion to PV growth, as it has been with some wind-farms.)

4. The Load Match Factors (LMF) for “Avoided Fuel-Oil Cost” (nat.gas:0.061) and “Avoided Plant O&M – Variable” are both 100%. Because utilities in Hawaii prevalently use fuel-oil to power over 90% of grid-tied generators, I updated its higher cost and doubled the 0.029 $/kWh CO_2 and NO_x emissions "cost" used for natural gas in Fig.3.
5. The added “Collected Minimum Monthly Charge” (MMC) line entry in Table 1 accounts for the presently levied MMC, not yet discriminating between PVs and PVBBs, which for an average 500 kWh/month household is worth 0.041 $/kWh. As shown, even with an LMF-PVBB of zero, the VOS of PVBBs would still be higher than the retail rate in Hawaii County.

The resulting VOS for PVs came out a bit lower than the retail rate in Honolulu County, but the VOS for PVBBs was higher (as expected) and even higher than the retail rate of around 42 ¢/kWh presently paid by ratepayers in Hawaii County (Big Island). More detailed and better-customized estimates for the “Gross Value” entries should be made to reflect the differences in population density (T&D costs), renewable PPAs (Power Purchase Agreements) and economies-of-scale between these two counties.

Table 1. VOS Estimate for Hawaii: Gross value, load match, loss savings and distributed PV value.*

	Gross Value × Load Match Factor x (1+Loss Savings Factor) = Distributed								Distributed
			LMF-PV	LMF-PVBB	LSF		PV Value		PVBB Value
25-Year Levelized Value	$/kWh	based on	%	%	%		$/kWh		$/kWh
Avoided F-Oil Cost (nat.gas:0.061)	0.2703	3$/gal, 33%	100	100	8	LSF-Energy	0.2919	V1	0.2919
Avoided Plant O&M - Fixed	0.0030		40	40	9	LSF-Energy	0.0013	V2	0.0013
Avoided Plant O&M - Variable	0.0010		100	100	8	LSF-Energy	0.0011	V3	0.0011
Avoided Generator Peaking Capital	0.0480	0.0457	40	90	9	LSF-ELCC	0.0209	V4	0.0471
Avoided Reserve Capacity Cost	0.0070		40	70	9	LSF-ELCC	0.0031	V5	0.0053
Avoided Transm. Capacity Cost	0.0038	33$/kWyear[4]	40	90	9	LSF-ELCC	0.0016	V6	0.0037
Avoided Distr. Capacity Cost	0.0200	200$/kW[4]	30	60	5	LSF-PLR	0.0063	V7	0.0126
Avoided Environmental Cost	0.0580		40	100	8	LSF-Energy	0.0251	V8	0.0626
Added Voltage Contr/Storage Cost	-0.1096	1000$/kWh	60	0	4	Added O&M	-0.0684	V9	0.0000
Added Solar Integration Cost	-0.0114	2500$/kW**	100	10	4	Added Cap.	-0.0119	V10	-0.0012
Collected Minimum Monthly Charge	0.0410	20.5$/mo.	100	100	0	Income	0.0410	V11	0.0410
				Total Value of Solar (VOS):			0.3120		0.4654
PLR = Peak Load Reduction; ELCC = Effective Load Carrying Capability									
* Table format adapted and expanded from ref.[4] "VOS calculation ...", Fig.3, p.42									
** Letters from HELCO, Sept 2013: Requirements in subgrid regions with high PV penetration									

Conclusions -- Table 1 leads to some concluding comments:
1. According to Table 1 below, non-PV ratepayers may have reason to complain that “plain” PV owners cause their rates to increase (because their PV-VOS is smaller than the retail tariff), but that may not be true for the case of PVBB owners, because their PVBB-VOS is larger than the local retail tariff.
2. The annual evaluation of VOS quantities is rather involved, but may not cause any more ratepayer costs than the present cost of preparing an annual IRP (Internal Resource Planning) report, which show on average home bills as 0.21 $/month, or 0.0004 $/kWh
3. It needs to be clarified whether and how a thorough VOS should include taxes and investor-dividend payments.
4. Many utilities charge on-grid PV and PVBB customers with NEM and FIT contracts a “Customer Charge” or “Minimum Monthly Charge”, when their bill is zero or negative. This charge should be deleted when switching from a NEM to a “VOS”-type FIT contract. The present MMC should be much lower for PVBBs than for plain PV systems.
5. Health care costs caused by emissions from fuel combustion, were estimated to be in the range of 14-35 ¢/kWh[7,8]. The ~44% utility share (and not the 50% transportation share[9]) of avoiding such emissions should be additional contributions to the VOS of PVs and PVBB, since they are much larger than the presently included “Environmental Costs” of 3 to 6 ¢/kWh, for natural gas-

and fuel-oil- powered generators, respectively, as they are being phased in and increased at a rate of ~4.3%/year[4].

My sincere thanks go to Minnesota's Legislature and Dept. of Commerce inspirational initiative and CleaPowerResearch's efforts, for the provided guidance to dig a bit deeper into the important VOS subject, which ultimately should help us grow renewable, sustainable and affordable energy supplies.

References

[1] Jules Kortenhorst, Lena Hansen and James Mandel (RMI), "Why the Potential for Grid Defection Matters," http://blog.rmi.org/blog_2014_03_11_why_the_potential_for_grid_defection_matters, Mar. 11, 2014

[2] Nancy Cook Lauer (West Hawaii Today, Kailua-Kona, HI, ncook-lauer@westhawaiitoday.com), "Electric rates rise for poor, middle class as affluent switch to solar," 5 Mar 2014 http://westhawaiitoday.com/news/local-news/electric-rates-rise-poor-middle-class-affluent-switch-solar

[3] Dan Haugen, "Minnesota becomes first state to set 'value of solar' tariff," MidWestEnergyNews blog on Mar 12, 2014, http://www.midwestenergynews.com/2014/03/12/minnesota-becomes-first-state-to-set-value-of-solar-tariff/

[4] Benjamin L. Norris et al (Clean Power Research, Kirkland, WA), "Minnesota Value of Solar: Methodology," https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7BEE336D18-74C3-4534-AC9F-0BA56F788EC4%7D&documentTitle=20141-96033-02, Jan 31, 2014
Contact: Lise Trudeau, Project Manager, 651-539-1861, lise.trudeau@state.mn.us, and
Brian Boler et al (Product Manager, brianb@cleanpower.com; 425.242.4174, Clean Power Research), "2014 Value of Solar at Austin Energy," Prepared for Austin Energy, October 21, 2013, http://www.cleanpower.com/wp-content/uploads/2014-VOS-at-Austin-Energy-Results-2013-10-21.pdf

[5] MN Dept. of Comm., "Value of solar tariff methodology," http://mn.gov/commerce/energy/topics/resources/energy-legislation-initiatives/value-of-solar-tariff-methodology%20.jsp

[6] U.Bonne (Keauhou, HI), "Arizona PUC decision to allow a $0.70/month/kW or about $5 monthly charge to PV owners," 19 Nov. 2013, http://alohafuels.pbworks.com/f/PB-13-MMC.pdf

[7] Justin Gerdes, "How much do health impacts from fossil fuel electricity cost the US economy?" 8 April 2013, http://www.forbes.com/sites/justingerdes/2013/04/08/how-much-do-health-impacts-from-fossil-fuel-lectricity-cost-the-u-s-economy/ A paper recently published by researchers at the Environmental Protection Agency finds that accounting for such costs would add an average of 14 to 35 cents per kilowatt-hour to the retail cost of electricity.

[8] Ben Machol and Sarah Rizk (EPA, 415 972 3142; rizk.sarah@epa.gov), " Economic value of U.S. fossil fuel electricity health impacts," Environment Internat'l. vol. 52, pp 75–80, (February 2013), web: March 2012, http://www.sciencedirect.com/science/article/pii/S0160412012000542. Abstract: Fossil fuel energy has several externalities not accounted for in the retail price, including associated adverse human health impacts, future costs from climate change, and other environmental damages. Here, we quantify the economic value of health impacts associated with PM2.5 and PM2.5 precursors (NOx and SO2) on a per kilowatt hour basis. We provide figures based on state electricity profiles, national averages and fossil fuel type. We find that the economic value of improved human health associated with avoiding emissions from fossil fuel electricity in the United States ranges from a low of $0.005–$0.013/kWh in California to a high of $0.41–$1.01/kWh in Maryland. When accounting for the adverse health impacts of imported electricity, the California figure increases to $0.03–$0.07/kWh. Nationally, the average economic value of health impacts associated with fossil fuel usage is $0.14–$0.35/kWh. For coal, oil, and natural gas, respectively, associated economic values of health impacts are $0.19–$0.45/kWh, $0.08–$0.19/kWh, and $0.01–$0.02/kWh. For coal and oil, these costs are larger than the typical retail price of electricity, demonstrating the magnitude of the externality. When the economic value of health impacts resulting from air emissions is considered, our analysis suggests that on average, U.S. consumers of electricity should be willing to pay $0.24–$0.45/kWh for alternatives such as energy efficiency investments or emission-free renewable sources that avoid fossil fuel combustion. The economic value of health impacts is approximately an order of magnitude larger than estimates of the social cost of carbon for fossil fuel electricity. In total, we estimate that the economic value of health impacts from fossil fuel electricity in the United States is $361.7–886.5 billion annually, representing 2.5–6.0% of the national GDP

[9] Jeremiah Johnson, D. Leistra, J. Opton-Himmel, & M. Smith et al (Yale U.), "Hawaii County Baseline Energy Analysis," Sponsored by the Kohala Center, Kamuela, Hawaii, May 10, 2006, rev. February 19, 2007, http://www.kohalacenter.org/pdf/hawaii_county_baseline_energ.pdf