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Clean Energy: Solar PV-with-battery storage for all?

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WHT reported Dec.6 on one of HELCO's community hearings, seeking inputs for their 2013 Integrated Resource Planning (IRP) – PUC Docket 2012-0036, on how to expand clean, renewable electricity and reduce $/kWh rates. This summary of a submission to PUC[1] suggests a HELCO business model based on many small, individual PV+battery back-up systems (PVBB) to realize:

- Electricity rates below 0.20 $/kWh, with proven technology,
- Uninterrupted power even during grid outages,
- Elimination of imports of oil or LNG for electricity,
- Preserving HELCO's transmission, metering, and billing infrastructure,
- Increased Hawaii economic activity, more jobs and sales,
- About same net State and County tax revenue despite PVBB subsidies, and
- Meeting State clean energy goals, while reducing air pollution cost effects[1] and obviate under-sea power-cable connections.

The Problem: As HELCO electricity rates increase, more and more households and businesses may join the folks who generate their own electricity on-grid or off-grid via PVBBs. There are reportedly over 200 applications for FIT (Feed-In Tariff) contracts waiting for approval by HELCO. In the past, HELCO has expressed little interest in on-site, distributed battery back-up to enable more distributed PV, while such back-up would reduce grid-load, and has demonstrated satisfactory operation in off-grid households for decades[2].

Large numbers of Net Energy Metering (NEM)- or FIT-PV contracts without on-site battery back-up are not economically nor technically viable for the utility. But NEM- and FIT-contracts become viable for both consumers and HELCO with on-site storage[1].

One Solution: PVBBs would not require new bio-mass, geothermal or power plants near anyone's back yard, but may enable HELCO to join contractors with financing (if needed), possibly owning, and/or installing distributed "HELCO" PVBBs on homes and businesses; would preserve its transmission (for excess PV power and for trickle-charging home batteries), distribution, metering, and billing infrastructure; and be a win-win for consumers, our economy, HELCO and government tax revenue. A shining example for businesses is the 250-kW-PV system, backed by 250-kWh of Li-battery storage, with a FIT contract, now supplying electricity to our West Hawaii Civic Center at ~0.20 $/kWh[1].

Primary PV back-up, (i.e. battery storage worth about 15-20 hours of average consumption[1]), would be located on-site and integrated with all newly-installed PVBBs. FIT or NEM contracts would feed surplus electricity to the grid as done today, although rate-independent NEM contracts would be preferred.

Analysis Conclusions – An analysis of installing PVBBs for all of the ~73,000 homes in Hawaii County looked at <u>30-year-levelized</u> cost benefits[1] for:

a. **Consumers:** Battery additions for PV systems raise their total cost, but provide uninterruptible power and are affordable now, i.e. on average may not cost more than SUVs or pick-up trucks. With total costs of 12.33 $/W(peak) before subsidies (incl. 4%/y interest for 10 years), the payback is 16.5 years, but ~8.3 years with present subsidies. Such a subsidized PV installation results in 30-year levelized rates of **16 ¢/kWh,** or **19 ¢/kWh** without the state subsidy, compared to a projected 30-year-levelized HELCO rate of 59 ¢/kWh, if rates escalate only 2%/year.

Without the Federal subsidy (which may expire in 2016), the 19-¢/kWh rate would rise to 27 ¢/kWh, but come down to **18 ¢/kWh**, incl. interest, if low installation costs (as in Germany[1]) were also achieved here, with support from high-volume pricing for 1000s.of PV installations, i.e. well below today's 6.7 $/W(peak) after subsidies.

b. Our Economy: The total imports for electricity generation (equipment plus fuel) for the County's ~73,000 households, over a 30-year period would presently drop by a factor of 3.7, from $5 to $1.4 billion, despite the initial ~10x higher import costs of PVBB hardware. Moreover, the money saved on oil and on reduced electricity rates, which frees up discretionary household money, would increase economic activity by the above factor times an "economic multiplier," which in turn depends on the fraction of those savings used on local vs. imported products and services, which we assumed to be 70%[1].

c. HELCO is now supplying some 500 kWh/month*73000*12 = 438 GWh/year to about 73,000 "average" homes, out of about 1100 GWh/year total sales. If PVBBs are installed in all those homes, HELCO would only need to deliver, on average, an estimated 2% or 8.8 GWh/year trickle-charge to those homes, saving about 40 million gallons/year of fuel, but losing electricity sales of ~430 GWh/year. However, HELCO would (1) Increase its income from the Minimum Monthly Charge (MMC, now $20/month) to over $17M/year, and (2) Derive additional income from sales of the excess free or discounted electricity from NEM and FIT contracts, respectively.

Clearly, grid loads would be starkly reduced, whether for trickle charging or for handling noon-time surplus power, as described in ref.[1].

d. State Tax Revenue: The 30-year levelized state and county tax revenue (~$18M/year for conventional generation hardware & oil imports, and electricity sales) may experience a possible "no change" or even a small increase, over the 30-year PV service life period, to ~$20M/year, after including the present <u>levelized</u> state PV subsidy (-$12M/year), thanks to an increase by $27M/year in tax revenue from the above increased economic activity.

Recommendations – Based on the above preliminary analysis results:

- **Hawaii County** should join hands with HELCO and solar contractors, to insure that no willing household and business is left behind, without a PVBB, for financial reasons.
- **Hawaii State** should emulate the low PV installation costs achieved in Germany, and harmonize the insurance and tax requirements of the more onerous FIT contracts with those now in place with NEM contracts[1].
- **HELCO** should expand its business model to finance and install distributed PVBBs on homes and businesses, jointly with contractors, whether retaining ownership or not.

References

[1] U.Bonne, http://alohafuels.pbworks.com/f/PB-12-HELCO-IRP-PUC-0036.pdf and http://alohafuels.pbworks.com/f/PB-12-HELCO-AKP-PUC-1.pdf, 6 Dec. 2012 and http://westhawaiitoday.com/sections/opinion/columns/clean-energy-solar-pv-battery-storage-all.html
[2] Jonathan R.Cole, "The Solar Option," http://www.lightontheearth.org

Comments:
Jan. 2, 2013, Jonathan Cole, Honokaa, HI, wrote:
In my view, we could save ourselves a lot of future grief and anxiety about energy costs and security, by helping our officials to proactively facilitate deployment of PVBB installations. For example, they could:

1. Prevent permitting and inspection delays for PVBBs of less than 10 kW. Allow PVBB installations without further inspections that have a licensed Hawaii Electrical Engineer's stamp of approval and are certified by the electrical contractor as being connected in accordance with the National Electrical Code. This still allows HELCO reasonable time to evaluate PV installations without battery backup and large PVBBs with little or no self-consumption (Independent Power Producers)
2. Streamline and secure Hawaii's solar rebate for low-income families and make rebates payable year-round upon presentation of installation invoices.
3. Harmonize the insurance and taxation of FIT to those of NEM contracts, i.e. there should be no extraordinary insurance requirements for PVBBs under 10 kW and any FIT payments or credits for PV-to-grid deliveries should be encouraged and be tax free.
4. More NEM contracts may be viable if associated with minimum on-site battery storage, i.e. for PVBB systems

Jan. 8, 2013, U. Bonne, Kailua-Kona, wrote:
Good points. I would add that:
The Hawaii State and County should encourage the Department of Commerce and Consumer Affairs to staff a PV-advisory office, which would list organizations, which are licensed to do so and able to provide assistance with installation of PV or PVBB systems to financially stressed households, and/or to impartially advise citizens on such matters. Mike, at the Hilo office of DCCA at 808-933-0910, told me that he presently knows of no such government activity, and that they now only handle complaints and prosecute law-breakers.

The Clean Energy Project Builder of Minnesota at http://thecleanenergybuilder.com/ lists all Minnesota clean energy businesses on a Google map, with addresses and specialties. I wish we had something like that in Hawaii. The SEIA (Solar Energy Industries Association, with headquarters in Washington, DC) website http://www.seia.org/state-solar-policy/hawaii only lists 7 (of over 30 listed in the Yellow Pages) solar businesses on the Big Island, and 76 state-wide

March 11, 2013, U. Bonne, wrote:
Sooner or later someone is going to ask about (1) The number of new jobs unlimited PVBB installations will create (2) How that will reduce their cost, and (3) How much larger would be the EOIR, i.e. the life-cycle Energy Output over the energy "Input" Ratio, i.e. input needed to mine, make and install PVs or PVBBs vs. such a ratio for conventional electricity generators:

(1) The solar Foundation (http://thesolarfoundation.org) on November 2, 2012 reports a 13% growth in US solar jobs, which brings its total to 119,000 employed by solar industry, according to the Annual National Solar Jobs Census, including PV, CSP, and WH.

The number of permanent, full-time jobs that a 50% PVBB penetration (i.e. to generate 50% of the present grid energy, despite the reduced grid-load because of self-consumption in those homes with PVBB on-site) for homes could sustain over a 25-30 year PVBB life cycle, for the Big Island might be as follows: Our ~200,000 residents live in 75,000 households. To sustain 50% of them with PVBBs, either new or replacement, requires 1500 PVBBs/year (4-kW PV + 15 hours of storage) at 10 person-days each for installation, or 60 full-time, permanent jobs. In addition, producing, marketing and shipping the 1500 PVBBs provides 1500*9 $/W-PVBB*4000 W *0.9 (production/total jobs)*(150 million US workers/ 15 T$ of GDP) = 485 jobs. Total jobs: 60 + 485 ≅ 500 jobs US-wide to sustain a 50% on-grid, PVBB generation. If we proportion those jobs needed to sustain PVBBs for the Big Island population of 200,000:

(A) To the 1.4 million people of Hawaii State, the total jobs created in Hawaii state-wide would be 1,000,000/200,000&60 = 7*60 = 420, or 7*500 = 3500 jobs created US-wide to sustain 50% PVBB penetration in HI-State; and

(B) To the total population of 300 million US-wide, and assuming that the average US household also consumes 500 kWh/month, thus needing the same ~4 kW(peak) of PV, the total number of jobs jumps to 0.75 million, which represents an about 7-fold increase over the present total solar jobs. Of course production and installation efficiency would bring that number down in time, at an annual percentage of 10-20%, which is also the range of expected PVBB price drops with time.

(2) The established "learning curve" effect has shown a drop product cost by 10-25% for every doubling in the produced product (not production rate). In 2012 we added about 53 MW(peak) PV generation in Hawaii (and probably ~ 7x less on the Big Island). This is commensurate with the rate of new or replacement installations per year for the Big Island, or 1500*4 kW(p) = 6 MW(peak) needed to sustain a 50% energy generation by PVBBs, which means that we are now on track to reach the 50% PVBB generation level in 25 years, because 6*25 = 150 MW(p) is about the present total island residential use of 47 MW out of the total average generation of 125 MW, which is equivalent to 43% of the total 1100 GWh generated per year. To accelerate deployment to reach 50% PVBBs in 13 years would require doubling the production and installation jobs. Assuming that we double the rate of annual PVBB installations, their price would come down 10 to 20% as it has done approximately in the US and in Germany, respectively, in the past few years.

(3) Such EOIR values were recently posted by a Stanford University team for electricity storag.** They came up with EOIR values of 240 for compressed air energy storage (CAES), 210 for pumped hydro, 10 for Li-ion batteries and 5 for lead-acid batteries. My estimates for:

- Li-ion battery (even assuming a 10,000 deep-cycle life and a cost 1000 $/kWh) is only **5.1**
- PV at 4 $/W(peak), 30-year service life and a capacity factor of 17% is **5.7**
- PVBB with a storage of 3 hours of peak PV output, is **3.2**, and
- Conventional oil- or LNG-fired generator of 2 $/W(average), of equal average energy output as the PV, but with an efficiency of generation and transmission of 30%, is **0.3**, weighted heavily by the fuel-energy consumed over its life-cycle

This means that PVBBs have a EOIR value (i.e. energy output / input ratio) that is over 10x larger than that of a fossil-fired power plant.

** Charles J. Barnhart, Sally M. Benson. "On the importance of reducing the energetic and material demands of electrical energy storage**,"** *Energy & Environmental Science*, 2013; DOI: 10.1039/C3EE24040A