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Comment Received From: Gene Nelson, Ph.D.
Submitted On: 1/18/2016
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"The folly of battery-backed power systems for residential or business use.

The supplied 11-page document provides clear evidence of the folly of utilizing systems such as the widely-promoted (mostly via earned media) Tesla Powerwall (R) Even using very generous assumptions, including the installation of an appropriately-sized rooftop solar installation, the payback period is substantially beyond the warranty period for the Powerwall. Thus, the user or business is likely to incur substantial operations and maintenance costs to operate the system to the point of economic payback, moving the payback period even further in the future.

California electric power system design and implementation should not be driven by slick press releases from Elon Musk's firm (and its peers,) despite their appeal to our emotions.

Instead, California power system design should rely on sound engineering principles and designs that have been refined during more than a century of operational experience. I seriously doubt anyone will queue up for a repeat of California's last experience with unreliable power circa 2000, when Enron Corporation manipulated California energy markets to cause system congestion, rolling blackouts, and billions of dollars lost from the California economy. A cornerstone of the California power system should be the continued reliance on safe, reasonably-priced emission-free nuclear power. California's largest electric power generator is Diablo Canyon Power Plant, which generates about 18,000 billion kilowatt-hours annually at a cost of about $.04 per kilowatt-hour. California state regulatory barriers should be removed for the plant's 20 year NRC license renewal. Additional nuclear power reactors are desperately needed in California.

Additional submitted attachment is included below.

Assembling reliable off grid power system for emergency preparedness

Rod Adams · January 17, 2016 · 8 Comments (and two supporting articles - GN)

http://atomicinsights.com/how-much-does-electricity-storage-cost-today/

Many advocates of unreliable power sources like wind and solar blithely toss out the concept of "storage" as the panacea that makes their favored energy sources viable competitors in the potentially lucrative business of supplying on demand power.

I'm skeptical because I have some experience with operating and budgeting for power systems that use batteries and emergency diesel generators to ensure reliable operation when there is a major power outage. However, my spreadsheets for that work were not my property. Even if they were, there have been several intervening years, so my numbers would be out of date.

Recently, however, I was privy to an email from an associate in California who is an Amateur Radio operator (ham) who takes his hobby seriously. Gene feels a personal responsibility to ensure that he can stay up on the air as an information relay during major disasters. In support of that strong sense of mission, he has invested in a system that ensures his radio will remain powered even if the grid is down for several days.

He gave me permission to share the email describing his system and possible alternatives. It does not offer a short, glib response to those who says that they will simply "store" excess wind or solar energy for use when those weather-dependent sources aren't available, but it sure puts some perspective on the challenges that must be overcome first.

Note: I edited the original email slightly for improved clarity.

By: Gene Nelson, Ph.D.

As an Amateur Radio operator (KE5HXX) who is an advocate for emergency preparedness in California, there is an advantage for disaster preparedness for those whose solar PV system includes energy storage. I own such a small-scale system in addition to owning a propane-powered 5 kW emergency backup generator. Solar PV systems with storage can supply emergency power, subject to the limitations of their storage systems. Unfortunately, the majority of residential and commercial solar PV systems in California lack any energy storage system for reasons of economy and reduced maintenance. These systems are constructed such that they will NOT produce power even when the sun shines if the the grid goes down, as would occur following a large-scale disaster. (See *How Rooftop Solar Homeowners Can Prepare for El Niño* from PG&E for details.) [See page 10 of 11, below.]

I would urge anyone who owns a rooftop solar PV system without energy storage to consider the purchase and installation of such an energy storage system and an automatic transfer switch if they have concerns about disaster preparedness. Current lead acid battery based

systems will require a concrete mounting pad, since the energy storage system has substantial weight of at least a ton and will cost several thousand dollars. The lead-acid batteries will need to be replaced every 5-7 years. Installation should be by a licensed electrical contractor. (The less-expensive approach would be to purchase an emergency backup generator powered by natural gas – with the additional-cost option of propane power as a backup.)

To obtain an understanding of the cost of a modern lithium-ion based energy storage system, consider the following.

Amazon carries Li-ion cells and charging systems. Here is an example set.

- Bundle: 4 Packs EASTSHINE E35 3500mAh 3.7V 12.9Wh Protected 18650 Rechargeable Li-ion Battery for $58.95 Sold by EASTSHINE and ships from Amazon Fulfillment. (Free shipping)

- Nitecore D2 Digicharger Bundle with Eastshine EB182 battery box and car charger: $19.00 Sold by EASTSHINE and ships from Amazon Fulfillment. (Free shipping when ordered with the above battery bundle.)

For a **12.5 kWh energy storage system, you would need 250 of the above sets using 12.5 Watt-hour batteries** for the battery and charger components of the system. (The pre-tax price of these 250 sets would be **$19,487.50** from Amazon) One should not scrimp and purchase a low-quality system, as lithium batteries have an unfortunate tendency to explode and burn if charged or discharged improperly.

According to the Wikipedia article about Lithium-ion batteries, the **Tesla Model S electric automobile requires 7,104 cells** rated at 11.965 Watt-Hour per cell. The list price for this Tesla Model S starts at $79,900.00 per with the 85 kWH battery, per the Wikipedia article about the Tesla Model S. **The battery cost is about 21-22% of the cost of the vehicle. The batteries are currently guaranteed for 8 years.**

The recent problem with the Boeing Dreamliner lithium-ion batteries was traced to wiring errors and a charging circuit that attempted to charge the batteries too quickly. The result were some fires and a grounding of the Dreamliner fleet during part of 2013 until the charging circuitry was redesigned.. See the Wikipedia article titled “Boeing 787 Dreamliner Battery Problems” for additional details.

This email provides documentation regarding the substantial purchase and maintenance costs of energy storage systems for low-duty-cycle generation technologies such as solar PV and wind. I invite your feedback.

Concluding thoughts

Though there is room for improvement in battery technology and there may be room for lowered costs with even larger scale manufacturing, the asymptote is not far away. Highly motivated engineers and scientists have been working on chemical storage batteries pretty steadily for more than a century. Lithium ion cells like those that Gene describes are already being manufactured in highly automated, mass production facilities to serve a market that is quite large and price conscious.

Lead-acid batteries have already achieved an even larger scale market in cars, trucks, and boats along with systems that have been installed to back up telephone networks and to provide uninterruptible power supplies to a wide variety of loads.

Another big challenge that a system using batteries to attempt to make wind and solar into reliable power supplies is that the batteries can only hold a finite amount of electricity. When they are depleted, they must be recharged. Blackout is the alternative. Consider what happens if the battery depletion arrives and there is still no wind or usable sunlight.

Finally, please consider our environment. The effects of extracting the materials required to increase battery capacity by several fold and the need to safely recycle or discard depleted materials after they are no longer capable of retaining a charge are not trivial or solved problems.

Hardy souls who are willing to tinker and cobble together a variety of power sources can go off-grid, but hooking wind and solar to storage is not a prescription for powering the population.

Categories: Alternative energy, Batteries, **Unreliables**

About Rod Adams

Atomic energy expert with small nuclear plant operating and design experience. Financial, strategic, and political analyst. Former submarine Engineer Officer. Founder, Adams Atomic Engines, Inc. Host and producer, The Atomic Show Podcast. Resume available here. Please subscribe to the Atomic Show RSS feed.

8 Responses to "Assembling reliable off grid power system for emergency preparedness"

1.  *Wayne SW* says:

   January 17, 2016 at 8:10 AM

   Also keep in mind that any battery storage system will have a limited number of deep charging cycles. That is probably the reason for the eight year lifetime of the Tesla S batteries. It is why you periodically have to replace your lead-acid car battery. The battery replacement cost often wipes out any gain you may have incurred from avoiding use of grid-based power, or gasoline in your automobile.

   Yet another reason why I don't understand why a lot of people are down on the grid-based power system we have today, a system that delivers a vital product (service) at reasonable cost, on-demand, with high reliability. I don't know what more you could ask for.

2.  *Engineer-Poet* says:

   January 17, 2016 at 9:36 AM

   It would probably resonate more with the public to substitute or add a calculation of the cost of the storage and inverter system using today's hot product, the Tesla Powerwall.

   o  *Rod Adams* says:

January 17, 2016 at 6:42 PM

As luck would have it, the IER recently performed a similar calculation based on the Powerwall. (See below)

http://instituteforenergyresearch.org/analysis/payback-on-teslas-powerwall-battery/

3. *Paul Wick* says:

January 17, 2016 at 11:43 AM

Excellent explanation of the extreme expense of reliable solar PV power, even in a niche application. However, within this calendar year, a new solar-thermal system for such micro-applications as homeowners, will be commercialized. What enables “something new” is the invention of a thermodynamically efficient and durable Rankine cycle steam piston engine. It overcomes the problems of turbines in micro-applications. Having studied this emerging technology for years, I am confident that by utilizing their reliable, new Thermal Storage Unit (using molten salt as the heat storage medium), as well as having an auxiliary burner that can utilize any liquid or vapor fuel without modification, it will provide a much better and cheaper solution to off-grid electricity needs than solar PV, including the inherent problem of… “nighttime”, clouds, snow, etc. See: http://cyclonepower.com/about-cyclone-power-technologies/solar/ (Of course, the engine can also run on synthetic fuels derived from nuclear heat, such as methanol and ammonia.) And of course, this is not a substitute for baseload electricity that nuclear power excels at.

4. *Dr. Gene Nelson* says:

January 17, 2016 at 4:58 PM

Thanks for publishing my email so that a large group could respond to it. In summary, to make intermittent sources such as solar and wind comparable to nuclear, there needs to be a large energy storage system powered by the intermittent source. For solar, with a typical capacity factor of 20%, the large energy storage system will produce on a 24/7 basis slightly less than 1/5 of the solar “nameplate” capacity. **That means that solar and wind are extremely expensive means to produce power compared to nuclear.**

One utility that has taken the first step is the Kauai Island Utility Cooperative http://website.kiuc.coop/ in Hawaii. The utility faces very high carbon-based energy costs as essentially all of that energy must be imported. Here’s their 09 September 2015 news release regarding the first dispatchable solar energy system – which includes energy storage.
http://kiuc.coopwebbuilder2.com/sites/kiuc/files/PDF/pr/pr2015-0909-solar.pdf
On 02 November 2015, the utility dedicated a second solar power system with a 6 Megawatt battery system to maintain grid stability when cloud cover interferes with power production.
http://kiuc.coopwebbuilder2.com/sites/kiuc/files/PDF/pr2015-1102-Anaholadedication.pdf

Thus, solar and wind only make sense in isolated locales that have either abundant sun or wind. The power produced actually has a high cost. Here’s the energy cost of the first project: “Under the 20-year power contract, KIUC will pay SolarCity 14.5 cents/kWh, less than the cost of

conventional generation in Hawaii, and slightly more than the cost of power from the co-op's other existing solar farms." http://www.utilitydive.com/news/hawaii-co-op-solarcity-ink-deal-for-dispatchable-power-from-solar-storage/405408/

Compare 14.5 cents/kWh for KIUC (a cooperative) with the roughly 4 cents/kWh for the 18,000 giga-watt-hours typically generated each year by the Diablo Canyon Power Plant (DCPP) for PG&E (a for-profit public utility.)

5. *Wayne SW* says:

January 18, 2016 at 5:47 AM

Maybe I'm just a simple-minded ex-physicist, but the thing I keep coming back to with any kind of storage system is that if you start drawing on the stored energy, in the event of absence of or limited resupply, eventually you deplete it. So it becomes a nervous balancing act between hoping your primary energy supply rate will keep your storage system "topped off" enough, at all times and under all conditions, so that you don't eventually end up with an empty tank because your depletion rate exceeds the recharge rate. You might say, well, you do that anyway, your coal plant needs a storage pile of coal, your car needs a tank full of gas, your reactor needs a fresh supply of fuel now and then. But the way things are now, you can go out and get those things when you need them. You can't go out and get more sunlight or wind if Mother Nature isn't providing them. It would seem undesirable to have a society waiting with collective baited breath, hoping and praying for adequate gusts of wind or a stretch of sunny days to replenish its supply of stored energy when the needle is touching on Empty. Better to have a reliable and sustainable supply of available fuel that is there when you need it.

o  *Rod Adams* says:

January 18, 2016 at 6:02 AM

@Wayne SW

You touched on one of the primary reasons I am so adamant about the need for reliable power and so focused on trying to help people pay attention to the limitations on batteries with which they should all be familiar.

Several times, I've been in a room packed full of people, all waiting with baited breath to hear the start of a diesel generator as a battery amp-hour meter ticked closer and closer to the rated limit of a large, multi-cell battery system. It's pretty nerve-wracking, especially when there are environmental conditions that restrict the ability to start the diesel. Fortunately for my own sanity and the safety of my shipmates, I also had the authority to halt the drill and restart the reactor.

▪ *Wayne SW* says:

January 18, 2016 at 8:53 AM

> Rod, yes, I was pretty sure you'd appreciate the concern for limited storage capability. When those batts are ticking down to zero, you have no ability to get the ED air to combust the diesel fuel, and the reactor is shutdown, you're looking at a pretty grim situation. Same deal with civilian electric supply that has gone all-in on unreliables. They've thrown away their reactors, can't use fossil fuels, and the sun isn't shining or the wind isn't blowing in the middle of a sub-zero winter in any Northern or Midwestern state and people are huddled in their rapidly-chilling homes while their vaunted storage systems drain away to zero output. Maybe their last thoughts will be, gee, if we'd only kept the grid with all those reliable reactors.

IER INSTITUTE FOR ENERGY RESEARCH

How Long Does It Take to Pay Off a Tesla Powerwall?

January 5, 2016

One of the biggest problems with electricity from solar and wind power is that these sources of electricity are not reliable because of their intermittent nature. We rely on having electricity when we require its use—24/7. Anyone familiar with the third world or even developing countries knows that unreliable forms of energy are a huge impediment to modern living standards and quality of life. One suggestion to make these intermittent sources more reliable is to use batteries to store electricity when the intermittent sources are producing electricity and then use the electricity when the sun goes down or the wind stops. The issue has always been that the battery back-up is expensive, particularly with regard to the scale of the grid or cost of batteries for home use. Tesla claims that they have overcome much of these problems with its Powerwall battery.

Powerwall is a daily use battery that is produced and marketed by Tesla to provide power to homes or businesses for part of the day, off-setting some electricity costs.[i] The issue that remains is the cost. How much does Powerwall cost initially, how much does it cost to operate, how much electricity will be offset, and how many years will it take to pay back the initial capital and installation costs? These costs must be considered in order to fairly compare our current electrical system to those that government policies are promoting through their push for renewable sources of energy. This article provides answers to those questions and a tool to estimate the payback period based on local electricity costs.

Powerwall Cost and Operation

Buying a Powerwall and inverter, as well as having it installed is estimated to cost $7,340 by SolarCity[ii] (like Tesla, Elon Musk is the CEO of SolarCity). The daily use Powerwall for homes is rated at 7 kilowatt hours,[1] with round trip battery efficiency estimated at 92 percent, and inverter efficiency estimated at 95 percent. About 7.5 kilowatt hours is needed to charge the Powerwall, providing about 6.5 kilowatt hours of power once charged.

With some utilities, consumers can choose between flat-rate electricity pricing (the price is the same no matter the time or day or demand on the electricity grid) and peak-rate pricing. With peak-rate pricing, electricity rates are low during off-peak hours and higher during peak hours.

To make optimal use of Powerwall, it should be charged using lower cost off-peak electricity, then operated when peak rates are in effect. If the home or business has solar panels or wants to invest in them, Powerwall can be charged with the solar power during the day, then used to power the home in the evening, night and/or morning.

As an example, assume peak rates at $0.15 per kilowatt hour and off-peak rates at $0.06 per kilowatt hour. At the off-peak rate, it would cost $0.45 to charge the Powerwall each night. Operating the Powerwall for 6.5 kilowatt hours the next day, saves $0.98 of electricity charges**. Factoring in the charging costs, saves $0.53 a day of electricity costs, or $193 a year, requiring a payback period of 38 years, which is almost 4 times the warranty period of 10 years for the Powerwall.**

If solar power was used to charge the Powerwall, it would save the charging fee of $0.45 a day, making the Powerwall savings each year $358**. Factoring in the installed solar panel cost of $3,570[2] for a 1.5 kilowatt system[iii], makes the payback period 31 years, still 3 times the warranty period.**

According to a 2012 study, the Federal Energy Regulatory Commission found that only 1 percent of U.S. residences have off-peak vs. on-peak electricity rates.[iv] **If a U.S. household has a single electricity rate at say $0.12 cents per kilowatt hour, it will cost more to charge the Powerwall than it provides in electricity**. In this example, it will cost the household $0.12 more a day ($44 a year) to use Powerwall than if the household purchased all its electricity directly from its utility company. In other words, the Powerwall must be charged at a low electricity rate or by a solar panel system, in order to make Powerwall economic. And, even then, the payback period for U.S. electric utility rates would be much greater than the Powerwall warranty period.

The tool below allows the user two options for determining the payback period for using Powerwall to offset electricity rates—either charging Powerwall using off-peak rates or via a solar system. Both options require the installed cost of Powerwall. The user needs to select the option, then either input the off-peak and on-peak electricity rates, or the installed cost of the solar system and the on-peak utility rate. The tool will then provide the user with the payback period. Please note that the tool does not work for a single utility rate because, as noted above, it would cost more to charge Powerwall than to purchase power from the local electric utility.

With the Obama Administration pushing policies to convert more of our electricity to intermittent renewable sources like wind and solar, it is important that the public understands the costs and tradeoffs from our current system, which in most people's minds, works well across a wide range of demands and uses. This blog answers some of the questions of the mysteries of energy storage and serves as a tool for consumers to judge the government's experiment and the costs that may be hidden by the hype promoted by those involved in providing "fixes" to the use of intermittent renewable energy in place of our normal, on-demand, reliable electrical system.

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[1] There is a 10 kilowatt hour model for businesses to use instead of a backup generator. The cost to installers is $3,000 or $3,500 for the 7 and 10 kilowatt hour Powerwall, respectively.

[2] The $3,570 is for a 1.5 kilowatt installed system **after government rebates**. The cost can range between $2,000 and $6,000, depending on the quality and longevity of the system.

[i] Gizmodo, Tesla Powerwall: A Battery for Your Home, May 1, 2015, http://www.gizmodo.com.au/2015/05/tesla-powerwall-a-battery-for-your-home/

[ii] Lifehacker, Tesla's Powerwall: Crunching the Numbers for Australia, May 25, 2015, http://www.lifehacker.com.au/2015/05/tesla-powerwall-crunching-the-numbers-for-an-australian-suburban-home/

[iii] Solar Choice, 1.5 kilowatt solar system: Pricing, outputs and returns, October 18, 2012, http://www.solarchoice.net.au/blog/1-5kw-solar-system-pricing-outputs-and-returns/

[iv] Friedman, Consumer-Friendly and Environmentally-Sound Electricity Rates for the Twenty-First Century, March 1, 2012, https://gspp.berkeley.edu/assets/uploads/research/pdf/Friedman_HOOP_retail_electricity_pricing_1.1.pdf

TAGS battery, electric grid, electricity, Powerwall, renewable energy, tesla

http://instituteforenergyresearch.org/about/

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DECEMBER 24, 2015

http://www.pgecurrents.com/2015/12/14/how-rooftop-solar-homeowners-can-prepare-for-el-nino/

PG&E PERSPECTIVES

By Tim Fitzpatrick
Chief Communications Officer

December 14, 2015

How Rooftop Solar Homeowners Can Prepare for El Niño

We've shared a lot about what to do to protect you and your loved ones during El Niño weather this winter. But what do you do if you're one of our 200,000 solar customers and you're worried about protecting your rooftop panels during high wind, hail and heavy rain?

Rooftop solar panels are designed and installed to withstand strong weather conditions but it's important to ensure your home is as energy efficient as possible.

This wasn't a relevant concern 20 years ago, but a lot has changed since the last strong El Niño barreled through California in 1997. That year, PG&E had eight rooftop solar customers connected to the electric grid. We now have more than 200,000 solar customers and expect to have 600,000 solar customers connected to the grid by 2025.

For their first El Niño, the majority of PG&E's rooftop solar customers — myself included — may be wondering what to do before, during and after the storm season to protect their solar panels. PG&E has outlined best practices for rooftop solar homeowners to ensure their panels are protected this winter season.

First off, don't worry! Rooftop solar panels are designed and installed to withstand strong weather conditions. But keep in mind that a robust El Niño could mean a general reduction in solar irradiance — how much solar energy your panels are generating — by about 20 to

50 percent compared to last winter. This means it's important to ensure your house is as energy efficient as possible ahead of the storm season.

Before the storm

- Review your rooftop solar contract to determine what is covered for maintenance and call your installer with any questions ahead of time.
- Confirm your installer's emergency telephone number in case you need it.
- If you suspect any issues with your roof (such as leaks or weak spots), have a roofer come out prior to El Niño weather. They'll be busy after the storms, so anticipating any problems could save money (and stress) in the long run.

During the storm

- **If there is an outage, solar systems shut down automatically for safety reasons. When PG&E restores power, your rooftop solar system should re-engage automatically**.
- Know that there is no risk related to lightning when it comes to your solar panels during a storm.

After the storm

- Check your panels. Is there any debris or leaves on the panels? If so, be sure to have a professional clean them off to ensure that your panels are performing at their best and to prevent possible damage.
- Check your panels' solar production after the storm is over. If production is extremely low or zero during the next reasonably sunny day, it's possible that the wiring for your solar panels could have been damaged. If this happens, contact your installer and request a service call.

PG&E's meteorologists help forecast when storms will be most severe and potentially lead to outages, which is an important part how we plan, prepare and respond to natural disasters and emergencies, including winter storms.

Whether you're a solar customer or not, PG&E offers many tips on getting ready for storms or other natural disasters at www.pge.com/beprepared.

Tim Fitzpatrick is PG&E's vice president of corporate relations and chief communications officer. Follow Tim on Twitter @PGE_Tim.