Environment

Thomas N. Russo

Challenges to Improving Energy Security Abound: Part 2

In Part 1[1] of this column, the author discussed the reasons why communities should rely on smaller decentralized electric grids and microgrids to attain energy security and make trade-offs between the four As of energy security[2,3] and the model of short-term energy security.[4] The major reasons for taking such a position are:

- high-level policy objectives appear to be out-of-touch with many stakeholders and communities who oppose very large renewable energy projects sited in their communities, and on federal lands and waters; and
- the reality on the ground is that duplicative federal and state environmental assessments, conflicts, opposition, and legal challenges will work to stifle any significant investment in renewable energy and energy transmission projects on federal lands and waters.

In a broader sense, this means relying on acceptable and smaller projects that locally produce energy to satisfy a community's needs for electricity and fuel. Smaller decentralized electric grids and microgrids can mitigate the risks of not attaining high-level clean energy goals in a timely manner. However, like all risk management strategies, it will not eliminate those risks entirely.

The concept of relying more heavily on locally produced energy has roots in the local foods movement, which began in the 1970s. The program advocates producing and consuming food locally (farm-to-market). The benefits of such an approach are better nutrition, and reduced energy use and costs and greenhouse gas (GHG) emissions.[5] This same construct can be applied to locally produced and consumed energy (LPCE). In other words, a community can minimize its

[1] Russo, T. N. (2022). Challenges to improving energy security abound: Part 1. *Climate and Energy.* 38: 16-21. https://doi.org/10.1002/gas.22272

[2] Cherp, A., & Jewell, J. (2014, December). The concept of energy security: Beyond the four As. *Energy Policy, 75,* 415-421. https://bit.ly/3saqmnV

[3] APERC [Asia Pacific Energy Research Centre]. (2007). *Quest for energy security in the 21st century: Resources and constraints. APERC.* https://bit.ly/31ORgXt

[4] Jewell, J. (2011, January). The IEA model of short-term energy security (MOSES): Primary energy sources and secondary fuels (No. 2011/17). *IEA Energy Papers.* https://bit.ly/3otAANp

[5] Janzer, C. (2018, June 22). The history of the farm to table movement. *Upserve.* https://bit.ly/3std0kS

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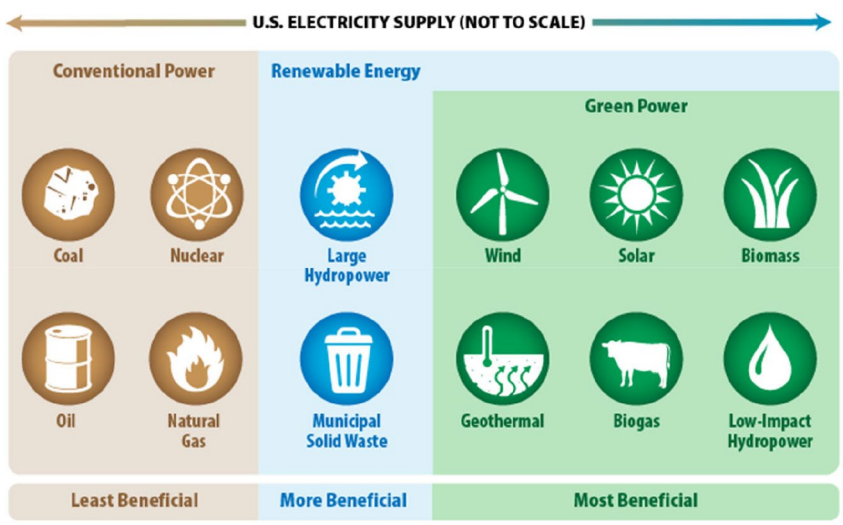
Figure 1. Different Types of Energy Resources Based on Their Environmental Benefits



Source: US Environmental Protection Agency.

energy security risks when it consumes less energy that must be transported to consumers over a long distance via high-voltage transmission lines from remotely located central generation or solar and wind.

The focus of an LPCE program is to eliminate the need to import energy over long distances to a community and to maximize the use of green power.

As discussed in this column, the idea of LPCE is not just limited to electric power. An LPCE program is much more than a microgrid. This author envisions an LPCE program to be as large as necessary to meet the needs of a city or county or group of cities and counties whose mutual goal is to maximize the production and consumption of energy within the community. The focus of an LPCE program is to eliminate the need to import energy over long distances to a community and to maximize the use of green power (**Figure 1**).[6] An LPCE program expands on the definition of a traditional microgrid well beyond electrification. This is because electrification of some sectors, like heavy industry and heating, may not be economically feasible, efficient, or acceptable and could limit a community's overall energy security goals. The program can also use combined heat and power (CHP), renewable natural gas (RNG),[7] hydrogen-enriched natural gas,[8] and responsibly sourced gas (RSG) to serve the energy requirements of the community for transportation, heating and cooling, and power needs.

[6] United States Environmental Protection Agency. (2017, January 19). *What is green power?* EPA. https://bit.ly/3L8G1uO

[7] Russo, T. N. (2020). Regulatory challenges facing renewable natural gas. *Natural Gas & Electricity.* 36: 25-32. https://doi.org/10.1002/gas.22172

[8] Russo, T. N. (2020). Hydrogen: Hype or a glide path to decarbonizing natural gas – part 2. *Climate and Energy,* 37: 24-32. https://doi.org/10.1002/gas.22187

A key benefit of an LPCE program is that local communities will have a greater say and control of how they resolve conflicts between the four As of energy security—availability, accessibility, affordability, and acceptability. Secondary benefits include communities not being subject to the risks discussed in Part 1 of this paper, such as relying on the timely construction of large generation from wind, solar, and clean transmission projects.

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Since the power density of solar is much lower compared to base load conventional power generating plants, such as nuclear, coal, and natural gas-fired power plants, an LPCE program would need to deploy solar power beyond traditional rooftop applications. By doing the latter, an LPCE program would create a larger market for solar, thereby driving down costs. For example, instead of relying only on solar rooftops, it would encompass solar roof shingles and expand the concept of solar building sidings. An LPCE could include the deployment of mobile rooftops on school buses and city fleets, and the installation of solar panels on sidewalks, roads, and bus stops, among other sites. Battery storage adoption at the residential level would be a key element of an LPCE program. These new mobile solar platforms and battery storage would have to be connected to a distribution system to benefit the community. The remainder of this column will discuss several technologies and ideas that could be part of a community's LPCE program.

SOLAR PANELS AND SOLAR ROOFS

During the third quarter of 2021, the United States installed 5.4 gigawatts direct current (GW_{dc}) of solar photovoltaic (PV) capacity to reach 113.5 GW_{dc} of total installed capacity, enough to power 21.8 million American homes.[9] Residential solar installations exceeded 1 GW_{dc} with more than 130,000 systems in a single quarter for the first time in the industry's history, while utility-scale solar installations set another third-quarter record at 3.8 GW_{dc}.

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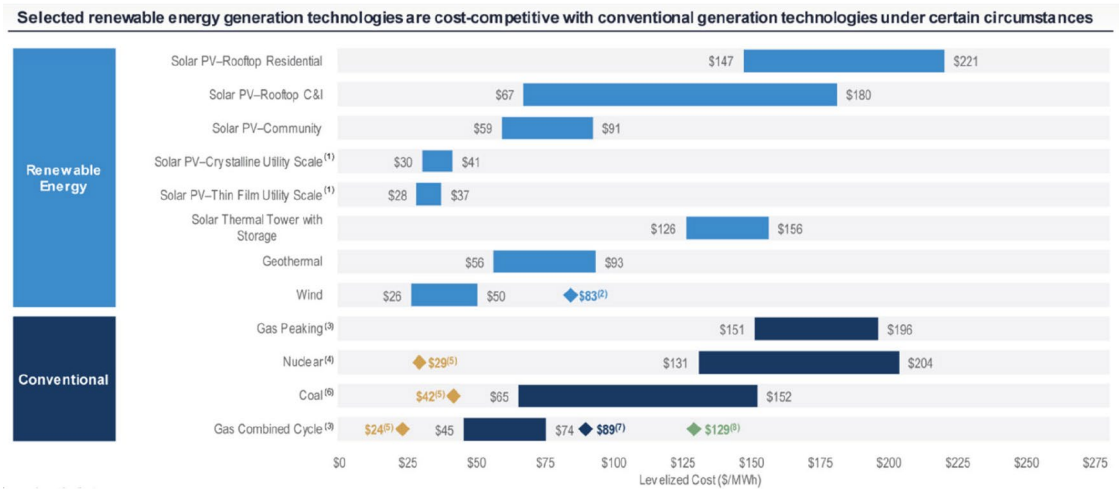
Most of the solar panel installations have been stationary and horizontal or panels angled to face the sun. There are also solar tracking systems that move with the sun to maximize power generation. Recent research found that most of the panels facing south maximize power generation. However, a Pecan Research Institute study cited by *Forbes* concluded that there were significant benefits to installing solar panels facing west.[10] The study indicated that west-facing PV solar systems help to reduce peak load, put less strain on electricity distribution systems, and may have more value to the grid than south-facing systems, despite producing less total energy over the course of a year.

Here in the United States, the majority of the states have net metering programs

[9] Solar Energy Industry Association. (2021, December 14). U.S. solar market insight. *SEIA.* https://bit.ly/3gnAFO8

[10] Konrad, T., (2013, November 22). Your solar panels aren't facing the wrong way. *Forbes.* https://bit.ly/3Gr3yU9

Figure 2. Different Levelized Cost of Energy Comparison Before Federal and State Subsidies



Source: *Levelized Cost Of Energy, Levelized Cost Of Storage, and Levelized Cost Of Hydrogen. (2021, October 28). Lazard.* https://bit.ly/34dmmJK

currently in place. Net metering programs allow homeowners who install solar panels on their roof to sell excess power back to their electric utility, with some utilities buying power back at retail rates and some at avoided cost rates.

West-facing solar panels make more economic sense for owners living in California and western states, especially if their net metering plans are based on time-of-use (TOU) pricing. TOU pricing pays homeowners more for solar energy produced during times of peak energy use. California officials are already positioned solidly behind the theory that the arrays are most beneficial to everyone involved when they face the Pacific Ocean since the power grid needs more peak energy during the late afternoon.[11]

Solar panels, roofs, and storage powerwalls are relatively expensive compared to utility-scale solar PV projects (**Figure 2**). The levelized costs of community-based solar PV range between $59 per megawatt-hour (MWh) and $91/MWh without federal and state subsidies.[12] The costs of a rooftop solar PV installation for commercial and industrial buildings and homes is two and three times higher before tax credits are factored in.

This author believes that community LPCE programs can drive down the costs of solar panels, solar roofs, and associated powerwalls by aggregating their purchasing power. The programs can pass on these savings to single and multifamily homeowners and renters to encourage increased PV solar panel installations.

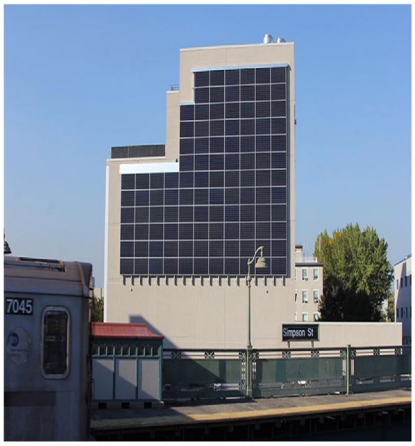
VERTICALLY INSTALLED SOLAR PANELS

Vertical installations of solar panels on commercial and industrial buildings are fewer in number. However, there is nothing that prevents a building owner from installing vertical panel systems. The costs of installation will include scaffolding and be higher than

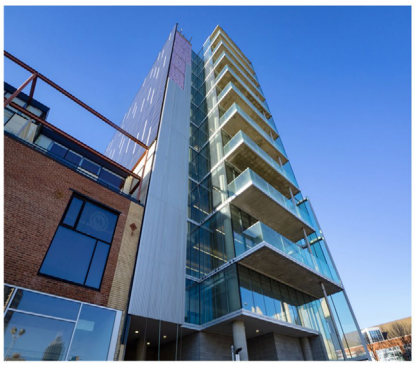
[11] Trabish, H. K., (2014, October 13). How California is incentivizing solar to solve the duck curve. *Utility Dive.* https://bit.ly/3sqqdLn

[12] The US Department of Energy defines *community solar* as any solar project or purchasing program, within a geographic area, in which the benefits of a solar project flow to multiple customers such as individuals, businesses, nonprofits, and other groups.

Figure 3. Examples of Buildings with Vertical Solar Panels



Source: New York City, Quixotic Systems



The solar wall of the Edge Building in Edmonton, Canada, image by Forum contributor Daveography

Installation of vertical solar panels. India's largest BIPV system in Mumbai — Photo credit: U-Sola

installing horizontal panels on a roof, but the costs associated with cleaning the panels may be lower. Vertical solar panels produce more energy in the winter months as the sun is lower in the sky.[13] However, during the summer months, when the sun is high in the sky, vertical panel placements begin to impact power production. Vertical solar panel installation is viable when space on a roof is limited, and a building has a south- or west-facing wall available to maximize power production (**Figure 3).**

Scientists at Rensselaer Polytechnic Institute demonstrated the potential of wedge-shaped luminescent solar concentrators (LSCs). These efficient modular solar units could easily be hung on the side of a building. The LSCs considered in this study are made of transparent plastic with a film of photoluminescent particles on the back, similar to those used in light-emitting devices (LEDs). Solar cells mounted on the larger edge of the LSC convert energy captured from the sun into electric power. The way these devices capture and concentrate sunlight enhances the power that is produced by each unit of surface area within a solar cell.

[13] Osman, N. (2015, February 5). *Best angle for solar panels.* Understand Solar. Retrieved from https://bit.ly/3LbrnTy

Table 1. Facts on Vehicle-to-Grid Integration

- 95 percent of the time, light-duty passenger cars sit in parking spots
- 58 percent of the time, long-haul trucks sit in trucking depots
- Most school buses are only in use twice a day and otherwise are charging

The researchers also used light data from the field to help predict annual energy production if the LSCs were to be hung on walls. Based on data from Albany, New York, and Phoenix, Arizona, the annual energy production predicted for these devices was up to 40 percent more than the annual energy produced by solar panels when both are installed vertically.[14] These efficient modular solar units could easily be hung on the side of a building.

If city bus and service vehicle fleets were electrified, they could not only displace gasoline and diesel fuel but could also store electricity for later use to the distribution system to serve local peak loads.

Tesla offers both solar panels and solar roof systems to the public. The company has installed more than 3.6 GW of solar energy across 400,000 roofs—the equivalent of 10 million traditional solar panels—since offering the product. The company has also expanded installation across the entire United States. Consumers can opt for a 13.5 kilowatt-hour (kWh) powerwall to store power.

VEHICLE-TO-GRID INTEGRATION

LPCE programs should also be leveraging vehicle-to-grid integration and mobile-rooftop solar panel installations. As shown in **Table 1**, passenger cars, long-haul trucks, and school buses just sit idle in parking lots making them ideal platforms for solar power generation.

If city bus and service vehicle fleets were electrified, they could not only displace gasoline and diesel fuel but could also store electricity for later use to the distribution system to serve local peak loads. This in turn would reduce loads on the power grid during emergencies **(Figure 4).**

EXPANDING THE FOOTPRINT AND SCOPE OF A MICROGRID

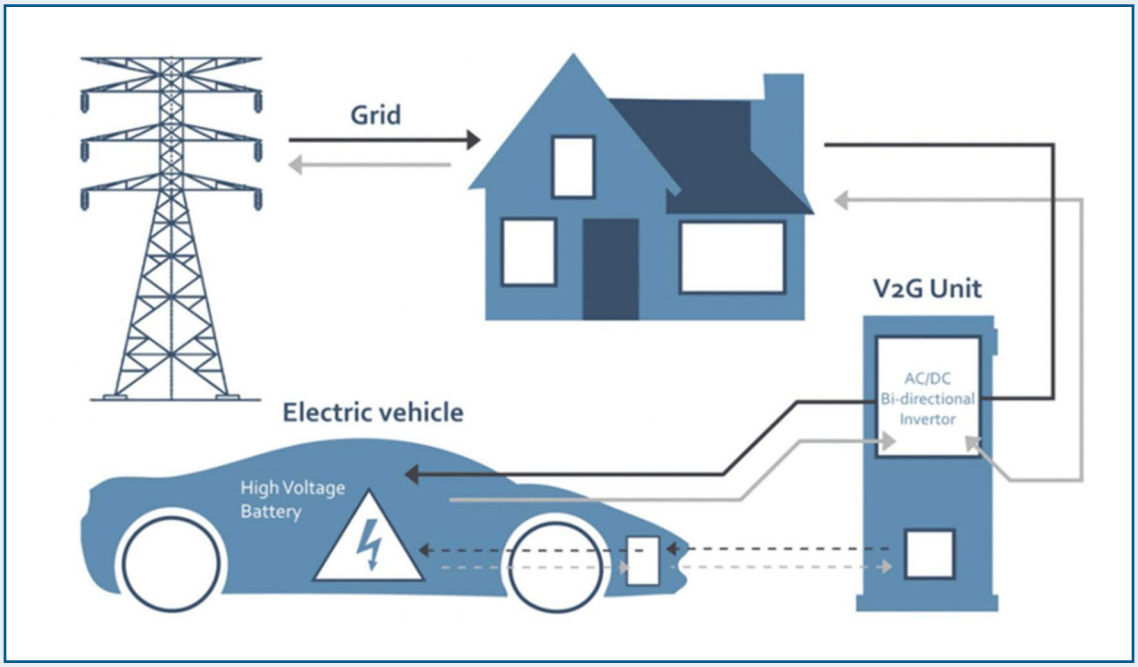
An LPCE program expands the footprint and scope of a traditional microgrid. The latter have been around for years and are popular at university campuses and military installations, to name a few. Microgrids focus mainly on solar power and energy storage and in some cases compressed hydrogen gas (CHG) or cogeneration facilities. CHG is very efficient providing not only power but also heat for beneficial uses. Fuels such as natural gas should be a part of an LPCE program especially if they are RNG or biogas from local landfills, livestock farms, and domestic wastewater plants.

RSG is another fuel that would be viable for an LPCE program if the certification met the requirements of the community. RSG is natural gas sourced from traditional oil and gas wells. The term means that a producer monitors methane emissions, flaring, and takes steps to reduce or eliminate methane and other impacts to protect the surrounding water, land, and communities. An independent certification company then measures performance via numerous metrics and certifies that the natural gas meets these performance goals.[15] Also, natural gas that has

[14] Hughes, M. D., Smith, D. E., & Borca-Tasciuc, D. A. (2020). Performance of wedge-shaped luminescent solar concentrators employing phosphor films and annual energy estimation case studies. *Renewable Energy,* 160, 513-525. DOI:10.1016/j.renene.2020.07.005

[15] Russo, T. N. (2021). Responsibly sourced gas: Time to change the natural gas industry's narrative. *Climate and Energy,* 37: 22-27. https://doi.org/10.1002/gas.22215

Figure 4. How Vehicle-to-Grid Works



been blended with hydrogen might meet the threshold test of a community's LPCE program, especially if it would be used to displace gasoline and diesel fuel in buses, garbage trucks, and gas-fired long-haul trucks. Any of the above fuels would be an excellent fuel for a CHP plant and provide improved affordability and acceptability.

LOW-IMPACT HYDROPOWER HAS BEEN OVERLOOKED

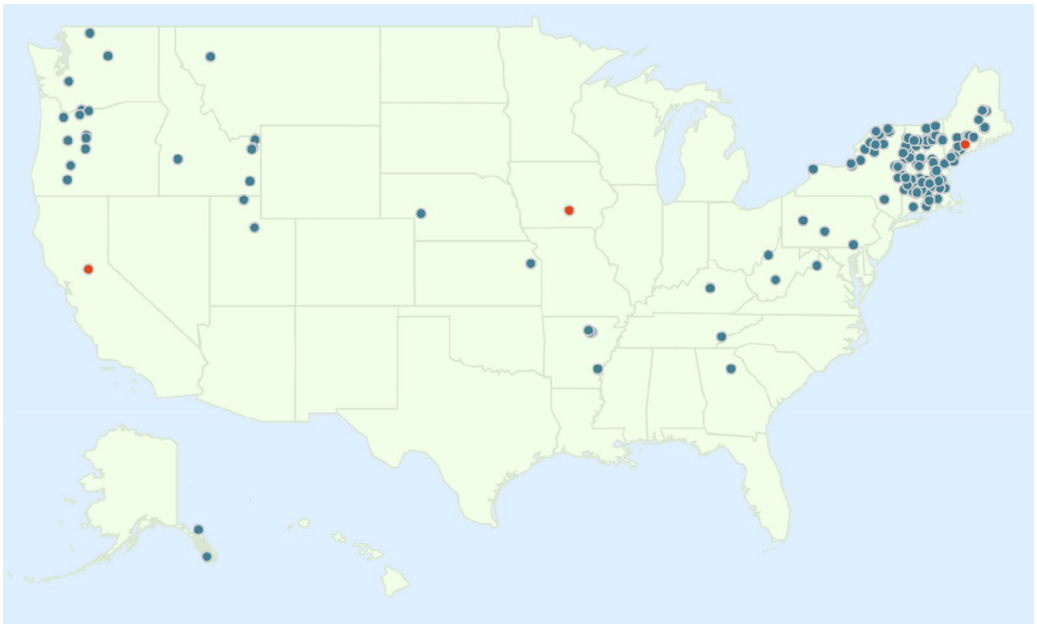
Low-impact hydropower projects are categorized as green power by the US Environmental Protection Agency (EPA) and part of the voluntary green power program. The recently passed Infrastructure Investment and Jobs Act provides $125 million to add hydropower capacity at existing dams that do not currently have power facilities.[16] These projects may be attractive to LPCE programs if they are certified as low-impact and green power.

[16] *Infrastructure Investment and Jobs Act 2021–2022* (USA). https://bit.ly/3INcsge

Approximately 187 hydropower projects in the United States have been categorized as low-impact by the Low-Impact Hydropower Institute (LIHI) and are recognized as green power by the United States EPA **(Figure 5).** The other part of the green power program is the compliance program, which is largely governed by a state's renewable energy portfolio standard. Many states, such as New York, recognize small hydropower projects as a part of their clean energy plans. However, only Massachusetts, Pennsylvania, Oregon, Delaware, Utah, and Ohio require LIHI certification for the project to be considered green.

This author believes that many hydropower projects in the remaining states would qualify as low-impact and green power. Over the years, most of the nonfederal hydropower projects have undergone relicensing by the Federal Energy Regulatory Commission and contain mandatory water quality certificates by the specific state's water quality agency.

Figure 5. Location of Hydropower Projects Certified as Low-Impact



Source: Low-Impact Hydropower Institute

Therefore, the projects operate in a sustainable manner and would likely qualify as low impact if they were reviewed by LIHI.[17] Clean energy advocates and those customers currently on LPCE programs would be wise to lobby state lawmakers to require LIHI certification so that the projects can be used as a source of green power under the US EPA Green Power Program. Hydropower projects considered low impact earn renewable energy credits (RECs), which attest that they are green power, and holders of such RECs can claim all the benefits of green power—that it is renewable, does not produce GHG emissions, and has a limited impact on ecological flows (i.e., upstream and downstream fish passage, water quality, recreation, and cultural resources).

[17] Russo, T. N. (2021). Rethinking low impact hydropower and renewable energy certificates. *Climate and Energy,* 37: 26-32. https://doi.org/10.1002/gas.22225

CONCLUSION

LPCE programs are not a complete solution for attaining the goal of clean and sustainable energy desired by many stakeholders nor are they intended to be. Instead, they should be treated as a risk mitigation strategy that can reduce a community's reliance on high-level federal clean energy policies and goals that may not be attainable or completed in a timely manner. LPCE programs expand the idea of a microgrid to include RNG, hydrogen blending in natural gas grids, RSG, and vehicle-to-grid integration. They also focus on the vertical installation of solar panels on commercial and industrial buildings by local governments and the private sector to increase solar energy production. Taken as a whole, communities that embrace the ideas of an LPCE program can better resolve conflicts between the four As of energy security, especially those dealing with the affordability and acceptability of energy that have alluded federal policymakers.

