Neighborhood Virtually-Enabled Microgrids (NVEM)

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1. Introduction

I frequently write about microgrids, and also about renewable energy sources at all scales. Recently I posted a paper on rooftop photovoltaics (PV) including PV + storage. This is described and linked below.

Rooftop Solar Energy Tug of War: *California has aggressively promoted photovoltaic systems for small and medium facilities – everything from the rooftops of single-family homes to solar parking lot covers for public campuses and private businesses, and medium-sized arrays on farms, ranches and industrial sites. By and large this program has been very successful. The following is from a post from an earlier paper.*

This post looks at the current battle taking place in the California PUC over continuing the state's current generous program to encourage solar rooftops, versus the equity imbalance this has created.

https://energycentral.com/c/cp/rooftop-solar-energy-tug-war

Earlier I posted the following paper:

The Future of Microgrids: *I responded to a question from one of my colleagues at Energy Central, which caused me to think about the subject of this post. This brought up some interesting possibilities.*

The California Electric Utility Culture has decided that microgrids will be very useful to prevent transmission lines that feed small isolated communities from starting wildfires.

This post expands on the possibilities for microgrids to expand into other segments once the wildfire mitigation market starts to saturate.

https://energycentral.com/c/ec/future-microgrids

The concept of a community microgrid has been floating around for some time, and my local (very large) utility has even embraced it as a one method of hardening their grid, under the name of "Remote Grid." See page 7 off the paper linked and described below.

PG&E Distribution Hardening: *PG&E's main wildfire document is their Wildfire Mitigation Plan, a detailed document that is updated every year.*

On July 26 PG&E announced a major new initiative to expand the undergrounding of electric distribution power lines in High Fire Threat Districts (HFTD) to further harden its system and help prevent wildfires.

This post will cover two areas related to the above:

- *Why PG&E feels that undergrounding the distribution lines is now viable, and*
- *What their Wildfire Mitigation Plan (WMP) says about the subject of distribution line hardening*

https://energycentral.com/c/gr/pge-distribution-hardening

However, none of the above concepts really makes the two major benefits of microgrids widely available. These benefits are:

- Lower-electric costs
- Higher electric resiliency

In noodling on the above concepts, I believe I have identified a potential method of doing this as described below.

2. Neighborhood Virtually-Enabled Microgrids (NVEM)

Each neighborhood that is a candidate for an NVEM should be on the same MV feeder, and be on contiguous feeder segments. A neighborhood should be composed of "residences," that is facilities (typically residential, but there could also be some small businesses) that reside in the NVEM's service area.

2.1. Why Now?

As more residents with energy producing assets improve the efficiency of their facility, it is likely that their energy production assets (typically PV and/or battery storage) will occasionally be producing too much energy. Although net energy metering provides a method to sell that energy back to the grid manager, there is currently a CPUC proceeding to see how this should be modified (see Rooftop Solar Energy Tug of War, described and linked in the Introduction). An NVEM is one potential variation on Net Energy Metering.

2.2. Virtual

In the NVEM's neighborhood, membership in the NVEM is optional, and thus the microgrid is virtual. But how is each virtual microgrid enabled? Read on.

2.3. Community Choice Aggregation

In California "*CCAs are local, not-for-profit, public agencies that take on the decision-making role about sources of energy for electricity generation. Once established, CCAs become the default service provider for the power mix delivered to customers. In a CCA service territory, the incumbent utility continues to own and maintain the transmission and distribution infrastructure, metering, and billing."*[1]

So the only major function that CCAs currently perform is contracting for electric energy. They are also responsible for Resource Adequacy (or will be shortly):

Resource Adequacy is a long-term planning tool required by the California Public Utility Commission (CPUC) and the CAISO, implemented by Load Serving Entities (LSEs) and Metered Subsystems (MSSs).[2]

In order to protect System Reliability, a resource adequacy program should include seven basic elements:

1. *A procedure for forecasting system conditions relating to Demand, including the forecast peak Demand*

[1] Wikipedia Article on Community Choice Aggregation, https://en.wikipedia.org/wiki/Community_Choice_Aggregation

[2] California Public Utility Commission, Resource Adequacy Homepage, http://www.cpuc.ca.gov/RA/

2. *A specified Reserve Margin – this is the amount of capacity over and above the predicted Demand that is necessary to provide adequate Operating Reserve and to account for Contingencies such as Generating Unit Outages and forecast error*
3. *Deliverability – this is a requirement based on Applicable Reliability Criteria that is designed to ensure that capacity needed to meet the Demand Forecast and the Reserve Margin is not constrained by transmission limitations when it is needed to serve Load. Local capacity requirements are also an important part of deliverability requirements.*
4. *Criteria for determining eligible resources and the amount of capacity able to satisfy the Reserve Margin*
5. *Plans developed by the LSEs that identify how they have met their resource adequacy requirements by assembling a portfolio of resources*
6. *Rules under which the resources identified in the plans are made available to the ISO Operator to balance Supply and Demand*
7. *A compliance program that ensures that LSEs comply with the resource adequacy program established by the Local Regulatory Authority and that precludes the LSE from inappropriately relying on the resource procurement practices of other Market Participants.*

I am proposing that CCAs would also be the logical entity to facilitate NVEMs.

2.4. Residents and Their Assets

Each resident will have the following choices relative to their electricity supplier:

- Contract for power from the investor owned utility (IOU) using one of the suitable IOU's tariffs,
- Contract for power from the CCA using one of the CCA's suitable tariffs, or
- Contract for power using the CCA and participate in the local NFEM.

Some residents in a neighborhood host PV power-producing assets, some host battery energy storage, some host both and some have no power-producing assets.

Each resident that has a power-producing asset (PV and/or storage) and is a member of the NFEM will execute a separate net-metering agreement with the NFEM/CCA. This agreement will specify how, when and under what conditions their facility will provide energy to the NFEM and how the resident will be compensated for this energy. It should be noted that each resident may have a different amount of energy made available under different conditions.

2.5. Metering

Residential meters for NVEMs will need to support the following special functions:

(a) Allow a resident to draw a limited amount of power from the neighborhood distribution grid

(b) Allow a resident to be disconnected from the grid

(c) Allow four-quadrant operation (power can flow either from the grid to the facility or from the facility to the grid) and provide interval metering for each direction independently.

Note that non-NVEM residents will need to be disconnected from the grid during an outage.

Since I worked earlier in the electric-metering industry, I know the above functions are available for residential meters and/or via accessories.

3. Advantages for NVEM Members

Benefits for residents without power-producing assets that are members of the NFEM/CCA:

- In the event of a neighborhood outage, each resident will still be able to draw a limited amount of power through the neighborhood grid. This will require islanding the neighborhood shortly after the outage starts, plus a procedure for reconnecting the neighborhood after the outage. This may or may not involve using neighborhood assets for mitigation of cold load pickup.
- Potentially less expensive power – especially during peak demand periods.

Benefits for NVEM residents with storage-only or PV+storage assets:

- Can allocate a percentage of their storage asset for emergency-outage-response, and be paid a monthly reservation charge
- Residents with power-producing asset(s) can over-produce electricity and inject the excess into the neighborhood grid to lower the overall cost of energy for the neighborhood grid.
- Residents will be paid for energy they inject into the neighborhood grid. The amount a given resident would be paid would be a resident-specified number of cents below the real-time price-per-kWh charged by the IOU.

It should be noted that, by using NFEM-produced power, the transmission charge for everyone in the NFEM would be reduced, but the distribution charge may increase slightly.

3.1. Other Considerations

For residents with power-producing assets and EVs in a NFEM, there would be a trade-off between using their assets to provide services (read energy reservation or supply) to the NFEM or to charge their EV (or EVs). The EV (or EVs) could also be used as additional storage asset(s) if they had vehicle-to-grid (V2G) supply enabled. The potential for using distributed assets is huge: the figure below is from a recent PG&E Investor Day Briefing and apparently identifies current storage assets on their grid.[3] PG&E is my electric & gas utility.

[3] https://investor.pgecorp.com/news-events/events-and-presentations/event-details/2021/PGE-Corporation-2021-Investor-Day/default.aspx

Utility scale

~2,700 MW

Distributed

~300 MW

Electric vehicles

~6,600 MW

The NFEM/CCA should also be responsible for recruiting future power-producing assets. This might be either by:

- Arranging financing for those assets and paying residents facility-rental fees (NFEM would own the assets and be responsible for maintenance).
- Providing financing with attractive rates/terms for residents to add or expand power producing assets. Residents would own the assets and be responsible for maintenance.

The NFEM would also be responsible for balancing the types of assets (like recruiting storage assets for existing PV-only assets).

At least part of the IT assets required to support operation of the NFEMs would probably need to be provided by the CCA.

4. Making NVEMs Happen

Obviously the above idea would need to be reviewed by all stake-holders, potential issues elevated and resolved.

The next step would be to run a number of pilot NVEMs, and again, fine tune the concept. These could start out with just functions that are easy to implement (like the power-producing NFEM members lowering the power costs of the non-power-producing NFEM members), and only add in the more difficult functions (like sharing power during an outage) in a later phase.

Then a number of NVEMs could be deployed by a number of CCAs to test how robust the concept is in different locations.

Mass rollout to all participating CCAs.