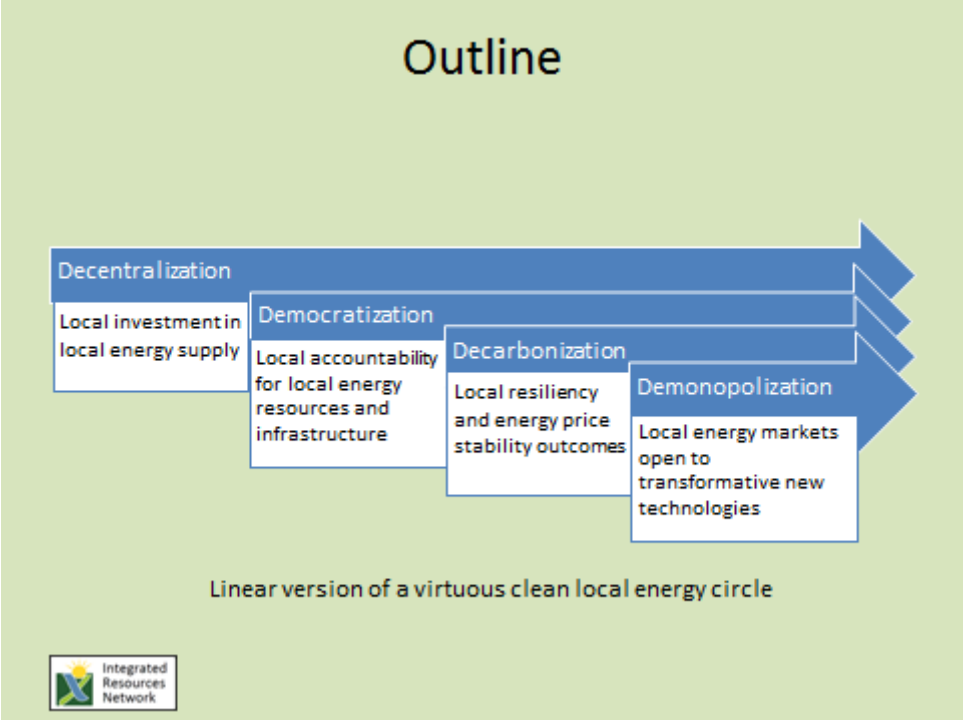
Electricity grid modernization, long a discretionary investment, is becoming imperative in certain states and localities. Why, and what will it entail?

Variable sources like solar and wind have long been environmentally preferred. Now, finally, and in general, they are also economically preferred.

They are connected to electricity grids. Because of their size, wind farms feed into the electricity grid at higher voltages. From a community perspective, they are sources of low cost energy. Good wind resource areas typically don't overlap population centers. Good solar resources do. Solar is now cost effective at any array scale and can even be connected to household circuits. So, solar can be both a local energy resource and a source of imported energy. So can wind, but the state-wide balance between local and imported differs significantly between solar and wind.

Grid modernization will continue at all levels of the grid. Local grid modernization will be paced by deployment of local energy resources. Historically, California state policy has favored locating electricity infrastructure outside the boundaries of local jurisdictions, thus positioning cities and counties as energy importers. Now, new technology is creating a new economic perspective, and local policy can shape the future of local energy service.

Will your community take the necessary steps to reap the economic rewards? What are these steps?

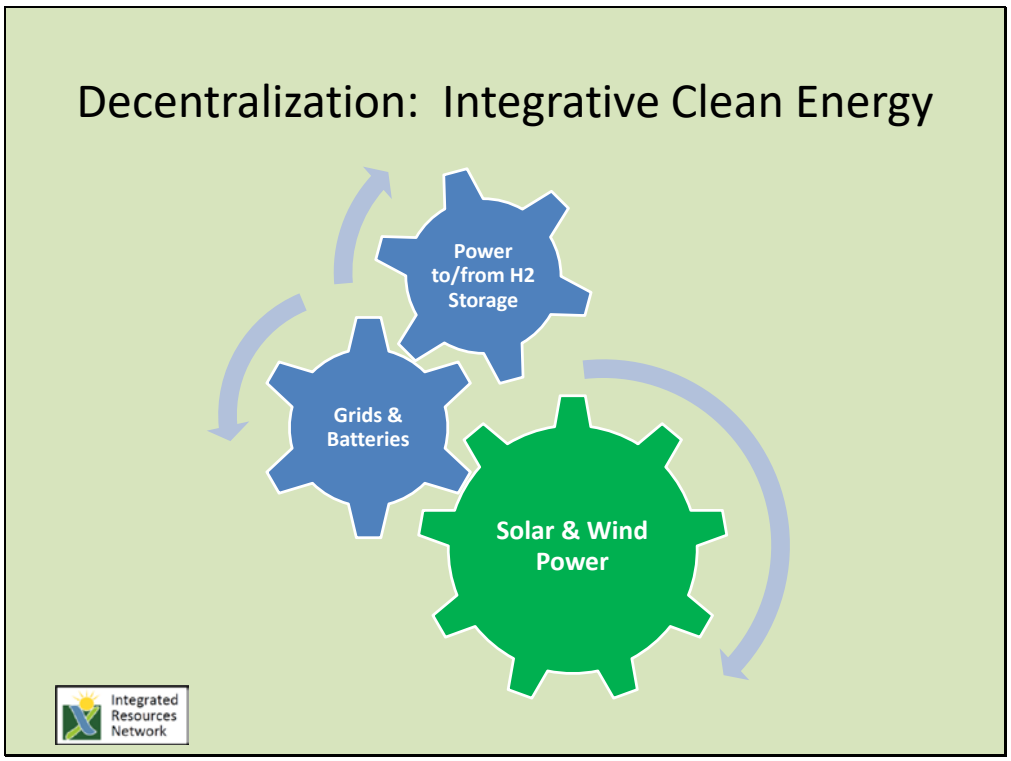


Local investment in local energy resources drives a need for local government engagement that can adopt and mirror best practices local jurisdictions apply in delivering other essential local services, e.g. water, waste disposal, traffic control, street lighting, and high speed communications.

Local energy infrastructure enables and is enabled by other local infrastructure. It is best managed with an eye to price stability and co-optimization of all other local utility services.

Managed with attention to integration and technology trends, clean local energy resources (CLERs) can deliver price stability, local resiliency, business investment opportunities and attractive, stable, well compensated local jobs.

Co-optimizing and integrating local energy services with other local utility services involves decentralization, democratization, decarbonization and demonopolization. It creates a virtuous circle (the four D's) that will be described in the following slides and text.



An integrative local clean energy vision features locally produced solar and wind electricity integrated with a smarter local grid and local energy storage.

Locally generated renewable electricity can be used directly, stored in vehicle batteries or converted to hydrogen. Hydrogen in turn can be used as both a storage medium and as a zero carbon and flexible electricity generation and transportation fuel.

The individual technologies and business models necessary to achieve the vision are becoming dramatically cheaper and capable of plug and play functionality.*

An important aspect of a robust local clean energy vision is the integration possible between local building and transportation energy services. The vision recognizes that hydrogen fuel cells and batteries powering vehicles can provide additional incrementally low cost service as stationary power generation and storage capacity when not on the road.

The vision will of course clarify as steps are taken toward realizing it.

*For a detailed discussion of relevant technology tipping points and progress curves, see Reference 3.

Decentralization is a Local Choice

Grid Modernization Pathways: Follow the Money

In California, how much "grid modernization" money is forecast to follow Wall Street pathway vs. pathways within communities?

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Financial markets serve the public's interest in efficient capital allocation. Money flows to and through Wall Street in order to be allocated to entities that use it to generate revenues from the sale of products and services. Money also flows to and through local banks and publicly owned utilities that put it to use generating revenues from the local sale of products and services.

Economic activity funded in a centralized way underpins all local economies. Economic activity funded locally keeps local dollars circulating locally, creating local jobs and local wealth.

Decentralization is a Local Choice

Grid Modernization Pathways: Follow the Money

"The company (PG&E) expects to spend $5.6 billion this year, including $2 billion on distribution, $1.2 billion on transmission and $700 million on generation, with annual investments ranging from $5.4 billion to $6.4 billion over the next three years."

PG&E's forecast for "behind-the-meter" generation additions in the next three years of roughly 1GW/year*. Related local investment will be in the range of $3B/year or considerably higher if some PV additions include energy storage.

*DRP DER Growth Scenarios Workshop, May 3, 2017

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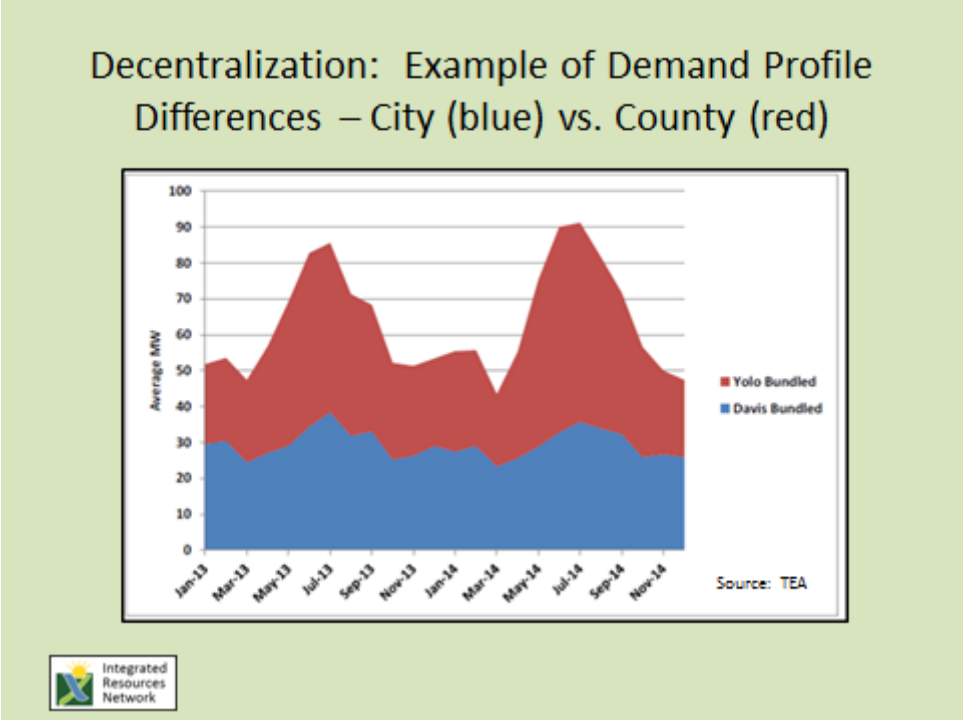
California's electricity grid can be modernized without changing its current centralized design, which relies almost completely on large power plants, sophisticated high voltage transmission systems, and relatively unsophisticated local delivery circuits. Now, modular supply and storage technologies are opening pathways for part or all of an individual community's energy supply to be generated locally and cost-competitively. Their impact is to "unload' the centralized system, reducing its requirement for Wall Street allocated capital while increasing opportunities for local ownership and investment.

Even now, local investment is at rough parity with non-local investment. California's on-going deployment of local energy resources provides on the order of 100,000 permanent local clean energy jobs, while its deployment of centralized energy resources primarily provides two orders of magnitude fewer temporary, large project related jobs. One choice now facing many California cities and counties is whether to be involved in electricity service and if so, in what proportion should they rely on local energy resources vs. imported energy resources.

In the past, the choice hinged on whether a publicly owned utility could offer stable competitive rates. Now the choice has an additional important dimension, i.e. the extent to which local energy resources can both strengthen the local economy and also reduce its exposure to risks undertaken on its behalf by the state its state regulated service providers.

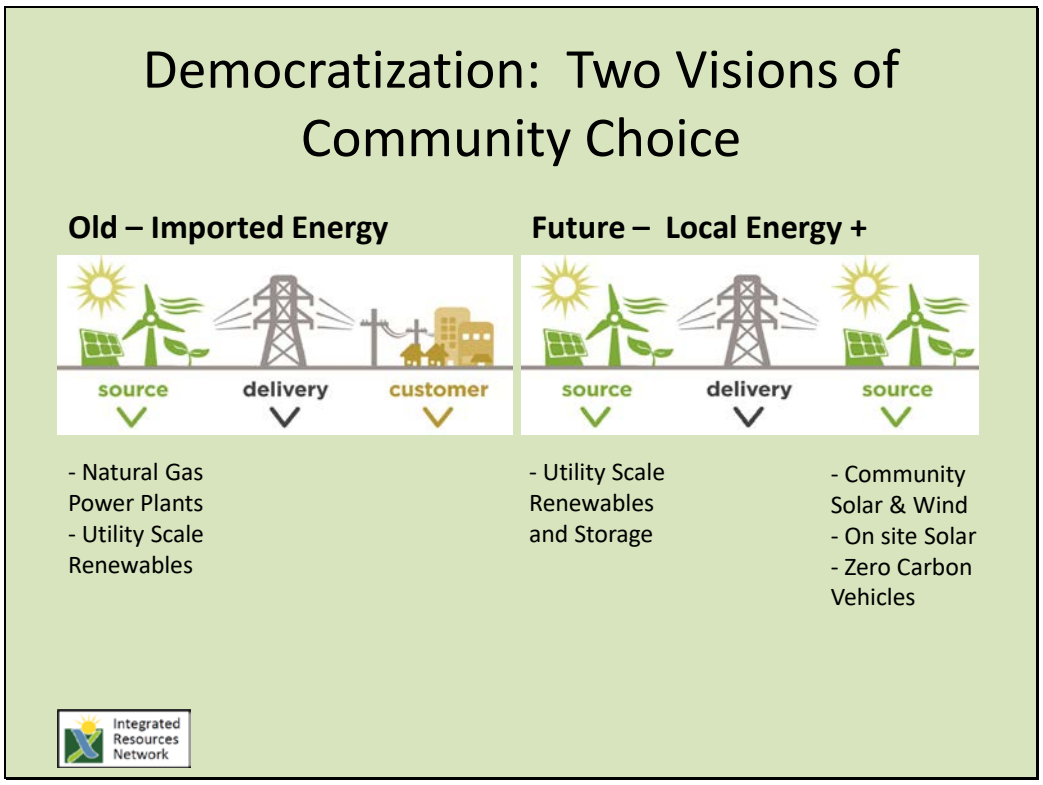


Important insights and planning data are available by drilling down to find out how each community's energy profile differs from others and from the aggregated profile a local energy service provider must supply.

In the past, centralized service providers took such differences for granted and viewed them as an economic opportunity. I.e., large numbers of individual customers using differing amounts of electricity for different purposes at different times meant their demand differences would tend to cancel one another out. Smaller differences between cumulative average and peak demand resulted in better economic utilization of grid assets.

Energy decentralization requires closer attention and more active intervention in order to level cumulative demand and maximize asset utilization. Specifically, more attention needs to be given to integration between surprisingly different usage profiles within a local area. E.g., between urban demand, which has significant daily variations, and agricultural demand, which tends to vary seasonally.

Equal attention needs to be given to opportunities to import renewable energy from rural areas where supply potential exceeds local demand and where local economies are at times under stress. The win-win possibilities are significant and often overlooked when here is no hub for local integration. Community Choice joint powers agencies are able to provide the necessary integration hub.



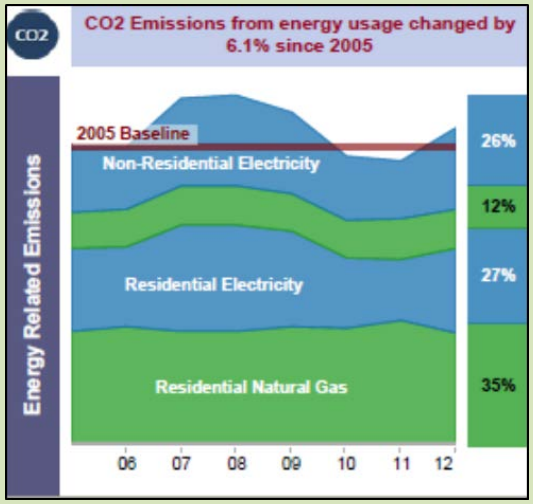
Community Choice also provides a vehicle for energy democratization.

The "old" Community Choice vision, which preceded California Community Choice implementation, mimicked that of regional monopoly energy service providers perfunctorily authorized by cities or counties to provide local service. These vertically integrated companies typically relied on an energy supply network fed by large power plants and/or pipelines carrying electricity and/or fuel to the city from distant sources. This legacy model, i.e. including its sourcing and delivery infrastructure, will continue to economically opportune and a necessary bridge to a more decentralized and democratized energy future. Changes will necessarily be incremental.

In the future Community Choice vision, electricity customers will have more choices, and communities will have an integrative role assisting and guiding the Community Choice provider. Incremental changes at the local grid level will be necessary to enable local energy resources to supplement and reduce imports.

Increasingly, local energy investment is being driven by competitive prices for solar electricity generated on homes, buildings and other local structures. Investment in local energy supply will gain additional momentum where economic and infrastructure resiliency is a priority.

Decarbonization: Buildings Sector GHG Emissions Profile for Davis, California



Integrated Resources Network

Source: PG&E

Another choice facing local jurisdiction s is whether to decarbonize. And how.

Just as local benefits of energy sector decentralization will not be captured unless cities and counties engage, neither will local decarbonization goals be achieved.

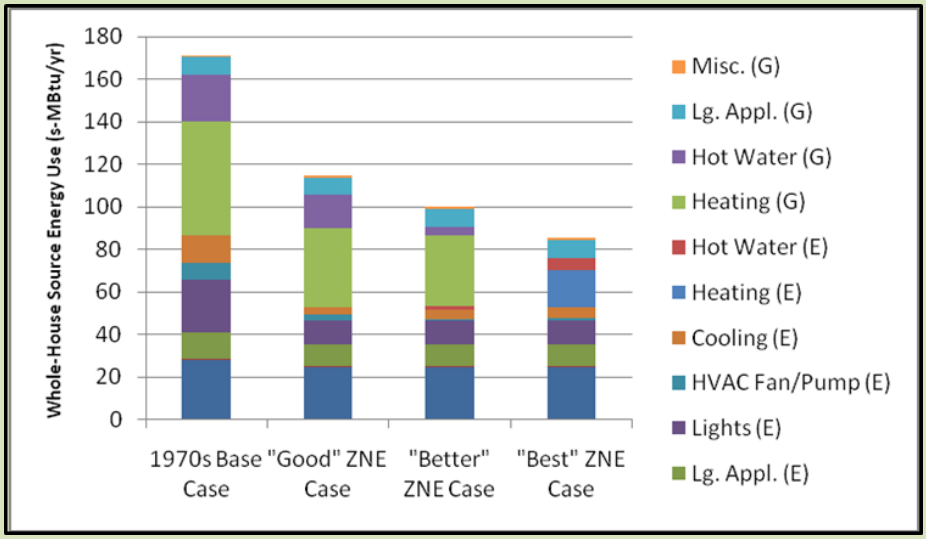
For example, the chart shows that CO2 emissions actually increased in Davis, California from 2006 to 2012 despite near zero population growth. In this period, the effects of state mandated renewable electricity, energy efficiency and rooftop solar investments appear to have been more than off-set by per capita usage increases.

But since 2012 on-site solar installations in Davis quadrupled and now account for 15% of the city's electricity consumption. The result has been significant and measurable decarbonization.

That is the good news. The bad news is that locally produced solar electricity is still under-valued by state regulators. The surcharges they allow regional utilities to impose have the effect of greatly reducing its attractiveness relative to centrally produced solar electricity. The surcharges are an artifact of the need to protect centralized project and infrastructure investors from the consequences of technology and market shifts they did not foresee and account for.

Fortunately, publicly owned electricity service providers, including municipal utilities and Community Choice agencies are not subject to state economic regulation and have considerable flexibility to encourage development of local energy resources.

Decarbonization: 1970s Vintage Home Net Zero Retrofit Energy Usage Reductions (Davis, CA)



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Source: BIRA Energy

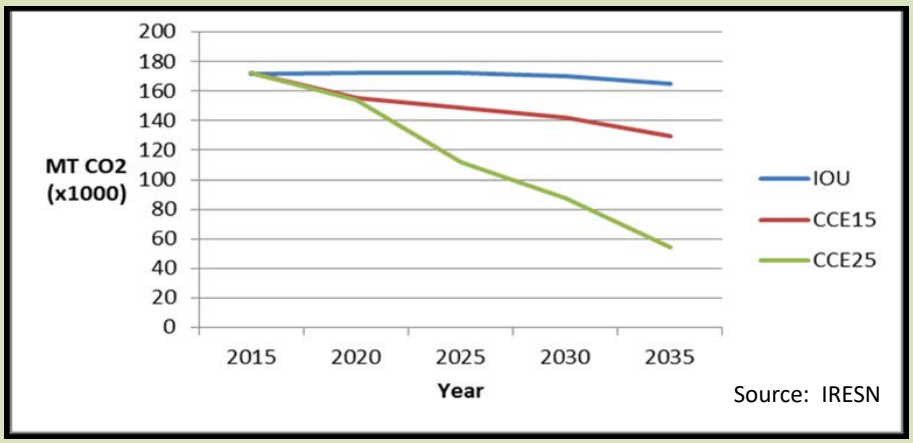
Full local decarbonization requires attention to buildings, vehicles, and several other even harder to regulate emissions sources, e.g. related to food and consumer products and their production, delivery and disposal chains.

Half of Davis's energy related carbon foot print is attributable to transportation energy use. Likewise, while state policy tends to focus on efficiency standards for new buildings and goals for new zero net energy buildings, the potentially fastest and most impactful local decarbonization steps will involve retrofitting existing buildings.

In the Davis Future Renewable Energy and Efficiency project, the city's GIS and permitting databases were used to determine retrofit choices appropriate to individual neighborhoods based on the "vintage " of the homes in the neighborhoods. Efficiency retrofits integrated with solar retrofits could, in the "best" cases involving substitution of electricity for natural gas , reduce an existing home's carbon footprint to near zero .

It is noteworthy that the city has not attempted to implement the program as designed , perhaps because its climate action plan, approved years before the DavisFREE effort, did not envision the possibility of integrative building retrofits. The city's subsequent initiation and current participation in a Community Choice program may enable the necessary program initiation and implementation.

Decarbonization: GHG Emission Reduction in Three Scenarios for Davis, California



IOU = Business as Usual
CCE15 = Community Choice Energy (CCE)
CCE25 = CCE with Local Energy Resource and Fuel Substitution Emphasis

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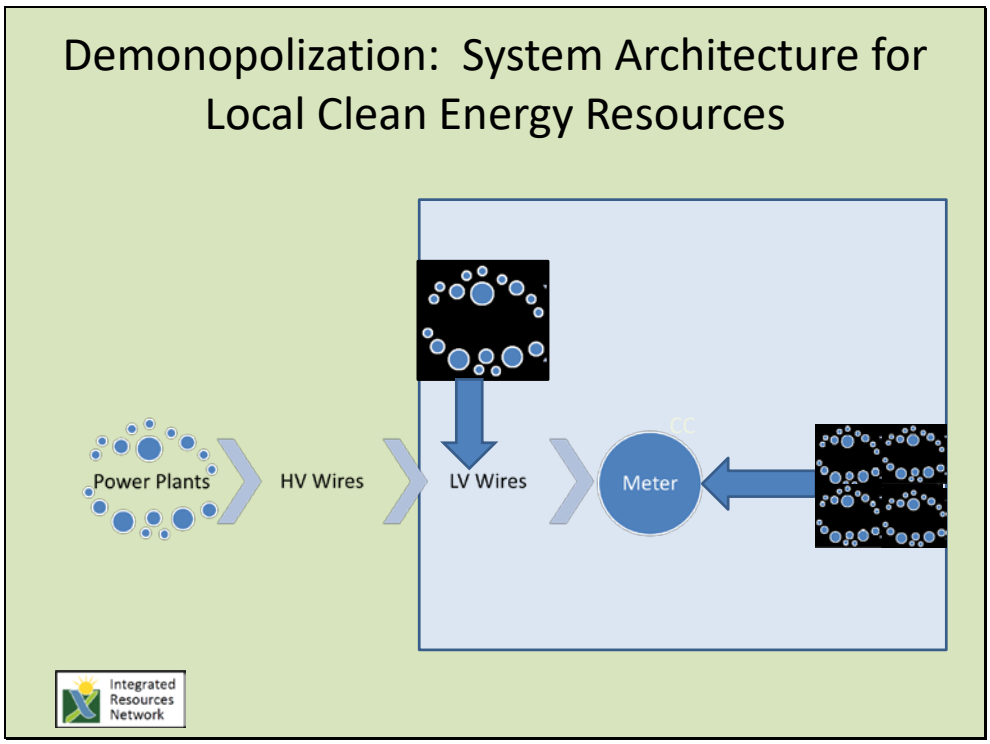
The DavisFREE project included a data driven integrated energy analysis to determine the impact energy service choices could have on the deployment of local energy resources and on the rate of substitution of clean electricity for carbon based fuels in both the building and transportation sectors.

Consistent with decarbonization trends discussed above, the business as usual scenario assumed a choice to continue centralized utility service was projected to result in an overall building-plus-transportation carbon footprint that would essentially flat over two decades as per capita energy usage increases, local energy resource deployment slows and centralized renewable deployment and transportation sector decarbonization progresses.[1] Two community choice scenarios were evaluated assuming: 1) the Community Choice business model (relying primarily on imported electricity) that was being implemented in a limited number of cases in 2015, and 2) a possible business model that might evolve over the 2015-2025 that would prioritize local energy resource development and aggressive fuel substitution in both the building and transportation sectors.

The comparison underscores the previous comment that the choice of how to implement Community Choice may be more economically and environmentally consequential than the initial choice to create a Community Choice agency.

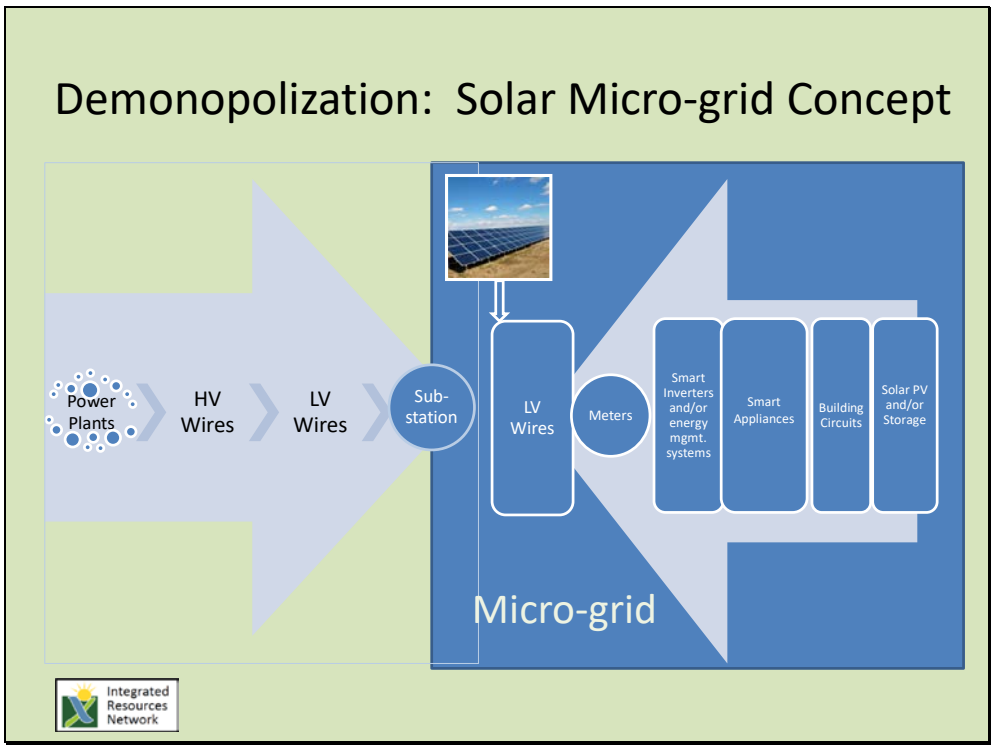
[1] The state's latest goals for electricity sector renewables and efficiency, if achieved, would result in somewhat faster decarbonization in the business as usual centralized utility service scenario. However, financing the centralized system expansion scenario essentially doubles down on a previous bet that proved to involve significant risks, including stranded investments.



The above two Community Choice scenarios involved differing degrees of demonopolization. At a minimum, Community Choice opens a pathway for community solar that is otherwise closed in California. Community solar is an option that complements on site solar where on site solar system sizing is limited by historical usage and fuel substitution, i.e. replacing gas space and water heating with heat pump base heating and internal combustion engine vehicles with electric vehicles, results in significant increases in electricity use.

In the scenario where Community Choice prioritizes local clean energy resource development, smarter local grid investment, design and real time operational control will be necessary. Specifically, the functionality of a local grid depending significantly on clean local energy resources is more like that of current regional transmission grids, i.e. needing to balance supply and demand in real time and economically optimize the mix of resources in play at any particular point in time.

Thus, in the scenario emphasizing clean local energy resources (CLERs), there may be a need for independent system operators for the local electricity grid. It seems likely the large regional utilities have capacity to serve this need but might prefer to remain focused on managing their centralized grid assets while also investing in local grid modernization as well. However, the best qualified and least conflicted organizations to manage local grids in line with local priorities may be existing municipal utilities and the vendor industry that supports them.



Grid modernization may mean more robust regional grids accommodating large solar and wind power plants, allowing highest quality resources to be developed in an environmentally responsible and cost-effective way. It may also mean more capable and flexible local grids. Or both. Or both, and more.

Deployment of new building and transportation technologies will not be uniform even at the neighborhood level, let alone at the city, county and state levels. Energy grids that accommodate and enable an extremely broad range of usage patterns and local energy resource capacities may be unaffordable even in the early stages of an integrated-decentralized scenario. As an antidote, so called "micro-grids" can serve as platforms to balance supply and demand over limited areas where the range of usage patterns and technology adoption levels is not so great.

Municipal and county grids can be upgraded to support greater reliance on local energy resources. So can grids that power neighborhoods, campuses, and aggregations of energy users that have different reliability or power quality needs than would be cost-effective to meet for each and every local energy user. The technical potential will soon exist to allow supply/demand balancing at smaller and smaller scales, even ultimately at the level of two adjacent buildings, one with a solar array large enough to power both. Where allowed by local regulation, local grids will be able to exchange electricity, not just with individual "customers" but with associations of "prosumers" connected to a micro-grid.

Recap - 1

- Energy/transportation technology tipping points make energy decentralization inevitable.
- Importing energy means exporting dollars. Now how much to import is becoming a local choice.
- Community choice enables community solar and also urban/rural energy exchange.
- Timely local decarbonization hinges on mass marketing of smart energy and net zero carbon retrofits.

Recap - 2

- Community Choice is natural partner in clean local energy resource (CLER) deployment, not a substitute for active city/county engagement.
- Economically optimum CLER deployment may require creation of local independent system operators.
- Solar micro-grids provide resiliency benefits and enable more economically efficient mixed portfolios of residential and community solar.

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