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Additional Research Needs for DER Research Roadmap: Realistically Adding Energy Users to the DER Vision. Comments by QQForward.

Additional submitted attachment is included below.

Comments by QQForward on Distributed Energy Resources (DER) Roadmap, 22 July 2019
Docket No. 19-MISC-01

For Workshop on DER Roadmap Prioritization Methodology

Additional Research Needs for DER Research Roadmap: Realistically Adding Energy Users to the DER Vision

The *DER Integration Technical Assessment* roadmap (Navigant 2018) offers a broad review of hardware elements of DER subsystems and a range of barriers and research needs related to these elements. It is a very useful document and obviously carefully constructed. The July 25th *Staff Workshop Notice* (Docket No. 19-MISC-01) asks: "What research needs (beyond those identified by the Technical Assessment) should be considered by the Energy Commission?" In response to that question, we believe that the Roadmap does not explicitly consider a number of significant risk factors that could very likely impair progress in DER grid integration and weaken results of California policy efforts toward decarbonization, emissions reduction, resilience, and social equity.

Missing from the DER discussions to date are nearly 40 million California residential energy users who will be implicated in every phase of DER build-out—not just at the end of the pipe as a "customer marketing problem" for technology deployment. How well technologies fit those users and their needs can make or break DER integration, no matter how sophisticated the devices and networks envisioned. So we believe that those users and uses must be thoroughly considered in advance and actually *designed into* DER technologies and devices, networks, regulatory systems, and user-facing policy initiatives. This is particularly important for the residential sector—and doubly important for attempts to integrate DER resources in that sector.

Unlike commercial, industrial, and agricultural energy users that have large clearly identifiable loads and capacities, and long-standing working relationships with utilities that make them good potential DER partners, the residential sector is a quite different story. In that sector, energy uses are highly varied and individual end-use loads tend to be small. However, the combined residential loads that the supply system faces and must serve are large and vary considerably across the day, week, and season of the year. They are also widely dispersed over a large state and diverse in volume and pattern across a population of 14 million California households. In addition, the relationships between those households and energy suppliers are uneven and sometimes fraught.

If it is to be reasonably expected that 14 million residential households will participate in significant new additions of renewables to the grid, choices to shift from natural gas to electric heating and water heating, buying and charging new electric vehicles, and exhibiting flexibility when faced with extreme weather conditions, then it will be crucial to have an idea how this might come about—and how all of this new activity might effectively be coordinated within the household, the neighborhood, the city or town, the distribution system, etc.

At present, this is almost inconceivable even in the small number of households in the state where there is interest in "smart" homes (a vision that is at least 30 years old) and where there is also technical knowledge and ample financial resources. In reality, for the vast majority of California residents, there are many significant barriers (quite different from the ones considered in the DER roadmap) to mass adoption and coordinated use of new technologies and network interactions. We believe that making DER "work" will be hard work that will require a combination of investments, creativity, shifts in beliefs and practices, reconfiguration of supply chains, redesign of technologies, of energy systems and possibly of energy system governance, and new policy regimes.

In the cold light of the present day, it is difficult to imagine how single-policy interventions such as "sending price signals" via mandatory time-of-use rates could trigger these developments at a large scale—although triggering other sorts of reactions can be imagined. And even with a suite of coordinated regulations and subsidies added in, it does not immediately follow that a rational response would be widespread purchase of new PV and EVs, fuel shifting for primary energy uses, energy efficiency and storage investments, and automated demand response capabilities.

Now a protest might be that EPIC can/should only fund research on hardware and related engineered systems—that things having to do with end-users are marketing and customer acquisition issues that utilities will tackle, and questions related to policy design and implementation are matters for regulators and legislators. That framing may have made sense in the past when concern was focused mostly on hardware, delivering incremental gains in energy efficiency, and ensuring adequate supply under more gradual rates of change. But as much as we should credit ourselves for gains in the past, the imperatives of a changing climate that threatens the health, welfare, and livability of Californians now and for generations in the future cannot continue to support that narrow framing.

We believe that a more coherent way to think about energy users and energy uses in the context of DER innovation and integration is in terms of *risk* and *risk factors*. Navigant's report already recognizes certain risks (see, e.g., Table 27) but these are mostly about acute technological failures, intentional attacks, and environmental threats, rather than the more basic risks and uncertainties posed in trying to build out DER as a very large system, the performance of which depends exactly on integration into society. Not understanding how the human, consumer, end-user, citizen, household—whatever you want to call them—participants in the system work and interact with hardware, devices, buildings, networks, infrastructures, etc. risk of sub-optimal build-out, risk of falling short of needed benefits from DER, and even means risk of failure to achieve integration at scale. In the current vision of California's evolving energy system and the future, failure of large-scale (in fact, on a hitherto unimaginably large scale) DER integration means failure of decarbonization, electrification, emissions reductions, energy equity, energy security, and so on. Failure of

DER to meet peoples' needs and align with their interests and capacities can mean failure of DER integration. So failing to bring those human factors into EPIC DER integration research puts the benefits of even the best hardware RD&D at risk.

Analysts who have looked closely at energy use and choice in the residential sector paint a picture of a complex reality made up of both people and technologies (often framed as "socio-technical systems") in which differences (in hardware, culture, resources, knowledge, interests, etc.) abound and where traditional efforts to encourage energy efficiency and renewables investment have often had a spotty record characterized by "market failures," "rebounds," and "efficiency gaps" between hoped-for and realized outcomes (Lutzenhiser et al. 2009, Moezzi et al. 2009, Lutzenhiser 2014, Moezzi et al. 2018, Lutzenhiser et al. 2017, Moezzi and Lutzenhiser 2019). In a complementary body of research, investigators who are interested in energy transitions and the evolution of "smart grids" and "micro-grids" at various scales, have found that the social and institutional parts of socio-technical energy systems are the least well-understood, but the most important, determinates of change in these systems (Wolsink 2012, Levenda 2016, Adil and Ko 2016; Levenda et al. 2019).

So what could go wrong? Slow rates of adoption and some misuse of technologies might be expected, and to some degree mitigated by state mandates and centralized control. But what about the possibility of very low adoption overall and tepid response even in the most receptive groups? How is this taken into account in DER planning? More specifically, there is the likelihood that smart houses may evidence very different demand patterns than system expectations, even with subsidies and rate differentials. Competing technologies and protocols, delivered through controlled supply chains, may slow and even block adoption. Then there are uneven code adoption and local resistance to electrification goals; failure of local DER pilots to provide consumer benefits; uneven uptake of technologies with particularly long lags in middle class adoption; low-income populations left behind with failing legacy technology, unaffordability of alternatives, lack of local DER; shrinking Federal and state funding for any level of participation; and lack of understanding (and lack of provider communications capacity) for significant elderly populations that have legacy systems and limited capacity to participate. At the end of the day, there is a reasonable possibility that even the most supply-beneficial DER system arrangement could be irrelevant to, and resisted by, the bulk of energy consumers—all for very good reasons, but almost none anticipated by a hardware-only orientation.

The bottom line: there is the distinct possibility of designing an elegant, efficient, and optimized DER hardware system in principle that will risk failure of integrating with the very large, very complex and dynamic social systems of energy use of 40 million Californians in their households.

Therefore, we recommend the following:

1) It would make sense for the Commission to take a few steps back the hardware systems DER vision in the roadmap to reframe the problem as involving large-scale reconfiguration of the California socio-technical energy system. This means

recognizing the importance of both the human and technological parts of the system and of their interactions in all sectors. Transitions toward a DER future will necessarily involve people as energy users and social beings, as well as new configurations of hardware and software that California households require and rely on. The current DER vision arises in the context of a long history of a mostly technology-only perspective on energy supply, configuration, and management. Taking on this larger view of DER, one that directly treats ramped-up DER as involving a larger societal transformation, will require some initial reworking of some fundamentals and honest conversations across involved disciplines and parties.

2) Without politicizing the vision or approach, a look at history means realizing that this is not simply a problem to be solved by market forces, market-driven innovation, and rational consumer response (Moezzi et al. 2019). Coordinated public, private, and civic action will be required for effective DER build-out at the time and spatial scales needed to address growing climate challenges.
3) Recognize that the knowledge base about socio-technical system transition, and especially the management of very complex and increasingly dynamic energy system changes, is very limited—and far from what it needs to be in the DER integration space (e.g., compared to current physics and engineering knowledge about grid-tied PV behavior, or communications software or battery chemistry). Planning needs to incorporate these uncertainties, build in realistic well-rounded feedback, and ensure time-sensitive response to this feedback.
4) As a part of short-term EPIC DER integration research, include a component that maps energy-using practices across households and demographic segments in the residential sector. This work should focus not just on devices and energy flows but also on patterns of use and logics of use and non-use, as well as how social processes at different scales (habits, cultures, employment and travel, child-rearing, codes, regulations, and supply chains) work to reinforce and change those patterns.
5) Bring the knowledge from that research to bear on: (a) device design, (b) network design, (c) communications channels and protocols, (d) system control regimes, (e) rates, regulations and subsidies, (f) strategic technological diversity; and (g) identifying opportunities for innovation and new ways of thinking about system transition. Accomplishing this kind of needed multi-disciplinary approach will likely mean involving social science research and researchers across the entire portfolio of EPIC DER RD&D on devices and networks.
6) Use new knowledge of socio-technical system dynamics to inform the design of a series of residential sector pilot demonstration and deployment projects. In evaluating and learning from those pilots, carefully examine social aspects along with technology performance and overall outcomes. Determine ways to improve technology usability and fit with users' needs and priorities. Identify uneven benefits of designs and possible negative equity impacts that might affect disadvantaged low-income and other demographic subgroups.
7) Recognize that there is no "one size fits all" DER solution, but different interpretations of DER potentials and outcomes—different translations and architectures of DER—that are appropriate in different geographies and for different user groups. Market-based solutions tend to move toward where the money is and the barriers are lowest. This probably will not be enough. The real challenge of successful DER integration on a

statewide and equitable basis is in how to realize incorporation of more and more renewables, while moving more domestic energy use toward electricity and away from fossil fuels, and pursuing resilience through new designs for bottom-up and middle-out, as well as top-down, solutions.

Thank you for your consideration.

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