Customer Resource Management Evolution & Revolution

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Transition to a Customer Empathetic Paradigm

One of the key functionalities that the industry sees as important to this transition is flexible customer load management as a resource to operate the grid. Managing customer consumption is seen as a low-cost option to address the system variability and mismatch between renewable generation production and consumer usage patterns. However, an inherent industry view of customers as load to be managed has set grid operators, service providers, and regulators collectively on a course that is increasingly at odds with customers' needs and interests. A more customer empathetic approach is needed to unlock the potential of engaging customers' collaboratively to leverage their resources and consumption for the benefit of the overall power system.

Today, consumers are being asked to conserve in more disruptive times of the day because, in simple terms – we have too much low-cost variable renewable energy during periods of the day we don't need it and insufficient energy capability during peak hours when we do need it. So, instead of fully addressing these issues within the power system, we also expect consumers to change their lives and businesses to meet the industry's needs. This involves asking customers to "shape, shift, shed and shimmy" as part of flexible load management initiatives as illustrated below (Figure 1).[1]

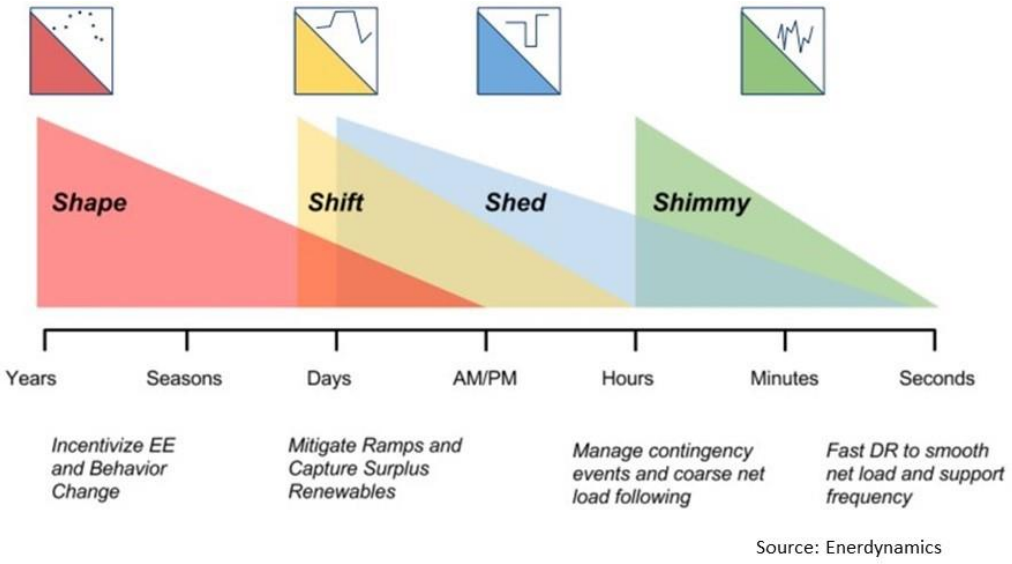

Figure 1. Emergent Framework for Flexible Load Management

Unfortunately, too often in the discussion customers are referred to as 'loads' and identified by 'rate or tariff classes. Rule-makers and suppliers largely decided the services and quality that

[1] P. Alstone, 2025 California DR Potential Study, Schatz Center-Cal Poly Humboldt and Lawrence Berkeley National Laboratory, 2017. Available at:

customers would receive.[2] As an example, flexible load management is defined by LBNL as "the capacity of demand-side loads to change their consumption patterns hourly or on another timescale."[3] Also, Brattle's 2019 report[4] on flexible demand management concluded that, "Improved assessment of load flexibility opportunities can reduce system costs, facilitate grid modernization, and provide environmental benefits." Brattle's report typifies the discussion of flexible load management that focuses almost exclusively on the technology and policy actions, but very little if any consideration of customers' electricity needs and interests.

Customers, however, don't view themselves or their energy needs as a resource to help manage the power system. This highlights the issue with traditional thinking on the role/relationship of the customer. Customers within the current system have largely been viewed as captive and entities to manage, not serve. However, customers over the past decade have increasingly had the opportunity to choose not to use the larger power system for their needs through solar PV, battery storage and back-up generation. This trend will only continue as distributed resources and electric vehicles become more capable and less expensive.

This is a paradox that the industry doesn't fully recognize – advocates for flexible load management view these new customer resources as an opportunity for them to manage for the grid, whereas customers view their devices as a means to significantly reduce dependency on the power system. The industry needs to adapt to customers' interests and recognize that a partnership with customers is needed to achieve the potential of flexible load management envisioned.

PEI's A Gambit for Grid 2035 paper described a step change that was occurring as power systems transition to a clean and more distributed future (Figure 2). The first of the two S curves (in blue) shows the current path of the industry. This curve represents the dominant paradigm of incremental adaptation that the industry has successfully used for many decades, but effectiveness of this model is coming to an end. The second S curve represents the future industry/grid that has changed how it engages customers, adapted to high levels of DER integration, and has added the necessary resiliency to handle dynamic real time load. A core aspect in this transformation is a change in the way the electric industry engages customers who increasingly are no longer captive or passive. As PEI noted, "We are nearing the tipping point in the proliferation of large scale and distributed renewables and storage, increasing potential for customer participation in the marketplace, and transportation electrification within this decade. The industry has already entered this transitional period involving structural transformation. The industry has 'crossed the Rubicon'."

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[2] Pacific Energy Institute, A Gambit for Grid 2035, April 2021

[3] Lawrence Berkeley National Laboratory website: https://buildings.lbl.gov/demand-flexibility

[4] R. Hledik, A. Faruqui, et al., The National Potential for Load Flexibility – Value and Market Potential Through 2030, Brattle, June 2019. Available at: https://www.brattle.com/wp-content/uploads/2021/05/16639_national_potential_for_load_flexibility_-_final.pdf

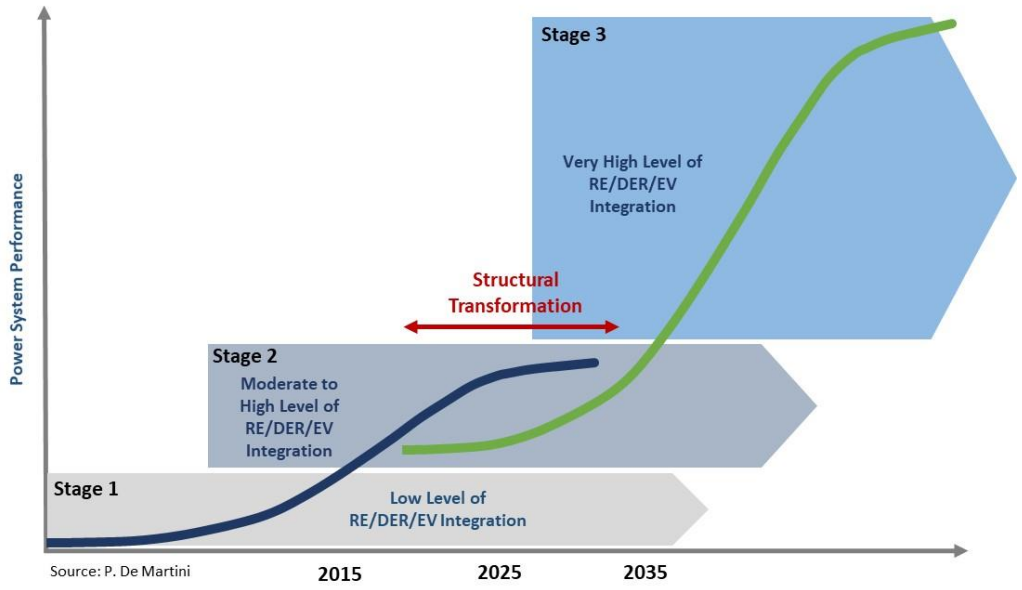


Figure 2: Electric Industry Structural Evolution

A critical aspect of this transition involves an evolution on how we engage customers. This involvement has to be on equitable terms and that cannot be achieved by managing customers if they are considered load. An example of how this has gone wrong is California's Power Down initiative to have customers conserve energy from 4pm to 9pm every day. This initiative is a result of the failure of industry planners and regulators to adequately address customer energy supply needs despite California consumers' energy consumption continuing to decline since 2017.[5] Unfortunately, too often the industry turns its energy supply problems into customer consumption problems. No other service industry operates this way.[6] Customers are certainly a principal driver of change, but their behaviors should be shaping how we design the industry and not something the industry unilaterally tries instead to manipulate through various sticks and a few carrots in order to reach its objectives.

Customer Co-creation

In contrast to this traditional industry approach, the 2nd curve represents a new paradigm, customer co-creation, that encourages customer participation in the problem-solving and program design process to produce a mutually valued outcome. Customer co-creation is defined as an active, creative, and social process, based on collaboration between producers and customers. The idea of co-creation is to actively involve customers in the design or development of future offerings, often with the help of tools that are provided by a company. Co-creation

[5] Y. Jung, "Energy consumption in California continues to decline but where might surprise you", San Francisco Chronicle, December 13, 2021

[6] A. De Martini, "This Little Light of Mine", Pacific Energy Institute, October, 2021

activities are performed in an act of company-to-customer interaction which is facilitated by the service provider – blurring the traditional provider-consumer lines. The acceptance of prosumers as a phenomenon implies that, rather than simply being passive constituents of an industry, customers become principal participants in the creation of and competition for value. This does not imply that all customers are required to participate, but rather by taking a more empathetic approach a greater number of customers may be willing to participate.

This shift to co-creation paradigm is essential as we face a second challenge to enable flexible load management; increasing operational speed necessary to manage a significantly more dynamic grid. The operational speed of the power system is increasing as more digital devices, such as inverters, battery storage and connected consumer devices are introduced this decade and beyond.

This digitalization of the grid is changing the requirements for grid services, energy dispatch and load management systems to become more continuous in operation. Markets too will increasingly be challenged to operate on shorter time cycles. Human in the loop (i.e., grid operator, aggregator, and customer) based methods will be too slow in such an environment. This may also affect the usefulness of discrete event-based solutions, such as traditional and aggregated direct load control and semi-automated schemes that allow customer overrides or take longer to respond. This changing dynamic is illustrated in Figure 3, adapted from an earlier version in the 2013 paper, DR 2.0 Future of Customer Response.[7]

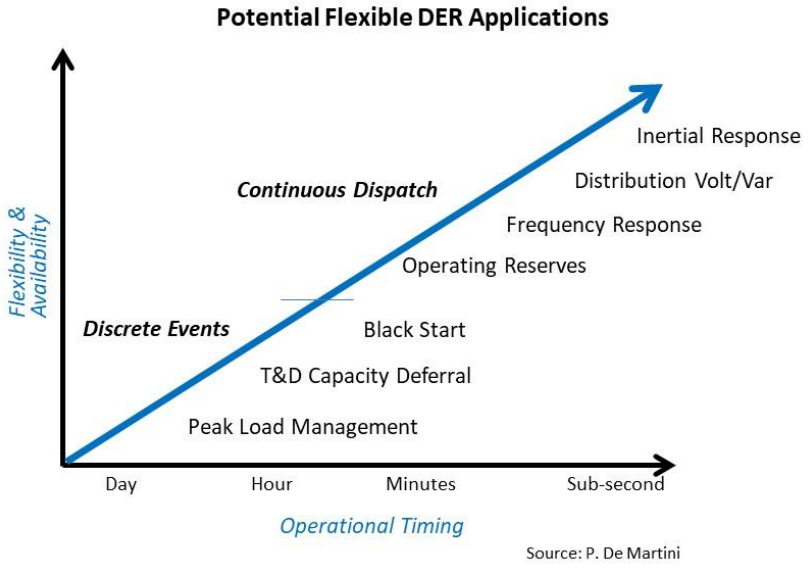
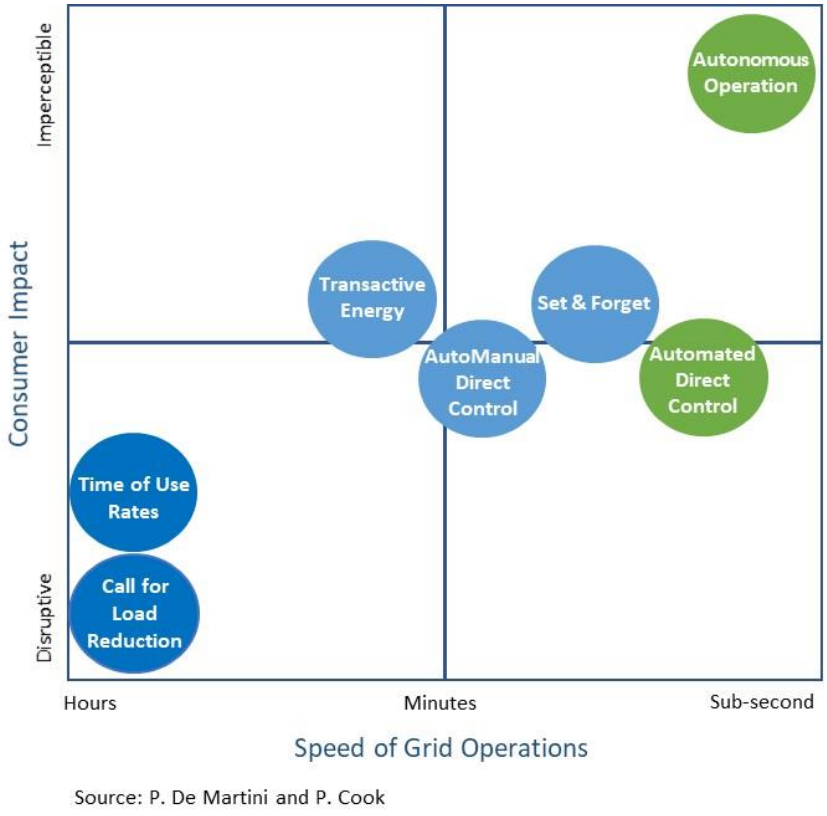


Figure 3. Flexible DER Applications

[7] P. De Martini, DR 2.0 Future of Customer Response, Lawrence Berkeley National Laboratory, July 2013. Available online at: https://s3.amazonaws.com/fonteva-customer-media/00Do0000000Yi66EAC/DR%202.0%20A%20Future%20of%20Customer%20Response.pdf

Flexible Load Management Solutions

Given the challenge of customer willingness to participate and the speed of operation, there is a need to understand the current methods employed in this context. Also, consider the requirements for new programs and methods needed if customer load management is to successfully scale to the level envisioned. Figure 4 below illustrates the current types of solutions employed, and the potential for a new type of autonomous solution, imperceptible to customers, that is beginning to emerge.



Source: P. De Martini and P. Cook

Figure 4. Flexible Load Solution Matrix

Traditionally, demand management involved time of use rates and direct load control programs (i.e., utility and aggregator) involving human decisions to then automatically control devices ("automanual") for air conditioning and electric water heaters. Occasionally, as periodic supply shortages may occur, public service calls for load reduction have been used. The current California request for powering down between 4-9pm is an example. Also, as smart home and building automation technologies have become more sophisticated, the opportunities for more automated methods of managing load have become more prevalent. These "set and forget" programs are often designed to minimize customer impacts by largely operating in the background. Additionally, these programs may be linked to transactive energy or other dynamic prices to devices initiatives that use prices as the trigger for a demand reduction. This has also

been employed in cases where customer premise battery storage (i.e., stationary and/or electric vehicle) is the load management device.

These five types of flexible load management solution archetypes (shown in blue) each have varying disruptive impacts on customers' ability to use electricity in their lives or business. Calls to reduce energy in the evening for 5 hours is extremely disruptive to customers. Time of use rates also involve a high level of customer engagement, action and potential disruption to a customer. Traditional direct load control programs also have a fairly significant potential disruptive impact on customers as seen in the fatigue rates after a series of load reduction events (Figure 5).[8]

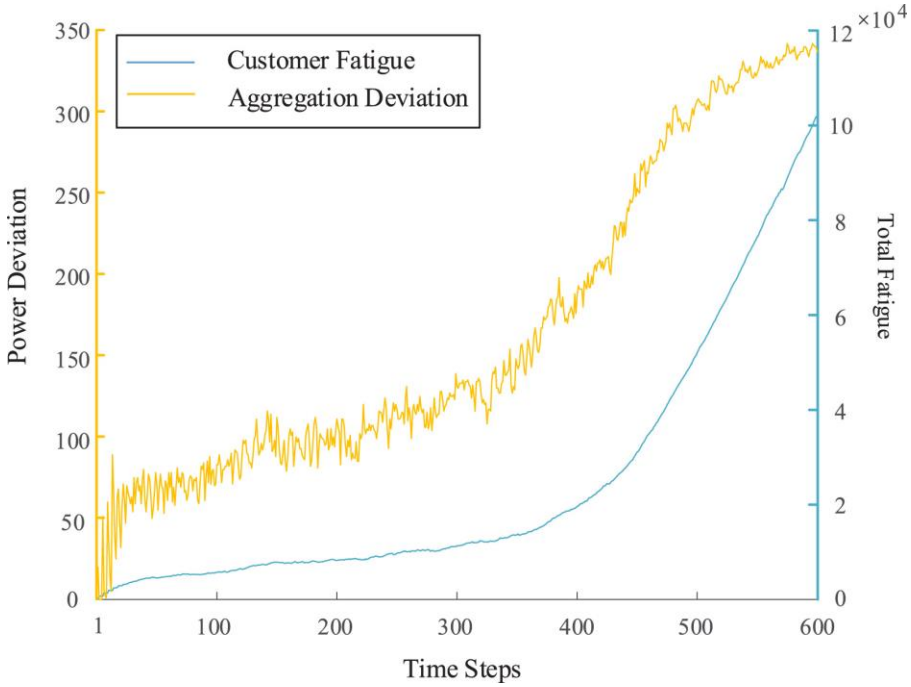


Figure 5. Customer Fatigue & Aggregation Deviation in Frequent Operations

The automated set and forget programs have less potential disruption, except in cases where high or low temperature or other events create issues for customer energy reduction. As a result, experience over the past 30 years has shown that only about 20% of customers are willing, sustained participants in these types of load management programs.[9]

[8] X. Chen, et al., Strategic interaction to reduce customer fatigue in load aggregation, 4th International Conference on Electrical Engineering and Green Energy, CEEGE 2021, 10–13 June, Germany. Available online at: https://www.sciencedirect.com/science/article/pii/S2352484721006417#sec4

[9] DOE, Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies Smart Grid Investment Grant Program, November 2016. Available online at: https://www.energy.gov/sites/prod/files/2016/12/f34/CBS_Final_Program_Impact_Report_Draft_20161101_0.pdf

Customer participation is not likely to dramatically increase until the methods employed for flexible load management achieve a much lower level of impact for customers' lives or business. Imperceptible operation is the goal, such that customers can go about their lives without having to forgo the use of electricity particularly in a more electrified world. It is essential to manage the power system without disrupting customers' lives and businesses, but collaboration should be mutually beneficial to both customers and the electric industry. This requires a step change in the methods employed to operate customer devices. There needs to be a more sophisticated level of operation employed – automated direct control and autonomous operation (shown in green in Figure 2). The reason for this is two-fold; 1) customer imperceptibility of load reductions, and 2) the speed of operation required for flexible load management is increasing as the grid becomes more dynamic.

The operational response times required for bulk power and distribution grid services by 2030 and beyond will increasingly be below 5-minute response times and for several services less than a second. These services will also need to be firmer in terms of grid operators having greater certainty on availability and actual performance in real-time. This suggests that ultimately flexible load management is heading towards automated operations, either through direct control (e.g., automatic generation control) or autonomous operation (e.g., frequency-watt inverter function). That is, an ability to sense grid conditions and respond autonomously based on a set of parameters pre-determined by grid operators (Figure 6).

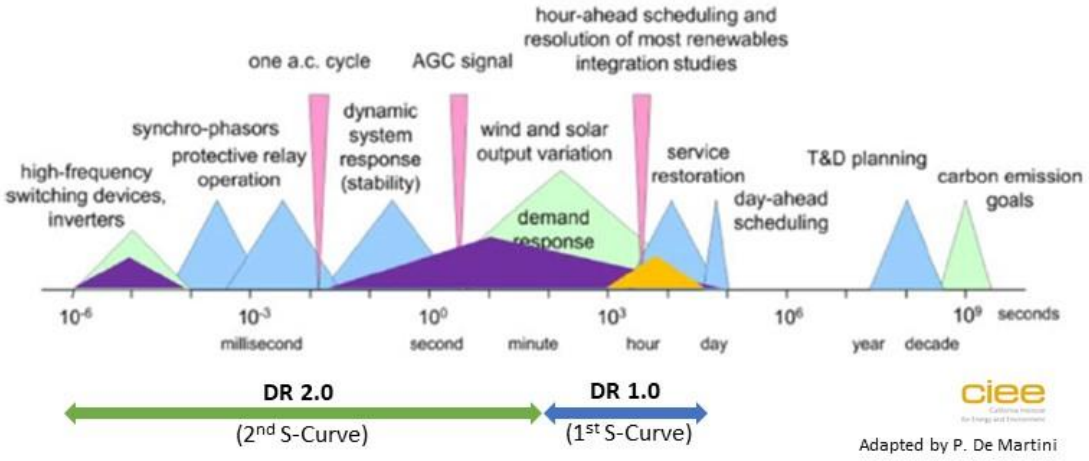


Figure 6. Operational Time Spectrum & Flexible Demand Evolution

In this context, time of use rates that are based on hourly time periods are far too slow and uncertain in terms of performance in real-time. Direct load control, and "set and forget" programs typically have one or more humans in the loop (e.g., grid operator and program administrator/aggregator) that need to communicate and activate the controls. These systems also do not typically have any real-time operational measurement to confirm performance. Autonomous operating devices or the associated premise will need to have real-time

measurement capability, not ex-post measurement as is common today, to determine performance if they are to become high value resources to grid operators.

Significant change needed if flexible load management is able to scale in terms of the number of customers willing to participate and the ability of their devices to affirmatively respond to grid needs. This level of more advanced automation will require a higher level of customer trust with the electric industry, including DER aggregators and other services providers.

New Customer Partnership

Flexible load management requires an effective partnership with customers to build the trust necessary for success. This will involve a 1) a new "customer compact", 2) customer co-creation partnership, and 3) a "social license to automate" in order to use customer resources and devices to manage the grid.

A new customer compact is required for a successful clean energy transition. Energy Consumers Australia undertook detailed research into consumer expectations in 2019.[10] One of the strongest findings was that households and small businesses are willing to play their part in the transition to a clean energy future, but that they want to be assured that there will be reciprocity – that the institutions and industry that make up the power system will also play their part in enabling and empowering consumer choice and control. Consumers also expect that the future power system will be affordable, and that it will be fair to people with the least resources and opportunities.

Therefore, it is critical to build a new compact with households and small businesses that are responsible for investing and participating in that future. In Australia, the Australian Council of Social Services and the Total Environment Centre with the support of Energy Consumers Australia proposed such a consumer energy compact that includes:[11]

Consumer focused
Design with and for consumers today and in the future. Ensure that everyone can access clean, affordable, dependable energy.

Deliver clean & healthy energy
Transform the energy system to achieve net-zero emissions by enabling the environmentally sustainable production and use of energy. The transition to a clean energy system is a shared responsibility.

Make sure it works

[10] Energy Consumers Australia, Behavior Survey, October 2021. Available online at: https://ecss.energyconsumersaustralia.com.au/behaviour-survey-oct-2021/

[11] Australian Council of Social Services, Total Environment Centre and Energy Consumers Australia, New Energy Compact - People centred vision for the Australian energy system Consultation Draft 5.0, November 2020. Available online at: https://www.acoss.org.au/wp-content/uploads/2021/02/NEC_Consultation-Draft-V.5-04122020.pdf

Ensure consumers can depend on energy system resilience and efficiency across the supply chain, promoting efficient energy use and new technologies and services that benefit people and the environment.

Think long-term & be flexible
Focus on delivering the energy system needed in the future to improve the outcomes for consumers and communities. A system that is flexible, innovative, responsive, and based on consumers' expectations.

This consumer empathetic compact is critical in driving industry leaders' decisions regarding this clean energy transition and as a starting point for flexible load management. It is essential that customers are required to disrupt their lives or businesses in order for the power system to operate efficiently in normal conditions. Any program that requires a customer to change their behavior, or charges them more for basic use during "peak hours" is not equitable in a world with increasing low-cost clean resources and ubiquitous storage solutions. Industry created problems shouldn't require extraordinary efforts from customers to solve, especially without meaningful compensation.

This compact will also require engaging customers as co-creators along the entire solution development process and continuing in the operation of the system. Successful programs will include customers in a participative co-design process that extends beyond the walls of the regulatory hearing room, and utility and aggregator offices. Customer empathy is at the heart of design. As IDEO describes, it is paramount "to understand what others see, feel, and experience." This is required "to appreciate the true scale and complexity of the challenge of understanding a complex social situation in order to design a system that supports many and various needs." Such participatory processes naturally incorporate customer empathy into the design process as customers are given decision making power. This level of co-creation can lead to more breakthrough solutions of the type needed.

Additionally, there is a need to consider the structure of the partnership with customers in order to use their generation and storage resources, and electrical devices to manage the grid. The IEA has a multi-national initiative including customer advocacy organizations focused on exploring the parameters of a Social License to Automate.[12] Specifically, this effort is considering "the dynamics of trust and related social dimensions which determine user engagement with automation technologies in demand side management."

Conclusion

The current pricing, programs and market methods for responsive customer demand is incompatible with customers lives and businesses in a highly electrified future. They are also inadequate for power system operations in 2035. As such, there is a pressing need to

[12] IEA Technology Collaboration Programme, Social License to Automate Task: https://userstcp.org/task/social-license-to-automate/

revolutionize the way the industry designs and implements flexible load management from a human centered perspective.

First, a customer empathetic power system must consider the basic human and economic needs of customers as part of any effort to utilize flexible load management as a resource. This requires empathy in the design of any tariff, program or market if flexible load management is desired at the scale envisioned by Brattle[13] and others.

Second, there is a growing need for grid services that continuously operate on very fast time cycles to support power system operations. This, in turn, requires faster response from distributed resources in order to manage a more dynamic grid – creating the need for more parametric based autonomous capability. As such, a new relationship with customers built upon trust and transparency is required, as a prerequisite to an explicit license to use customers' resources (incl. energy consuming devices) to manage the grid.

[13] Brattle, National Potential for Load Flexibility, 2019