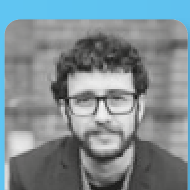
REDUCING BARRIERS TO ENTRY AND HEDGING AGAINST OBSOLESCENCE **WITH SMART GRID INTEROPERABILITY**



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REDUCING BARRIERS TO ENTRY AND HEDGING AGAINST OBSOLESCENCE WITH SMART GRID INTEROPERABILITY

By Cheyney O'Fallon & Avi Gopstein

Interoperability is the last significant barrier to the full participation of distributed energy resources in electricity markets and operations. The opportunities for diverse and unconventional system participants to create value will continue to grow as the challenges of systems and market integration are mitigated. Enhancing interoperability to ease energy systems integration opens opportunities for operational improvements and value creation that exceed the horizons of any single installation or project. Today, interoperability can help lower barriers to initial market entry that arise from informational asymmetry. For potential market participants to design solutions they must have information about the value space and opportunities for improvement that exist in the system. Interoperability is a countervailing force against market fragmentation that divides and devalues critical network infrastructure according to these historical informational asymmetries. Interoperability can also ensure the ability to stack value streams associated with grid technologies, hedging against obsolescence as today's innovations age into tomorrow's legacy equipment. Going forward, interoperability can enable legacy assets to enter subsequent markets by equipping technical solutions purchased to meet present needs to continue delivering value even as public policy, operations, and market paradigms evolve.

Interoperability is the last significant barrier to the full participation of distributed energy resources ("DER") in electricity markets and operations. The shrinking scale of technology and associated per-unit investment costs, the reduced engineering and environmental issues for siting and permitting of small-scale commodity energy technologies, and the emergence of energy service companies to manage procurement and installation challenges allows the non-institutional participant to invest in and provide resources to energy markets as never before. Technical innovation and the inherent modularity of modern energy technologies have already substantially addressed barriers previously associated with energy market participation. The opportunities for diverse and unconventional system participants to create value will continue to grow as the challenges of systems and market integration are mitigated.

There is a pressing need for strategic responses to the threats posed by climate change, cyber adversaries, economic inequality, and growing competition for scarce natural resources. The perception that innovative energy resources pose a threat to traditional grid operations[2] must be overcome, and the barriers and frictions that dissipate value brought by new market entrants should be reduced to maximize the societal return on grid modernization investments. Many of these market barriers and frictions generally arise from a lack of interoperability and can emerge as additional and unnecessary integration or operating costs.[3] And while these barriers are often perceived as protecting existing business models,[4] the associated costs harm both the emergent DER owners and incumbent operators with whom they might otherwise cooperate.[5]

Like many commodity industries that provide value through their inputs to other economic sectors,[6,7,8] the electric grid has historically created more societal value than is captured through the sale of electricity. The value not captured by electric sector utilities, vendors, and system operators is instead realized through the productive actions of stakeholders throughout the economy who benefit from abundant and affordable energy — to say nothing of the concomitant societal benefits brought by reliable and equitable energy access. For sectors like electric power, where network effects are strong, eliminating market failures that benefit few and disadvantage many is key to maximizing economic and societal benefits.[9]

Enhancing interoperability to ease energy systems integration for new resources opens opportunities for operational improvements and value creation that exceed the horizons of any single installation or project. As interoperability requires ongoing attention, and backwards compatibility is not inevitable, firms and stakeholder groups need to become more comfortable with the process of maintaining high levels of interoperability for these emerging opportunities to remain open in the future. So maintained, interoperability and systems integration cultivate a persistent benefit that is revisited upon stakeholders each time new technologies emerge from research and laboratories to find their place on rooftops, utility poles, and servers. Thus, interoperability can also ensure the ability to stack value streams associated with grid technologies, hedging against obsolescence as today's innovations age into tomorrow's legacy equipment.

While there will always be uncertainty regarding the future of the electric power sector, early obsolescence of today's investments as operations and markets evolve is not a foregone conclusion. Interoperability helps equip infrastructure solutions purchased to meet present needs to continue delivering value even as public policy, operations, and market paradigms evolve.

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2 George S Day & Paul JH Schoemaker, *Scanning the periphery*, 83 Harvard business review (2005).

3 Steven C Salop & David T Scheffman, *Raising rivals' costs*, 73 The American Economic Review (1983).

4 Julian Birkinshaw, *Ecosystem businesses are changing the rules of strategy*, 8 Harvard Business Review (2019).

5 Harold Demsetz, *Barriers to entry*, 72 The American economic review (1982).

6 Stefan Heck, et al., *Creating value in the semiconductor industry*, 1 McKinsey on Semiconductors (2011).

7 Jacques Bughin, *The web's! 100 billion surplus*, 2 McKinsey Quarterly (2011).

8 Severin Borenstein & Nancy L Rose, *How airline markets work… or do they? Regulatory reform in the airline industry*, *in* Economic regulation and its reform: What have we learned? (2014).

9 Francis M Bator, *The anatomy of market failure*, 72 The quarterly journal of economics (1958).

Information asymmetry is a central challenge to the emergence of new energy services and products.[10] For potential market participants to design solutions they must have information about the value space and opportunities for improvement that exist in the system. Incumbent suppliers have made considerable investments to better understand the needs of their customer base, the constraints of their infrastructure networks, and the cost structures of their generating fleets and delivery technologies; this information is not generally available to new entrants. That some participants are closer to the market and have some informational advantage may be the unavoidable, and perhaps desirable, outcome of prudent investment. However, it is in the interest of economic competitiveness that informational advantage earned through sound investment strategies does not unnecessarily preclude other stakeholders from making complementary investments in shared systems. Where coordinated action can create new value streams or reduce system costs, greater interoperability of data and communication stands to benefit the many segments of the economy served by energy infrastructure.

For many energy service providers that are capable of designing and installing DERs for non-institutional participants, the requisite information on customer needs and use patterns has been historically collected and protected by utilities.[11] This defense of the data against disclosure serves both pecuniary and regulatory imperatives of doing business in the electric power sector. Expectations for data sharing and cooperation have increased as utilities have adapted to threats to the safe and cost-effective operation of their systems. Initial improvements in system performance have come from customers making informed choices regarding their energy consumption patterns as utilities have implemented better metering systems and made that data available to end users. Standardization of data recording and communications between utilities and customers enables utilities to realize new internal efficiencies. As interoperability improves, third-party service providers are aggregating customer-based contributions to grid operations that were previously too small or scattered to be worth pursuing.[12] Interoperability is a countervailing force against the market fragmentation that divides and devalues emerging resources and our critical network infrastructure.

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Interoperability improvements targeting greater consistency in data access strategies across service territories and political boundaries can harmonize market access strategies and reduce the market fragmentation that limits opportunities for developing DER installations and energy service solutions for non-utility market participants. By increasing the scale of the economic prize to be obtained through product and service development, transaction and soft costs can be spread thinner over more customers, thereby reducing individual burdens of participation. As interoperability improves throughout the electric power sector, the complexity of porting effective strategies from peer communities is also reduced, and so more people will benefit from lessons learned and value created in adjacent settings. Information asymmetries that arise from the complexity of data access present an excellent target for interoperability improvements. This is especially true of improvements that create value by reducing barriers to entry for end use energy consumers, the utilities that serve them, and those third-party firms that can innovate cooperative strategies when reliable high-quality data is available, communicable, and actionable.

Many of the most energy intensive appliances and grid assets commonly found across the country are, for sensible reasons, designed with sufficient robustness to outlive their place at the top of the technological merit order. For example, just a few years after purchase, a conventional water heater installed in a home will in many cases no longer constitute the most efficient or cost-effective technology for producing warm water for household use when it is needed. Tankless heat pump water heaters are presently much more efficient at using energy to meet hot water requirements for many homes. Nevertheless, replacing heavy and expensive durable equipment that must be decommissioned and physically removed from plumbing

10 Wayne P Olson, *Lessons from the new institutional economics*, 10 The Electricity Journal, 46, 54-55 (1997).

11 See Avi Gopstein, et al., NIST framework and roadmap for smart grid interoperability standards, release 4.0 59 (Department of Commerce. National Institute of Standards and Technology. 2021).

12 Eva Niesten & Floortje Alkemade, *How is value created and captured in smart grids? A review of the literature and an analysis of pilot projects*, 53 Renewable and Sustainable Energy Reviews (2016).

systems comes at a cost that can be a barrier to energy efficiency retrofits. Present labor market conditions and rising costs of capital further limit the opportunities for many to retrofit such systems, exacerbating technology lock-in throughout the sector.

Although technical advances can leave energy consuming devices installed in a home or business cost-inefficient compared to the most modern offerings, the costs of replacing technology before the end of its useful life often deprioritizes modernization investments as much of the value to be gained from the new technology could be dissipated in the replacement process. Interoperability can change how we use technologies that are no longer strictly the most efficient at their original use case, yet are still more than capable of delivering value. Interoperability and direct load control may enable older devices to escape the stranded asset trap of early obsolescence by changing the way we use them.

Interoperability can help to enable devices—like these water heaters—that were sensibly installed in the recent past avoid obsolescence through the stacking of new value propositions. Conventional water heater tanks constitute thermal energy storage in a house. Such water heaters operate on a duty cycle, and do not draw their rated load at all times in order to meet homeowner or business operator needs. For conventional tank-based water heaters, interoperability to enable direct load control could enable the user to add to the original hot water supply value proposition by including the emergent value stream of demand response for grid stability. In this way, both the utility and the customer can benefit from the value created as interoperability enables new functionality for legacy assets.

Interruptible water heaters that are able to coordinate with similar devices across a service territory and are interoperable with utility or service aggregator signals can deliver demand-side flexibility to help system operators to manage the grid and better ride through periods of physical or financial stress.[13] By reducing the cost of meeting loads, through reducing demand for energy to heat water when the marginal cost of electricity generation and delivery is high, older yet interoperable water heaters create value for the system with no inconvenience to the customer.

While the value propositions tied to a single device is small in uncoordinated isolation, once aggregated across many similar devices the obtainable value becomes meaningful to both the system and the consumer. Demand response becomes meaningful when marginal energy uses can be paused for the betterment of system operations without visiting outsized costs or value destruction on end use customers. And beyond the relatively simple water heater example provided here, the ability to interoperate with and coordinate the actions of diverse and distributed resources can bring about additional value propositions across the full range of long-lived conventional grid assets, resources, and loads.

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Energy sector executives and households across the world are confronting a decision-making environment described by rising costs of inputs as the complex global economy continues to reconfigure itself in the shadow of threats to public health, energy and cyber security, resource production, and energy delivery. Strategies predicated on the ability to eliminate uncertainty are untenable and will most likely lead to suboptimal future states. Interoperability can improve the set of options at decision makers' disposal when confronting events ranging from garden variety economic shocks to the low probability, high impact events that readily overcome even the best laid plans. Interoperability is foundational to the development of more inclusive grid institutions as it works to dissolve barriers to entry for new participants who can contribute to the value creation process of complex systems like the electric grid and prevent early obsolescence from eroding these gains as technologies and the demands we place on them rapidly evolve.

13 Gopstein, et al., 41. 2021.

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