NEW POLICY FOR AN ERA OF ENERGY DIGITALIZATION:

POWER

OCTOBER 2018

EC-MAP

ENERGY CONSUMER MARKET ALIGNMENT PROJECT

ABOUT EC-MAP

The Energy Consumer Market Alignment Project (EC-MAP) is a Washington, DC non-profit operating in collaboration with the Keystone Policy Center, an independent non-profit founded in 1975 to drive actionable, shared solutions to contentious policy issues. We envision an energy future where digital technologies drive greater transparency, fair competition, and consumer choice—and where policy enables innovation instead of creating market barriers.

EC-MAP seeks to work with stakeholders to advance knowledge and associated policy mechanisms to accelerate the era of energy digitalization. Our goal is to enable a critical dialogue around identification of policy barriers and the future role of government to promote free and fair market competition and build policy consensus that benefits energy consumers, the economy, and the environment.

ACKNOWLEDGEMENT

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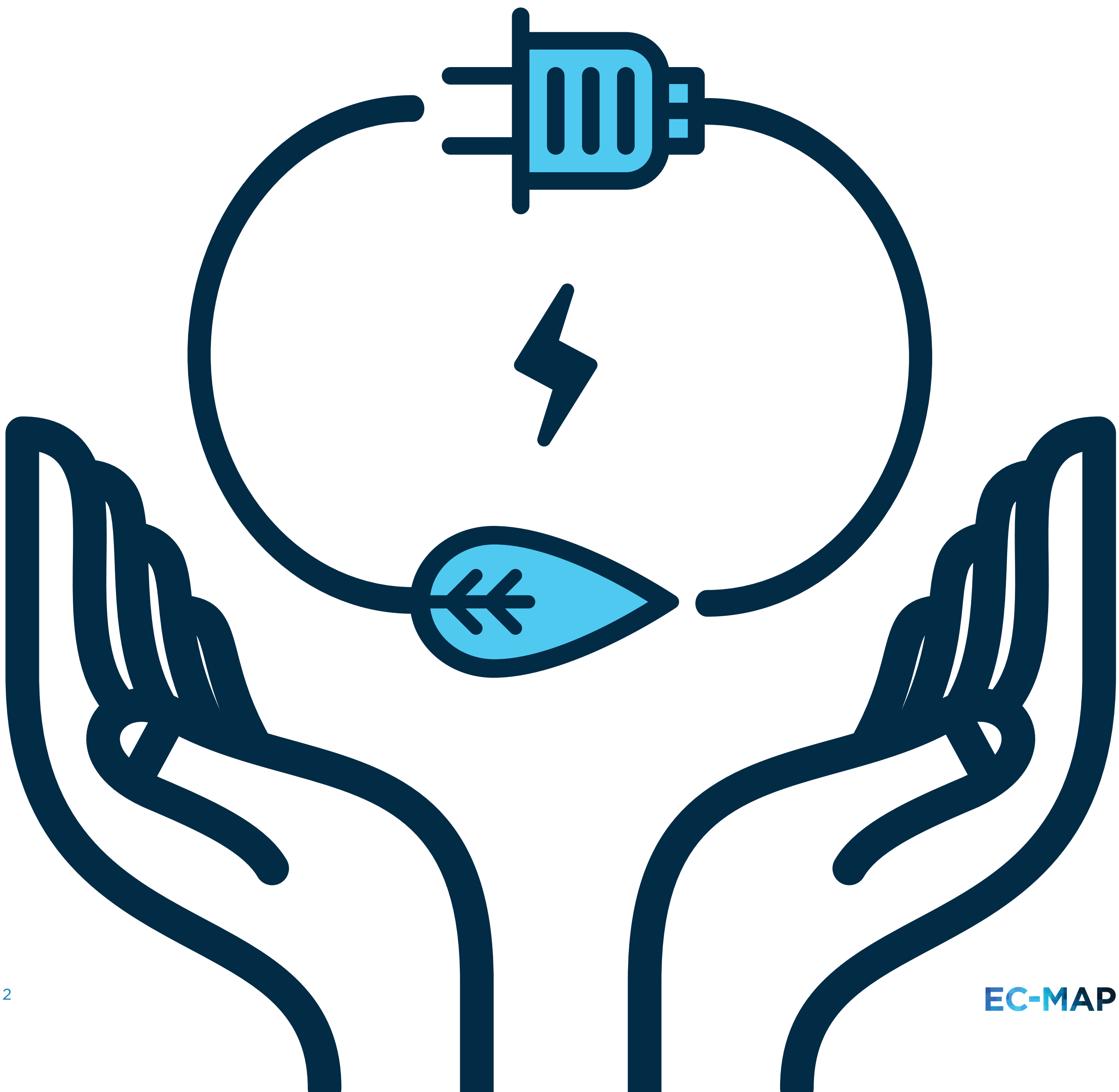
TABLE OF CONTENTS

EXECUTIVE SUMMARY



Throughout history, the energy system has gone through revolutions driven by technology and innovation. Today, change is being driven by three trends: decentralization, connectivity, and automation. Economies of scale for clean energy generation are rapidly transforming the grid. Real-time access to the internet, broadband, and mobile devices is driving consumer demand for transparency, empowering sustainable data management, and circumventing traditional limits to choice. Advances in computing and machine learning have enabled automation and advanced functionality to be embedded within energy delivery systems and distribution networks.

Together these trends are enabling a new era of energy digitalization. This era will be dominated by crosscutting digital tools and platforms that can be applied to the energy system in myriad ways—technologies including artificial intelligence, blockchain, crowdsourcing, the internet of things, and software that enables new business models. This era is also one where change will be driven from the bottom up—in other words, one where consumers play a much more significant role in meeting their energy needs and driving goals around cost, sustainability, and efficiency.

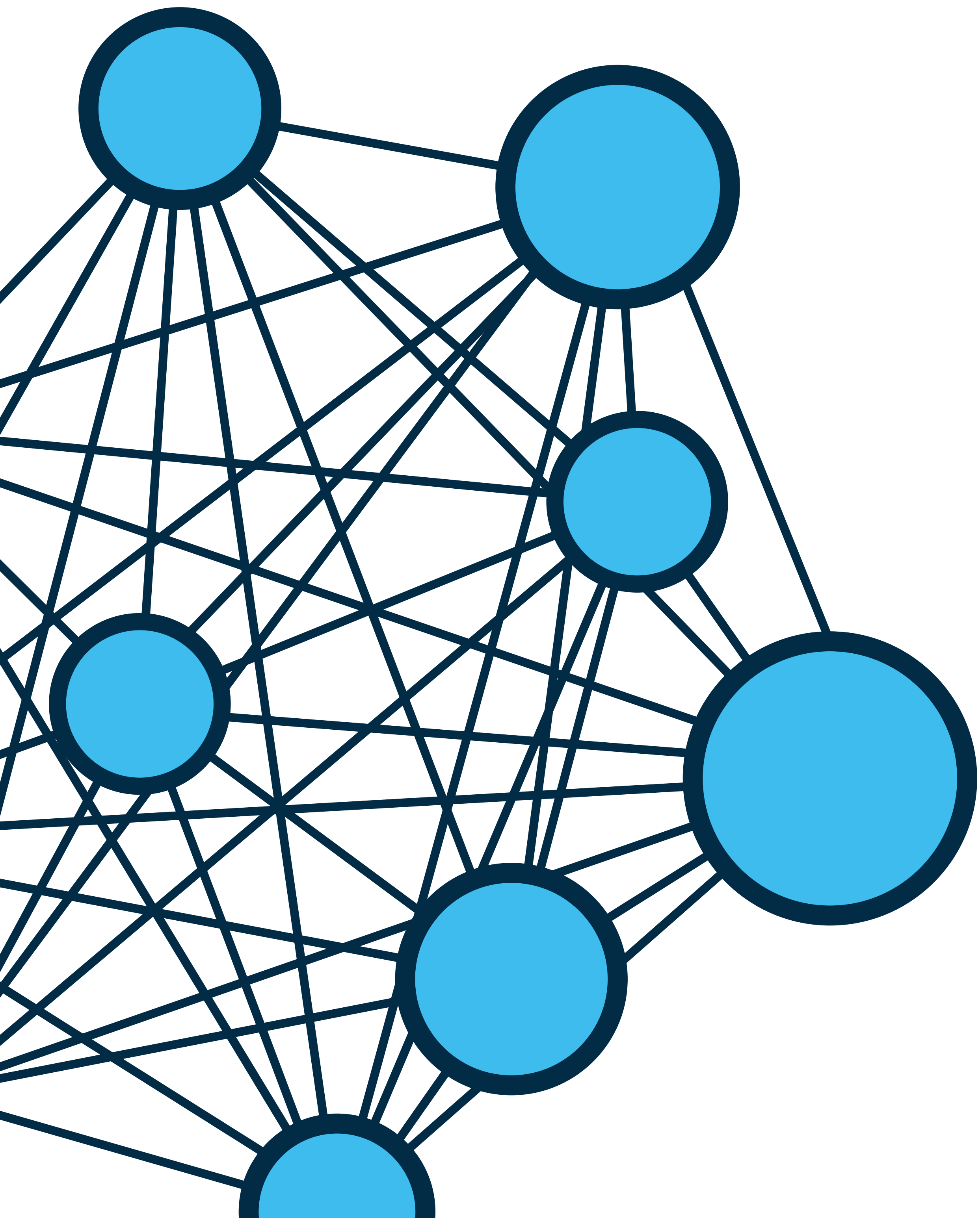
The era of energy digitalization requires policymakers and regulators to embrace a new way of thinking about energy governance. The energy system of the past required intermediation—i.e. establishing regulation and incentives to protect the public interest and to promote specific resources and technologies deemed superior or desirable. The era of energy digitalization, in contrast, requires disintermediation—i.e. removing barriers to facilitate new markets, enable new forms of transactions, and empower consumers.

Today, there are increasing tensions between digital innovations well positioned to deliver what consumers want and policy that creates barriers to their adoption. Competitive markets that enable consumer choice are often stymied by outdated approaches to governance. Policy and regulation often create barriers to new technologies and business models that were not yet contemplated when the policies were introduced. Digital technologies that enable secure, decentralized electricity transactions are poised to put the consumer rather than a monopoly in the center of the market and enable faster, more efficient approaches to regulatory compliance—if governments will let them. Specifically, statutes such as the Federal Power Act, Clean Air Act, and Public Utility Regulatory Policies Act (PURPA); approaches to setting energy efficiency standards and tax policy; and state regulation including Renewable Portfolio Standards (RPSs) are increasingly not aligned with emerging digital innovations.

EC-MAP is challenging stakeholders to consider a different future—one where digital innovations enable consumers to express preferences that drive markets—and where policy plays a more limited and nuanced role. This future does not require significant new R&D, and it is not one that is decades away; this future is already emerging.

EC-MAP and our partners believe the era of energy digitalization is inevitable; the only question is whether government will accelerate or impede its benefits. EC-MAP plans to work with incumbent stakeholders, new stakeholders, policymakers—and you—to align policy with a digital energy future.

I. OUR CHANGING ENERGY SYSTEM



TECHNOLOGY DRIVES CHANGE

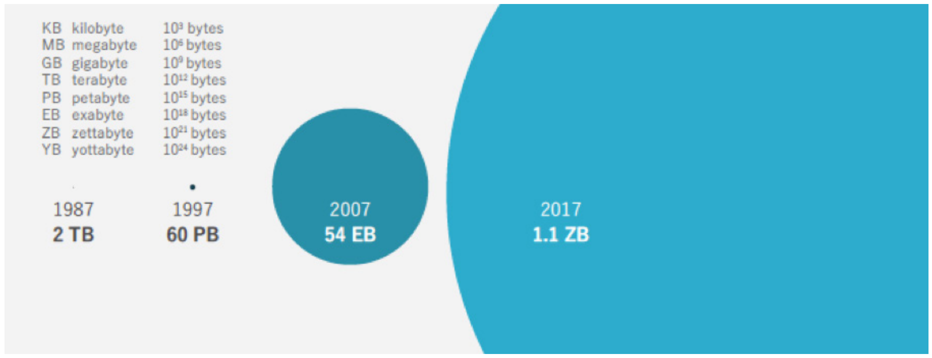
Throughout history, the energy system has gone through revolutions driven by technology and innovation. Before the Industrial Revolution, agriculture was central to energy, with wood used for heat and horses for transportation. In the 19th Century, the invention and development of modern drilling techniques, the use of kerosene for lighting, and finally the development of the internal combustion engine, all helped unleash an era dominated by fossil fuels. The 1973 oil embargo catalyzed another revolution, this time focused on domestic energy production, resource diversity, and energy efficiency. Now, just a few decades later, the energy system is in the infancy of another transformation—one that integrates and harnesses the power of the internet and digital technologies to democratize access to information and energy management.

There are three significant and inexorable trends now driving change in the energy system: decentralization, connectivity, and automation.

- **Decentralization**. Economies of scale for energy generation are rapidly transforming the grid. Renewable generation technologies (in particular solar PV) are increasingly economic not only at large utility scale but also at smaller scales appropriate to residential, commercial, and industrial buildings.
- **Connectivity.** Real-time access to the internet, broadband, and mobile devices has increased exponentially (see Figure 1). In the U.S., smartphone adoption has surpassed 80 percent.[1] Smart meter technologies have become fundamental to distribution utility business models, with 70 million deployed as of 2016.[2] For consumers, expanded connectivity is driving demand for transparency, empowering sustainable data management, and circumventing traditional limits to choice.
- **Automation.** Advances in computing and machine learning have enabled advanced functionality to be embedded within energy delivery systems and distribution networks.[3] Such technologies are already being applied to the electricity sector in the form of self-healing grids that re-route power to maintain reliability and in-home devices such as smart thermostats capable of integrating consumer preferences and reacting to energy price signals.[4]

Together these trends are driving change from the bottom up, with consumers playing a much more significant role in meeting their energy needs and driving goals around cost, sustainability, and efficiency.

Figure 1
Growth in Global Internet Traffic



Source: International Energy Agency

THE ACCELERATING PACE OF DIGITALIZATION

Information and communications technologies are increasingly dominant in the economy as a whole.

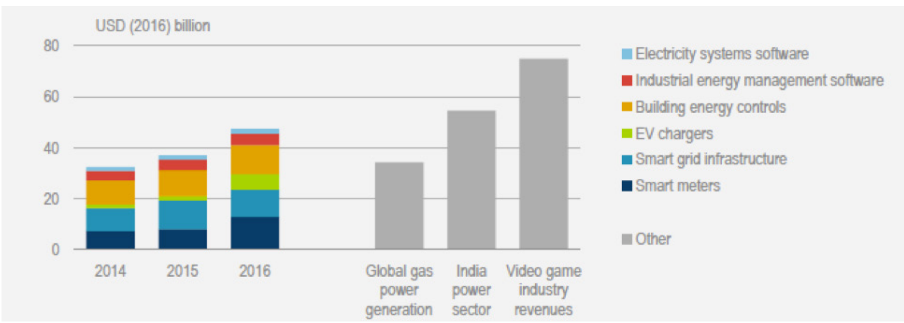
Information and communications technologies are increasingly dominant in the economy as a whole. As recently as the early 2000s, the world's largest companies represented a diversity of industries; however, today all are companies focused on information and communications technology (see Figure 2).

Information and communications technologies are intersecting with the energy system in a variety of ways, including through data collection, data analytics, and real-time communications networks.[5] Although the intersection of information technology and energy is far from new, the pace of adoption is accelerating dramatically. Investment in digital technologies by energy companies grew by more than 20 percent between 2014 and 2016 (see Figure 3). Bloomberg New Energy Finance has projected annual benefits from digitalization of the energy sector will rise from $17 billion in 2017 to $38 billion in 2025. Analysts also note that mature technologies such as smart meters show the largest benefits in the near-term, but "services to provide flexibility to the grid and leverage residential energy loads" grow the fastest over the long term.[6] Accelerated adoption of smart, two-way communications technologies is also already driving increased engagement by utilities around the appropriate and necessary allocation of broadband spectrum to accommodate them.[7]

Figure 2
Largest Companies by Market Capitalization

Source: International Energy Agency

Figure 3
Recent Growth Trends in Digital Energy Infrastructure Invesment



Source: International Energy Agency

Unlike many innovations of past decades, emerging digital innovations are not technologies that serve a single purpose, such as electricity generation. Rather, most are crosscutting digital tools and platforms that can be applied to the energy system in myriad ways. They include:

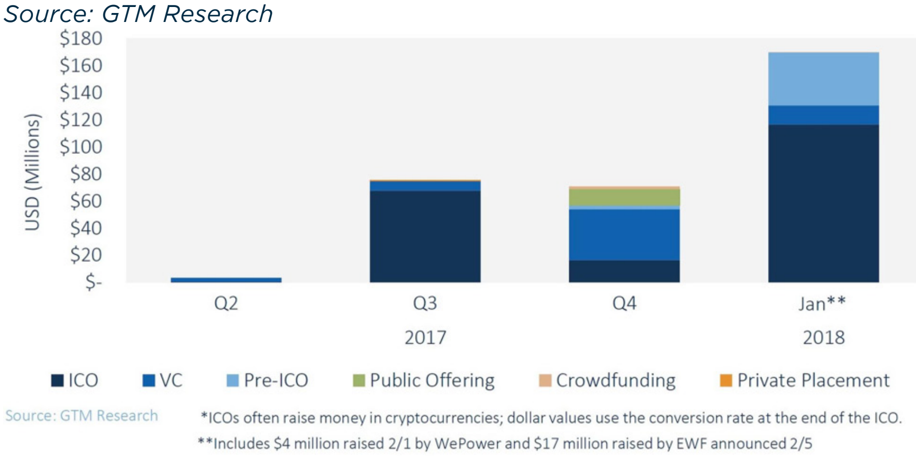
- Artificial intelligence and machine learning that enable increased automation;
- Blockchain technologies that enable secure, decentralized, peer-to-peer transactions;
- Crowdsourcing platforms that enable creative finance mechanisms and expose consumer preferences;
- The internet of things, which connects smart appliances, electronics, mobile devices, and sensors and enables them to communicate across a network; and
- Software and systems that enable new business models for energy services.

These digital tools and platforms create new data streams that have significant potential to enhance measurement, reporting, and verification (MRV) related to carbon and other emissions reporting, energy efficiency optimization, and renewable energy and distributed energy resources transactions. Digital MRV can improve speed and accuracy of reporting, lower reporting and verification costs, and increase scalability and security of MRV systems.[8] It can also enable new approaches to policy design, more effective enforcement of regulations, and better oversight of policy effectiveness.

Investment in these areas is growing rapidly. Investment in blockchain by energy organizations, for example, has gone from nearly nonexistent a year ago to approximately $170 million in January 2018 (see Figure 4).

Figure 4
Investments in Blockchain by Energy Organizations

Source: GTM Research



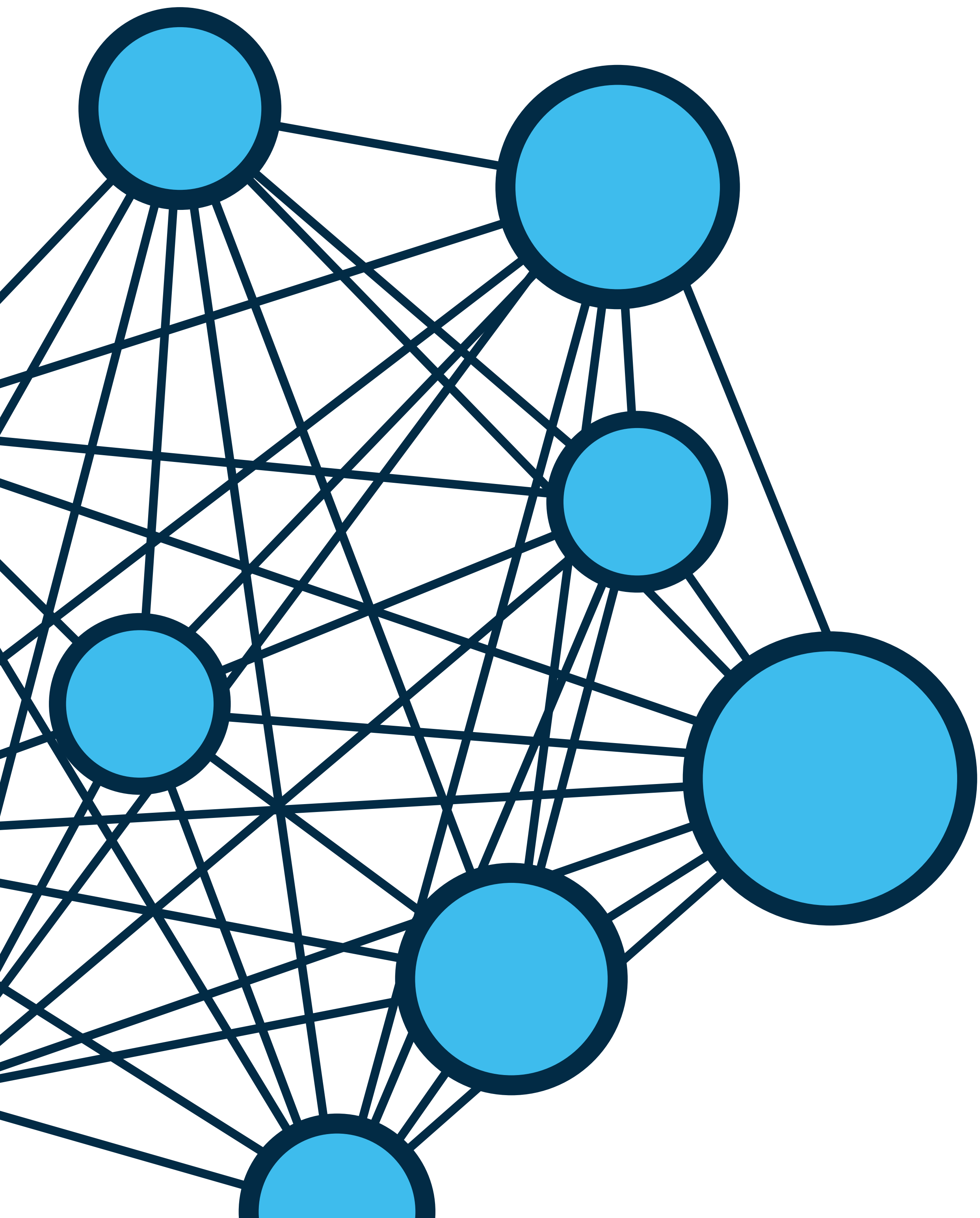
THE NEW ROLE FOR GOVERNMENT

Government plays a fundamental role in the energy system. However, as an institution, government is not designed to move quickly. The era of energy digitalization requires policymakers and regulators to embrace a new way of thinking about energy governance. Historically, government intervention was designed around the concept of intermediation—i.e. establishing regulation and incentives to protect the public interest and to promote specific resources and technologies deemed superior or desirable by policymakers. The era of energy digitalization, in contrast, requires intervention designed around the concept of disintermediation—i.e. removing barriers to facilitate new markets, enable new forms of transactions, and empower consumers. If government is to remain relevant, policymakers and regulators must align energy policy to enable competitive markets that are designed to accelerate innovations and optimize benefits to consumers.

The era of energy digitalization requires policymakers and regulators to embrace a new way of thinking about energy governance.

The era of energy digitalization does not require that all policy and regulation be abolished; but neither should policymakers reflexively assume that existing policy and regulatory architectures are still relevant or necessary. Section II reviews how existing policy and regulation create barriers in our changing energy system; Sections III and IV outline a framework for developing new policy approaches that are better aligned with the era of energy digitalization. EC-MAP and our partners believe the era of energy digitalization is inevitable; the only question is whether government will accelerate or impede its benefits.

II. HOW EXISTING POLICY AND REGULATION CREATE BARRIERS TO CHANGE



No policy or regulation is perfect; most energy policies were initiated with good intentions, such as to spur economic growth, boost national security, help consumers, and protect the environment. However, too often as the energy system evolves, policy remains stagnant. In today's world of exponentially accelerating change, old ways of thinking have the potential to—intentionally or unintentionally—block the very innovations necessary to achieve policy goals.

Already, much of today's energy policy architecture is no longer aligned with the realities of the energy system. Policies originally designed decades ago have often been extended over and over again as a matter of course without reassessment of fundamental goals and impact; others have not been altered significantly in that same timeframe. Some utilities and other incumbent stakeholders logically seek to protect the status quo (in which they have often invested significant resources) while blocking changes that would disrupt their interests or incentivize alternative solutions.

Policies originally designed decades ago have often been extended over and over again as a matter of course without reassessment of fundamental goals and impact.

Below are four current issues that illustrate tensions between status quo policy approaches and a future where digital innovations enable markets to respond directly to consumers and enable consumers to express preferences that drive markets. At the end of Section II, Table 1 inventories a broader selection of existing policy and regulatory architectures and how they create barriers to emerging innovation, market efficiency, and consumer choice.

MARKETS VS. POLITICS

States that restructured electricity markets in the 1990s formed or joined regional transmission organizations (RTOs) and independent system operators (ISOs), which were tasked with setting market rules to ensure reliable, efficient, and cost-effective wholesale electricity supply and delivery. The Federal Energy Regulatory Commission (FERC) regulates wholesale electricity sales and transmission, including ensuring that wholesale electricity rates are just and reasonable. Competitive markets have proven they can accelerate innovation; however they do not always result in outcomes aligned with political priorities.[9] As a result, there is increasing tension between policies that favor specific generation sources and competitive wholesale markets that seek to optimize price, reliability, and efficiency regardless of fuel. A blurring distinction between the bulk power grid and the distribution system is further exacerbating these tensions.

At the Federal level, one of the dominant energy policy issues of the past year began with the Department of Energy Notice of Proposed Rulemaking for the Grid Resiliency Pricing Rule (DOE NOPR). The DOE NOPR directed FERC to require cost recovery for merchant generators that keep 90 days of fuel supply on site in order to improve resiliency; as a practical matter, the requirement would have largely benefitted coal and nuclear plants. FERC rejected the proposal in early 2018, but also acknowledged the value in considering broader resiliency issues and opened a new docket to do so. It became clear that the Trump Administration would continue to consider options to support ailing coal and nuclear plants when a National Security Council memo addressing the issue was leaked in June 2018. The memo suggested providing support to plants using authorities under the Federal Power Act and Defense Production Act, although to date, additional details about how the proposal would be executed have been scarce.

Similar issues have bubbled up at the regional and state levels. In March 2018, a two-part capacity market proposal by the New England ISO seeking to prevent subsidized resources covered by tax credits or mandates from depressing prices was narrowly approved by FERC but with significant dissent.[10] A few months later, two pricing reform options proposed by the PJM Interconnection met a different fate; both were rejected by FERC in a complex set of opinions, sending PJM back to the drawing board. Meanwhile in New York and Illinois, zero emission credits (ZECs) intended to bolster struggling nuclear plants have faced legal challenges;[11] recent court decisions may shift the debate back to FERC.[12] And in Nevada, some environmental advocates are opposing a November ballot measure intended to spur the growth of renewables by allowing retail electricity choice after one monopoly utility (NV Energy) committed to doubling its investment in renewables if the measure is rejected.[13]

Tensions are also increasing as market operators consider new rules on resiliency, energy storage, demand response, and distributed energy resources (DERs). FERC considered how DERs can participate in power markets at an April 2018 technical conference, and follow-on regulatory action is expected in the near future.[14] Many states are also looking to revise renewable portfolio standards (RPSs)—in some cases to open them to a broader array of clean technologies and in other cases to incentivize resources that can help meet peak demand.[15] In many states, new clean energy initiatives are designed as standalone programs, rather than from a holistic perspective that takes into account past investments and efficiencies across the grid. This approach can result in overlapping subsidies that increase costs to consumers and potentially reduce states' ability to achieve their clean energy and emissions goals.

It is inherently challenging—if not impossible—for governments to keep up with accelerating changes in technologies and consumer preferences.

In these and similar cases, policymakers have focused on reconciling state preferences for generation sources with technology-specific market rules, rather than reconsidering whether both state policy and market design should be refashioned to accommodate and value a much broader array of energy services and products with beneficial attributes. Further, there is no clear way today to compare and contrast how different states are approaching these issues; without such baseline data, it will be challenging to devise and advocate for effective incentives.

As market operators grapple with these issues, how can policymakers help reconcile political priorities with market principles that can best drive innovation and consumer choice?

STANDARDS THAT CAN'T KEEP UP

The first energy efficiency standards were enacted by California in 1974 and at the Federal level in 1975. During each subsequent update in 1979, 1987, 1992, 2005, and 2007, standards have become more specific and more prescriptive. The most recent legislative update in 2007 also included a requirement that the Department of Energy (DOE), which has standards-setting authority, maintain a schedule to regularly review and update all standards and test procedures.[16] Nonetheless, it is inherently challenging—if not impossible—for governments to keep up with accelerating changes in technologies and consumer preferences. The recent high-profile fight over an otherwise obscure standard for natural gas furnaces is illustrative.

In 2007, DOE proposed raising the furnace standard from 78 Annual Fuel Utilization Efficiency or AFUE (set in 1987) to 80 AFUE. Legal intervention by California and a coalition of environmental and consumer groups ultimately led to a new DOE proposal in 2011 that proposed raising standards to 90 AFUE, but only in the northern U.S. The American Public Gas Association filed a lawsuit objecting to the expedited process used for this rule, and in 2014, a settlement agreement was approved that vacated the 2011 standards and required DOE to begin another new rulemaking.[17] DOE issued a new rule in 2015 that proposed raising the standard to 92 AFUE nationwide. Industry, in conjunction with the Gas Technology Institute, conducted extensive technical analysis that concluded in a 2017 report that the DOE methodology for the new proposal relied upon nonpublic data and flawed methodologies; further, the study found that high initial costs associated with installation and additional requirements could push many residential customers to purchase and install less efficient home heating alternatives.[18, 19] After a decade of debate, litigation, and revision, the standard remains unresolved; further, even if the current proposal were approved, it would not take effect for several years.

After a decade of debate, litigation, and revision, the standard remains unresolved; further, even if the current proposal were approved, it would not take effect for several years.

The furnace example illustrates how adhering to a decades-old process for developing Federal energy efficiency standards fails to align with what energy efficiency means today. Increasingly, energy efficiency is not just high efficiency equipment and products. It also includes sophisticated energy management systems, internet-connected devices, and data analytics that enable buildings and facilities to optimize an entire system, while sharing information about energy use and savings with consumers.[20] The efficiency of specific products still matters, but increasingly it matters in the context of a broader connected system where software and artificial intelligence can recognize consumer behavior and optimize for consumer preferences.[21]

Will policymakers continue to adhere to top-down, technology specific standards-setting methods or instead consider how standards can empower consumers with data and technologies that can optimize their preferences?

BEYOND WINNERS AND LOSERS

The Investment Tax Credit (ITC) was first created in 1978 to incentivize electricity produced from synthetic fuels, solar, wind, geothermal, and biomass. The Production Tax Credit was created in 1992 and covered wind and biomass projects entering service through the end of 1999. Both emerged during an era that sought greater energy independence and resource diversity, and both incentivized specific technologies positioned to achieve that outcome.

Over time, constituencies grew for new technology verticals, and both tax credits were expanded. Electricity from refined coal, municipal solid waste, fuel cells, and ocean and hydrokinetic facilities became eligible, even when some technologies themselves faced technical or financial barriers that kept them out of the commercial marketplace—and from benefitting from tax incentives. Both the ITC and PTC were also extended periodically, often a year at a time, and sometimes after they had already expired.

Although incentives for wind, solar, and several other renewables are currently slated to phase out permanently, some policymakers and stakeholders continue to advocate for further expansion of the ITC and PTC to additional technologies, including energy storage. Most recently, policymakers revived similar tax credits specifically for nuclear energy (45J) and carbon capture, storage, and utilization (45Q). Other proposals seeking to incentivize technologies with certain performance attributes, such as carbon intensity, have also emerged.

Such proposals may have merit; however, they represent blunt instruments that are potentially misaligned with evolving innovations—innovations that are less like "hard tech" that does a single thing (e.g. generate electricity) and more like the internet, which does a multitude of things simultaneously depending on how consumers choose to use it. New energy tax policy—if it is necessary at all—will need to contemplate rewarding or accelerating winners in the marketplace (i.e. products, services, and attributes valued by consumers) rather than a single resource or technology favored by policymakers.

As the era of energy digitalization emerges, will policymakers continue the same conversations about winners and losers and the usual technology siloes or will they reconsider whether new approaches to tax policy—or no tax incentives at all—can best drive digital innovations and meet consumer demand?

PLANNING FOR A DECENTRALIZED FUTURE

An integrated resource plan (IRP) is a tool for ensuring utilities can meet forecasted energy demand and deliver reliable, cost-effective service to customers. Integrated resource planning began in the late 1980s, as some states looked for ways to respond to the 1973 oil embargo and nuclear plant cost overruns, as well as a desire to better plan for energy efficiency and resource diversity.[22, 23] States generally set requirements for IRPs that include a planning horizon (typically 20 years), frequency of updates, resources that must be considered, requirements for stakeholder involvement, and the role of public utilities commissions in reviewing or approving the plan. During the era of electricity restructuring in the mid-1990s, IRP requirements in many states were either repealed or ignored. Since that time, some states have revisited IRPs and updated their rules to reflect evolutions in the energy system, while others have left outdated rules on the books.[24]

Grid planning, however, faces new challenges as decentralization of the energy system grows. A recent study by the Pacific Northwest National Laboratory found that most states have not yet begun to directly engage in longer-term (five to ten year) planning for distribution systems[25] and that "existing planning tools and procedures are not adequate" to address rising penetrations of DERs.[26] Figure 5 summarizes the current state of distribution planning across states. Utilities that cannot accurately and dynamically forecast the pace and impact of DERs are at significant risk of missing opportunities to understand the locational value of DERs, leverage them as non-wires solutions to distribution system investments, and integrate technologies such as electric vehicles and battery storage.[27] However, utilities and regulators (among other stakeholders) are also clashing over the cost of grid modernization and what measures should be prioritized.[28] Further, as the grid evolves toward a network of connected infrastructure and devices, utilities may become only one of several actors critical to the planning process. The perspectives of third-party energy service providers, as well as individual consumers, may need to shift from the periphery to the center of IRPs.

One former regulator has described planning for DERs as "trying to catch up with a train that has already left the station and is picking up speed."29 Will policymakers and utilities consider how embracing participation by consumers, innovators, and third-party service providers in IRPs can help them catch up?

Figure 5
State Activities on Electric Distribution System Planning

	States with advanced practices					Other state approaches											
	California	Hawaii	Massachusetts	Minnesota	New York	D.C.	Florida	Illinois	Indiana	Maryland	Michigan	Ohio	Oregon	Pennsylvania	Rhode Island	Washington
Statutory requirement for long-term distribution plans or grid modernization plans[(a)]	✓			✓					✓							
Commission requirement for long-term distribution plans or grid modernization plans[(a)]		✓	✓		✓					✓	✓					
No planning requirements yet, but proceeding underway or planned						✓							✓		✓	✓
Voluntary filing of grid modernization plans								✓				✓		✓		
Non-wires alternatives analysis and procurement requirements	✓				✓										✓	
Hosting capacity analysis requirements	✓	✓		✓	✓											
Locational net benefits analysis required	✓				✓											
Smart grid plans required													✓			
Required reporting on poor-performing circuits and improvement plans							✓	✓				✓		✓	✓	
Storm hardening requirements							✓			✓						
Investigation into DER markets		✓														

(a) For one or more utilities.

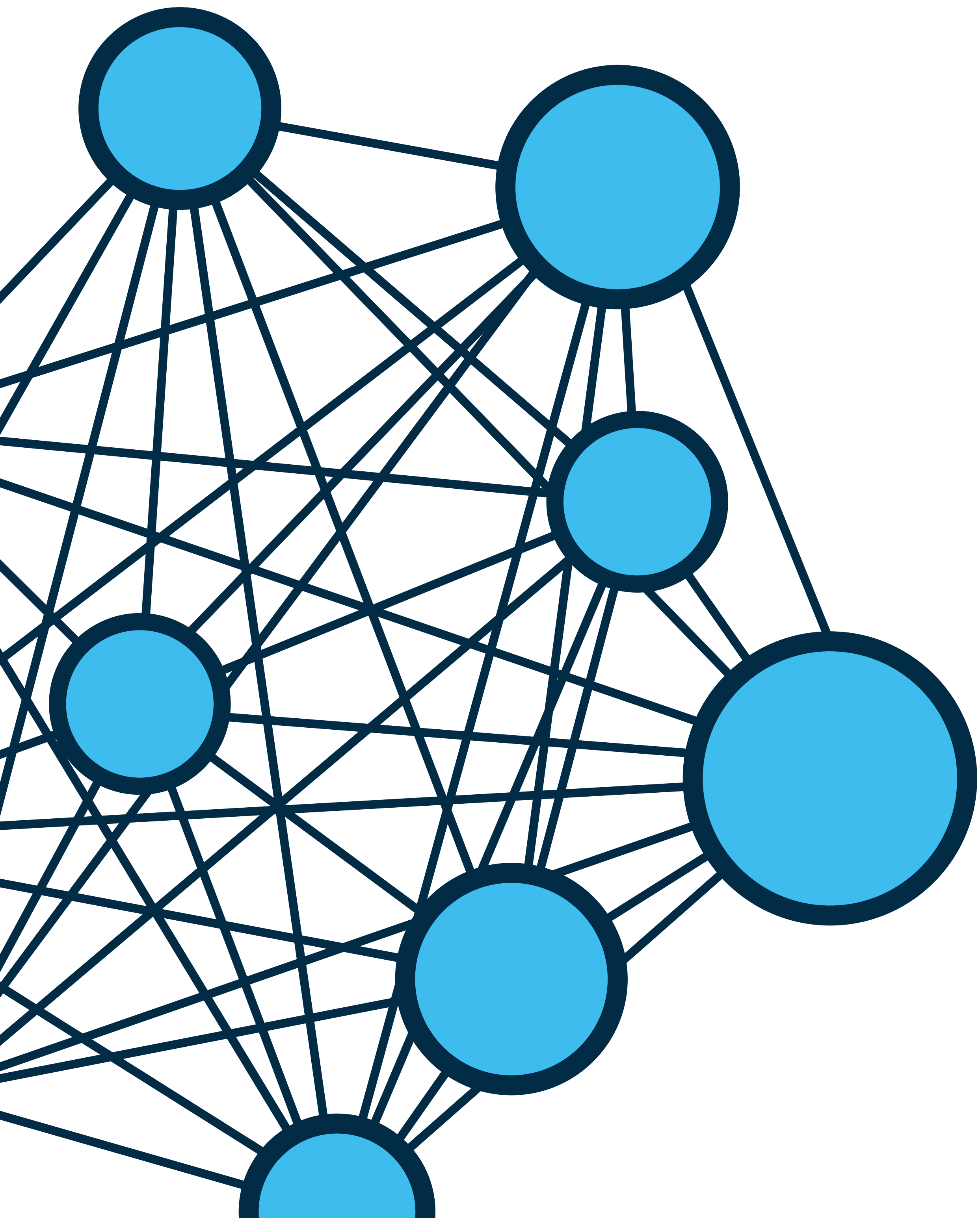
Source: Pacific Northwest National Laboratory

TABLE 1: POLICY AND REGULATORY ARCHITECTURES NO LONGER ALIGNED WITH A CHANGING ENERGY SYSTEM

Existing Policy	Historical Overview	Barriers to Emerging Innovations, Market Efficiency, and Consumer Choice
	Federal Policy	
Federal Power Act	• 1920: Originally enacted to regulate development of Federal hydropower • 1935: Established FERC authority over interstate electricity • 1992: Expanded FERC authority over transmission access • 2005: Expanded FERC authority over reliability, cybersecurity, market manipulation, and interstate transmission siting	• Competition at the wholesale level varies unevenly across states and regions • There is little to no market incentive for utilities outside of competitive markets to test new technologies and business models or prioritize customer choice • There are few incentives or requirements for utilities to share electricity data necessary to reveal true value of emerging digital innovations • Barriers to entry create hurdles to wholesale and retail market participation of DERs and third-party energy services providers • Price formation rules across competitive markets do not always ensure prices reflect market fundamentals • Rules and models for considering and valuing non-wires alternatives are nascent[30]
Clean Air Act	• 1963: Originally established to monitor and control air pollution • 1970/1977: Expanded authorities over stationary and mobile emissions; created EPA • 1990: Expanded authorities to acid rain, ozone, air toxics, and stationary source permitting, including New Source Review (NSR)	• Existing law has not been updated for nearly three decades; recent policy has been driven by the political priorities of each Administration and decisions by the courts • Under a Supreme Court ruling and subsequent EPA finding, carbon dioxide and other greenhouse gases must be regulated as pollutants, but there is little consensus on the appropriate regulatory approach • The complexity and timeline of New Source Review (NSR) regulations often blocks efficiency improvements and adoption of new technologies • Emerging technologies are well positioned to contribute to emissions reduction, but are often slow to be considered or adopted for compliance • EPA issues have become highly politicized, making constructive conversations about new approaches and emerging solutions very challenging
Public Utility Regulatory Policies Act (PURPA)	• 1978: Originally enacted to promote energy conservation and use of domestic renewable energy • 1992: Expanded eligible resources and updated rate-making policies • 2005: Restricted eligibility for Qualifying Facilities (QFs) in competitive markets • Since the mid/late 2000s, state RPSs and decreasing costs for wind and solar have driven dramatic expansion of QFs	• Avoided cost calculations have not kept pace with market prices and advanced technologies[31] • Mandatory purchase requirements sometimes exceed demand, and existing assets cannot easily be replaced because of reliability and cost issues • The one-mile rule is sometimes gamed • Renewable project finance is often dependent on PURPA to secure long term PPAs • FERC has limited authority over PURPA implementation; no consensus has yet emerged for state-level PURPA reform

Existing Policy	Historical Overview	Barriers to Emerging Innovations, Market Efficiency, and Consumer Choice
Federal Policy		
Department of Energy (DOE) Organization Act	• 1977: Originally established DOE to support development of nuclear energy and coordinate energy science and R&D across the Federal government[32] • 1992/2005/2007: Expanded energy efficiency standards and R&D activities to include new categories of technologies	• Existing authorities and direction are often prescriptive and technology-specific; energy efficiency standards do not always keep pace with technologies and market realities; R&D is siloed by technology verticals • With a few exceptions, such as ARPA-E, R&D programs are authorized to continue indefinitely regardless of outcomes, and oversight of outcomes is limited • There is limited effective use of innovative tools such as prizes and crowdsourcing to identify new ideas, new players, and new innovations
State Policy		
State renewable portfolio standards (RPSs)	• 1983: Iowa adopts the first RPS • Currently 29 states have an RPS[33]	• Tensions are growing between states seeking to increase renewable mandates and competitive market rules regarding how renewable energy participates and is priced • Utilities in some states have committed to voluntary clean energy and carbon emissions goals that exceed state mandates[34] • Emerging technologies that did not exist when RPSs were first designed have the potential to incentivize power generation attributes that can more efficiently and effectively achieve broader RPS goals, such as decarbonization[35]
State retail electricity policies	• 1990s/2000s: 13 states and the District of Columbia restructure their retail electricity markets • Currently 15 states have some level of retail electricity competition[36]	• Consumers' ability to choose their electricity supplier at the retail level varies across states • State policies have not fully evolved to reflect the value of new technologies, including DERs • There are few incentives or requirements for utilities to share the electricity data necessary to reveal the true value of DERs, including clean, local, and resilient attributes that consumers demand • State regulators do not always have access to data and information related to pilot and demonstration of new technologies • The level to which consumers understand and take advantage of competition varies dramatically across states and depends significantly on how the market is structured[37]
State net metering policies	• 1983: Minnesota adopts the first net metering policy • Currently 38 states have net metering policies[38]	• Deployment of advanced metering infrastructure is still in process; without it, more sophisticated time-of-day, location-based, and DER rates are not possible[39] • Debates about the structure of "net metering 2.0" are nascent, and may be overtaken by innovations in two-way power flow and blockchain-enabled customization or transactions that better reflect accurate price signals

III. A DIGITAL ENERGY FUTURE



A wide variety of stakeholders have already imagined the future of energy through frameworks and concepts such as grid modernization, utility 2.0, and smart cities. Most of these futures share common attributes; stakeholders generally seek an energy system that is:

- Affordable and accessible to a wide range of consumers;
- Clean and sustainable, minimizing impacts to the environment and health;
- Efficient in production, delivery, and consumption;
- Reliable and available whenever, wherever energy is needed; and
- Resilient to growing physical and cybersecurity threats.

Digital innovations are positioned to enable and accelerate these attributes in transformational ways. Artificial intelligence and machine learning can automate the grid to respond in real time to faults and outages as well as consumer price signals. Blockchain technologies can enable consumers to buy and sell electricity and other energy services based on preferred attributes. Crowdsourcing platforms can unleash new sources of investment and accelerate deployment of clean generation and both physical and digital infrastructure. The internet of things can help optimize energy efficiency and cost effectiveness in homes and other buildings. And software and systems can enable new business models for energy services that deliver reliability and resiliency benefits at lower costs to utilities and consumers alike. Adoption of these digital tools and platforms remains nascent, but most do not require additional R&D. Rather, they require policy, regulation, market design, and tools that can enable stakeholders to understand and capture their value.

To help stakeholders imagine a world driven by digital innovations, we have developed five hypothetical scenarios from a not too distant future. These snapshots are optimistic, but based in reality. Below each hypothetical scenario is a description of an actual pilot project operating today. Each of these projects is already leveraging one or more digital tools and platforms to move the electricity system toward the era of energy digitalization. However, barriers highlighted in Table 2 create hurdles to broader adoption, and a combination of legislative action and agency engagement (by FERC and DOE among other Federal agencies) as well as RTOs/ISOs and state public utility regulators will be necessary to scale to a digital energy future.

DIGITAL CONVERGENCE

Just a few years ago, a young energy executive stood on stage at a conference and pronounced that the future of energy was digital; she was met with blank stares. Today she sits in the audience at the same conference; this year's keynote speaker just opened with a joke about the old "analog" grid. The room erupted in laughter. In 2025, the value of digitalization to energy service providers and consumers has reached more than $50 billion, 30 percent more than Bloomberg New Energy Finance predicted back in 2017. Surprising to many has been the acceleration of dynamic, digital, distributed energy resources (now known as the "Three Ds")—which make up about a third of the digital market and have surpassed O&M savings from smart meters, renewables, and traditional fossil plants combined. The leaders in digitalization are the states that fully embraced best practices that emerged from the National Association of Regulatory Utility Commissioners (NARUC) digital energy working group in 2020. These recommendations enabled travel-exchange programs for regulators to see new digital technologies piloted in the field and development of a centralized database for pilot projects and their results. The database itself employs machine learning to analyze data across all projects and determine which projects were most successful as well as the conditions necessary for success. FERC has issued guidance directing RTOs and ISOs to integrate results from the database into their market rules; but the move was actually unnecessary—market operators and even the few remaining vertically integrated utilities were already clamoring for access to the data for different reasons—the Three Ds have been proven to lower costs for utilities and customers alike while increasing the resilience of transmission and distribution networks. The executive decides to head out of the keynote; why listen to old news when she could check out the tradeshow floor and see the innovations of the next decade...

In late 2017, Arizona Public Service and Sunverge announced a pilot program to install battery-inverter units and home energy management systems to "help balance rising neighborhood-level swells and sags in customer-generated solar power throughout the day."[40] Under the pilot, ten homes will be equipped with a 6.4-kilowatt/11.8-kilowatt-hour lithium-ion battery and inverter unit. Another 65 customers will receive Sunverge's energy management gateways, which centrally manage and optimize networked distributed energy resources, and in turn, minimize electricity demand, maximize savings against time-varying rates, and provide demand response and other grid services.[41] Sunverge seeks to minimize customer involvement in the unit's operation; instead they focus on keeping customers up to date about how much they have earned. The pilot gives stakeholders "a glimpse into the future of the grid," where energy supply and demand is balanced "home by home," while not sacrificing comfort.[42]

THE NEW SIDE HUSTLE

A new industry has begun to sweep small towns across the U.S.—clusters of neighborhoods and Main Streets far from the biggest cities where rugged individualism coexists with strong communities. In these towns, energy GSD—generation, storage, and delivery—has become a "side hustle" for many residents, albeit an automated one that doesn't require much "hustle" at all. The economics are attractive for people with full-time jobs, freelancers, and stay-at-home parents alike. Few users actually understand the technologies that enable their hustle (mostly built on blockchain platforms). No matter; there are a handful of mobile apps (NeighborShare and Peers Energy are the most popular) that handle all the transactions for them. Individuals with resources to sell—solar PV generation, home battery systems, EVs sitting in the driveway, even smart refrigerators that do a lot more than keep their milk cold—just log on, agree to let the system detect and analyze available systems, and then receive an estimate of how much they can make that day. The apps make price estimates (which are 90 percent accurate) based on sophisticated weather data, historical demand, and predictive analytics about what energy services the town will need over the next 24 hours. Seller revenues go straight into their mobile money accounts, which even the small businesses in town now accept for payment. "People used to dream about free energy," one resident remarked. "Now our energy systems pay us."

In 2016, LO3 Energy launched the Brooklyn Microgrid, a blockchain-enabled platform that allows participants to "generate, store, buy, and sell energy at the local level."[43] Fifty participants have installed smart meters equipped with blockchain technology that tracks the energy they generate and consume, and automatically records contracts and transactions between neighbors.[44] The LO3 blockchain platform "activates an internet of things within the local power grid, enabling it to generate market signals that will govern and balance neighborhood loads…and coordinate with the broader interconnected transmission grid."[45] The Brooklyn Microgrid also holds community workshops to engage in discussions about how technologies can go further to empower consumer choice.[46] Accenture analysis shows that already today, 69 percent of consumers are interested in an energy-trading marketplace and 47 percent plan to sign up for community solar projects.[47] Many believe the Brooklyn Microgrid is the beginning of a "prosumer" future.

CHOICE IS THE NEW GREEN

"We are leveraging over a century of investment in the electricity grid to promote the technologies that best meets the needs of you—our customers." The utility executive's TED Talk entitled "Beyond Green" began with something people weren't used to hearing from a utility—a holistic approach to grid modernization that leverages existing assets, embraces access to data, and delivers what customers actually want—whether it's low-emission, low-cost, off-grid, or locally-produced power. Utilities have come a long way since the 100% renewable movement, led by tech and other companies seeking more flexible green energy options. In 2017, a collaborative contract between Microsoft and Puget Sound Energy (PSE) that allowed the tech giant to pay an exit fee and buy renewable energy in the market was considered revolutionary. Today, "stranded assets" are now easily repurposed under new business models that are embraced by utilities and entrepreneurs alike, and exit fees have disappeared as new regulatory structures automatically factor the cost of past investments into prices paid by consumers.

Automated digital systems and access to data across states and regions have enabled utilities to aggregate clusters of DERs and tailor energy services to just about anything a business or community needs. Real-time, digital price signals now accurately reflect the value of energy and capacity as well as the cost of carbon across on-grid and off-grid resources. As a result, customers of all shapes and sizes can understand how the sustainability of rooftop solar compares to power from a local distribution utility; how to charge EVs to minimize their own costs and maximize services to the grid; and how to communicate with utilities in real time to enable demand response based on system needs and system conditions. "Today," the utility executive concluded, "we don't have to settle for green. We can be green, digital, low-cost, flexible, profitable, and resilient. By leveraging and reimagining our distribution networks, we can be anything you want us to be, and we can power the economy today, tomorrow, and into the future."

Founded in 2014, "digital utility" Arcadia Power allows individual consumers to access clean energy no matter where they live and without leaving their existing distribution utility. The company connects wind producers who generate renewable energy certificates (RECs) to individual customers through an easy and convenient software app that tracks customer usage and impact and seamlessly handles payment to the traditional utility. In recent years, Arcadia has added options for customers to access (and receive credits for) community solar projects[48] and receive (in states that allow retail competition) "Price Alerts" for alternative suppliers that on average have saved customers 17 percent on their electric bills.[49] The company is also building out options for home energy efficiency and demand response. As of August 2018, the company is working with over 100 utilities and more than 175,000 customers nationwide.[50]

AN INTERNET OF ENERGY[51]

Most people remember a time when a "ding" on their phone meant a new text message or social media alert. Now in 2030, it often indicates they've just successfully completed an energy transaction with the community systems operator (CSO). It all began when state regulators restructured planning requirements for IRPs; utilities across regions and communities began sharing ideas about the best ways to plan for DERs. The results were surprising; several studies and analyses found that utilities could best monetize their assets by sharing data and control of their systems. In 2018, the first "independent distribution system operator" was proposed; just over a decade later, the concept is being replicated at an even more decentralized scale; CSOs are popping up in just about every metropolitan area across the country. The CSOs are independent of the owners of distribution system assets and have responsibility for planning and operational control of the automated, blockchain-enabled local distribution grid or a subset of community microgrids. Many consumers have become "prosumers" automatically producing energy and providing other distribution services as they are needed; consumers also have the ability to set preferences with the CSO about what types of energy and services they want to buy based on cost, sustainability, and other localized attributes. A new kind of internet has arrived.

In early 2017, the Rocky Mountain Institute and Austrian blockchain company GridSingularity established the Energy Web Foundation. The global non-profit is focused on accelerating the development of blockchain solutions in the energy sector, including to address challenges like controlling demand, tracking flows of energy, market participation, and prioritizing customers and DERs in the market. The group is currently developing a public, open-source blockchain platform purpose built for the energy sector, while its affiliates (80 and counting) focus on building industrial-grade applications of blockchain technology.[52]

THINK GLOBAL, INVEST LOCAL

"People want to vote with their wallets." That's what the founder of EmPower said back in 2021 when he started a crowdfunding company with an exclusive focus on energy innovation. Today the company is the go-to platform for financing community solar plus storage, consumer vehicle-to-grid integrations, and blockchain-enabled microgrids, with more than 600 projects worth nearly $1 billion in operation as of December 2029. The company's market cap has just surpassed that of the nation's largest vertically integrated utility. Building on a loosening of regulations around institutional investors that were instituted in the 2010s, Federal financial regulators further enabled new investors and new investment products when they raised the cap on investment from $1 million to $5 million. The projects financed through the EmPower platform have helped several states meet carbon reduction goals ahead of schedule across both power and transportation sectors. The platform has also strengthened communities, especially outside large metropolitan areas—55 percent of investors on the platform choose to support projects within a 25-mile radius of where they live. EmPower is set to open an international version of its platform next year and take its local crowdsourcing model global.

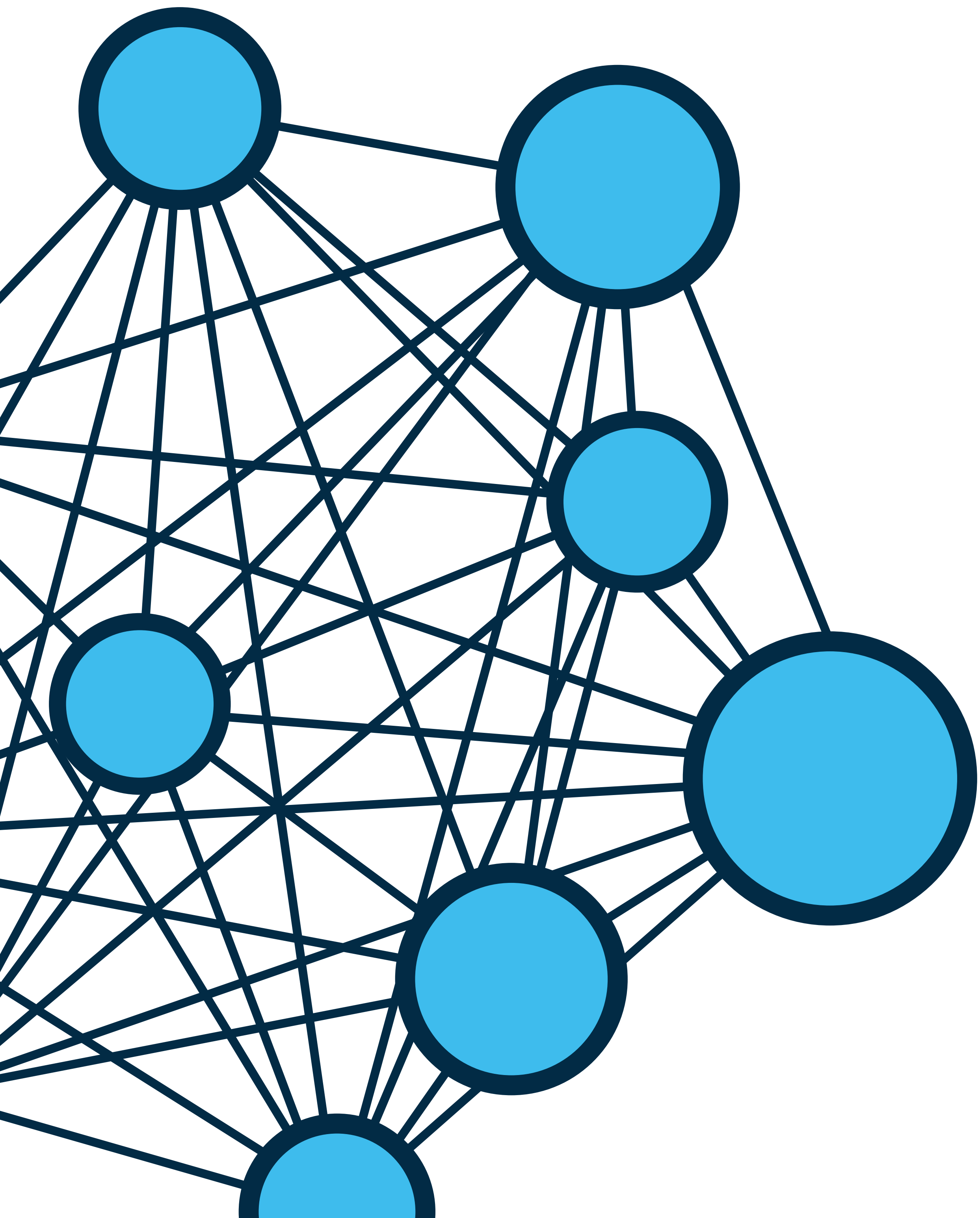
In 2015, Gridshare[53] launched a renewable energy crowdfunding platform to facilitate debt and equity funding for accredited investors. In early 2017, the company received approval from the Financial Industry Regulatory Authority (FINRA) to widen its platform to non-accredited investors, and unlock the financial power of a broader "crowd" of individual investors. Potential investors can browse projects online and pledge funding in exchange for equity or interest. Projects on the platform are currently limited to raising $1 million, and typically combine crowdsourced funding with other funding streams.[54] As of the end of 2017, GridShare represented one of 36 crowdfunding platforms that in aggregate have raised nearly $90 million.[55]

TABLE 2: POTENTIAL BARRIERS TO A DIGITAL FUTURE

Future Scenario	Policy/ Regulation	Potential Barriers to This Future
"Digital Convergence"	Federal Power Act	• There is little to no market incentive for utilities outside of competitive markets to test new technologies and business models or prioritize customer choice • There are few incentives or requirements for utilities to share electricity data necessary to reveal true value of emerging digital innovations • Barriers to entry create hurdles to market participation of DERs and third-party energy services providers
	DOE	• Existing authorities and direction are often prescriptive and technology-specific; RD&D is siloed by technology verticals • There is limited effective use of innovative tools such as prizes and crowdsourcing to identify new ideas, new players, and new innovations
	State RPSs	• Emerging technologies that did not exist when RPSs were first designed have the potential to incentivize power generation attributes that can more efficiently and effectively achieve broader RPS goals, such as decarbonization
"The New Side Hustle"	Federal Power Act	• There is little to no market incentive for utilities outside of competitive markets to test new technologies and business models or prioritize customer choice • There are few incentives or requirements for utilities to share electricity data necessary to reveal true value of emerging digital innovations • Barriers to entry create hurdles to market participation of DERs and third-party energy services providers
	State retail electricity policies	• State policies have not fully evolved to reflect the value of new technologies, including DERs • There are few incentives or requirements for utilities to share the electricity data necessary to reveal the true value of DERs, including clean, local, and resilient attributes that consumers demand • State regulators do not always have access to data and information related to pilot and demonstration of new technologies • The level to which consumers understand and take advantage of competition varies dramatically across states and depends significantly on how the market is structured

Future Scenario	Policy/ Regulation	Potential Barriers to This Future
"Choice is the New Green"	Federal Power Act	• Competition at the wholesale level varies unevenly across states and regions • There is little to no market incentive for utilities outside of competitive markets to test new technologies and business models or prioritize customer choice
	Clean Air Act	• Emerging technologies are well positioned to contribute to emissions reduction, but are often slow to be considered or adopted for compliance
	State retail electricity policies	• Consumers' ability to choose their electricity supplier at the retail level varies across states • There are few incentives or requirements for utilities to share the electricity data necessary to reveal the true value of DERs, including clean, local, and resilient attributes that consumers demand • The level to which consumers understand and take advantage of competition varies dramatically across states and depends significantly on how the market is structured
"An Internet of Energy"	Federal Power Act	• There is little to no market incentive for utilities outside of competitive markets to test new technologies and business models or prioritize customer choice • There are few incentives or requirements for utilities to share electricity data necessary to reveal true value of emerging digital innovations • Barriers to entry create hurdles to market participation of DERs and third-party energy services providers
	State retail electricity policies	• There are few incentives or requirements for utilities to share the electricity data necessary to reveal the true value of DERs, including clean, local, and resilient attributes that consumers demand • State regulators do not always have access to data and information related to pilot and demonstration of new technologies
	State net metering policies	• Deployment of advanced metering infrastructure is still in process; without it, more sophisticated time-of-day, location-based, and DER rates are not possible
"Think Global, Invest Local"	Federal Power Act	• There is little to no market incentive for utilities outside of competitive markets to test new technologies and business models or prioritize customer choice
	PURPA	• Renewable project finance is often dependent on PURPA to secure long term PPAs
	DOE	• There is limited effective use of innovative tools such as prizes and crowdsourcing to identify new ideas, new players, and new innovations
	State retail electricity policies	• There are few incentives or requirements for utilities to share the electricity data necessary to reveal the true value of DERs, including clean, local, and resilient attributes that consumers demand

IV. HOW DO WE GET THERE



Grid modernization efforts are not new. Many organizations are already working to identify and advocate for policy and regulation to enable a future similar to the one imagined here. The most recent quarterly analysis by the North Carolina Clean Energy Technology Center found that in Q2 2018, 42 states and the District of Columbia took more than 300 policy and deployment actions related to grid modernization. However, the three most active states (New York, California, and Massachusetts) comprised 30 percent of the total actions.[56]

EC-MAP and our partners are focused on aligning and accelerating these efforts in three ways: 1) by building support among a wider diversity of policymakers from different geographies and political parties; 2) by promoting approaches to policy centered around the concept of disintermediation—where markets drive innovation that empowers consumers and consumers leverage innovation to participate in markets; and 3) by developing policy maps to align policy with a digital energy future—a future where government empowers consumers, supports free and fair markets, and enables innovation.

"There is no grid modernization template."

One expert recently noted, "There is no grid modernization template."[57] In the coming months, we plan to engage stakeholders across political parties and industries around questions critical to building the policy and regulatory architectures necessary to unlock the digital technologies, tools, and platforms described here. Some of these questions will be uncomfortable to ask and complicated to answer; but to ignore them will only slow our progress toward a more affordable, clean, efficient, reliable, and resilient future. It is critical to ask questions in at least three areas:

1. How existing policy designed decades ago for a different kind of electricity system creates barriers to innovation, such as:
    - Where are monopolies still necessary in the electricity sector? What role should Federal regulators play in encouraging states and regions to design markets in order to take advantage of emerging digital innovations and empower consumers?
    - How do jurisdictional tensions between states and the Federal government create hurdles to digitalization and emerging consumer-driven innovations in the power sector?
    - How might electricity markets—where a variety of generation sources and energy services can participate—accelerate emissions reductions faster than the Clean Air Act?
    - As renewables become more economically competitive, are state RPSs still needed? Are there more effective policies (e.g. new rate designs and contracts, market participation for DERs) for aligning consumer energy preferences with energy supply?
    - How can PURPA be updated to preserve investment in worthy projects while recognizing how the grid has evolved?

2. How new policy can be designed with the flexibility to enable adoption of emerging digital technologies today and technologies not yet imagined in the years to come, such as:
    - How can policymakers and the private sector ensure digital electricity systems are resilient to physical and cybersecurity threats? What is the proper role of government as a strategic risk manager of new threats and vulnerabilities of the digital age?
    - How can policymakers increase access to transparent, verifiable data streams and empower consumers to drive markets?
    - What policies can incentivize the necessary investment in emerging digital tools and platforms (including by individuals and small communities)?
    - How can policymakers best ensure that markets value new services enabled by digital innovations as well as externalities that may not be fully captured by market design rules?
    - How can policymakers best assure the role of government evolves as a facilitator of fair, open and transparent markets?

Policy can and should better align energy consumers and markets through innovation

3. How policy and regulation can ease the transition to an era of energy digitalization, such as:
    - How can stranded assets be repurposed to serve their communities?[58]
    - How can new data streams from digital innovations—for example sustainability attributes verified by a blockchain system—be best integrated with existing measurement, reporting, and verification (MRV) frameworks?
    - How will utility adoption of digital technologies and enhanced government requirements around grid cybersecurity impact the need for broadband spectrum? Can blockchain itself be utilized to help address these issues?[59]
    - How can policymakers help the electricity sector workforce gain the skills they need to accelerate a shift to digitalization?
    - What are the best ways to educate and empower consumers? What role can policymakers play to ensure consumers can access digital tools to meet their individual needs?

While questions like these are a starting point, we recognize we don't have all the answers. Some barriers are so entrenched they may seem insurmountable, but potential solutions are also advancing at an unprecedented pace. Policy can and should better align energy consumers and markets through innovation; EC-MAP plans to work with incumbent stakeholders, new stakeholders, policymakers—and you—to build a map to get there. We hope you will join us in accelerating the era of energy digitalization.

FURTHER READING

The following is a selection of resources related to the topics covered in this paper. These sources may be instructive for future EC-MAP discussions and activities.

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