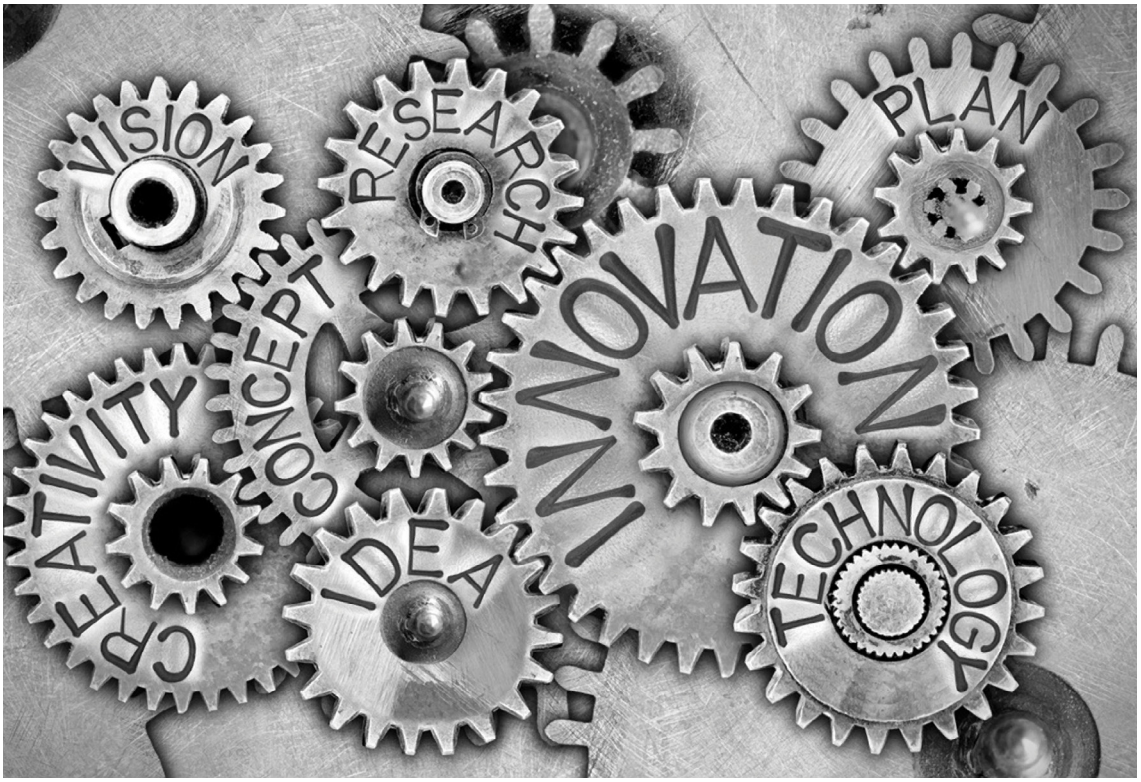
NARUC
National Association of Regulatory Utility Commissioners

Regulatory Training Initiative

Regulatory Innovations Platforms for Public Utilities



Tom Stanton

May 2023

Abstract

This paper is about the design, functions, and implementation of regulatory innovations platforms for public utility. Such platforms are intended to enable the rapid testing of new technologies and business models, incorporating at least some regulatory flexibility as necessary to facilitate testing, while managing and limiting exposure to associated risks. The platforms are also designed to ensure rapid learning for all participating parties, including innovators, utility companies, and utility regulators.

Almost every regulatory jurisdiction is home to at least some kinds of organizations and functions that support innovations, and participants often include one or more government agencies. But not every innovation platform focuses on or includes regulatory innovations. At least some innovations in the realm of public utility services could possibly be associated with, or even necessitate changes in, long-standing regulatory practices. Therefore, industry participants might have a special interest in mechanisms that can allow regulatory flexibility, at least to enable innovations trials. This paper seeks to identify, describe, and review regulatory innovations platforms that include four major features:

1. Public announcement of the innovations support activities, including a broad invitation for participation by all parties that are genuinely interested in potentially viable innovations
2. Some focus on regulatory innovation, which might include innovations in financial incentives and business models for regulated utility companies, competitive utility services providers, and new market participants
3. Regulatory flexibility, where regulators might relax or waive rules or agree to allow, during innovations trials, specific activities that could otherwise face challenges under existing rules and regulations
4. A prominent oversight role for the utility regulatory authority, participating in the design and implementation of trial projects intended to validate innovations

This report explores reasons why regulatory innovation is needed now and examines how regulatory innovations platforms are defined, designed, and implemented. The current heightened interest in, and urgency associated with regulatory innovation stems from perceived needs resulting from multiple interconnected factors. This report reviews those underlying pressures for change, and briefly describes ongoing energy regulatory innovations activities in a dozen US states and the District of Columbia. It reviews literature about regulatory innovations platforms, describing both the major potential benefits associated with such platforms, and their attendant potential risks, tensions, challenges, and obstacles.

Then the report presents preliminary ideas about how state policy makers, including public utility regulatory commissions, might consider implementing such approaches.

An Appendix briefly summarizes energy utility regulatory innovations platforms already operating in nine other countries (Belgium, Canada, France, Germany, Italy, Lithuania, the Netherlands, Singapore, and the United Kingdom) and a few in planning stages (Australia, Austria, and Sweden).

Executive Summary

This report reviews public utility regulatory innovations platforms that are intended to accelerate innovations while providing ample consumer protections and limiting risks associated with potentially disruptive technologies and business models. Several regulated industries are encountering major system changes in the face of new technologies and recently added goals and objectives, including policies implementing renewable and clean energy portfolio standards and major actions to mitigate and adapt to global climate change. This time of rapid and widespread change is associated with ongoing uncertainty about the best approaches to both regulated and competitive markets for regulated utility services.

This report considers the many forces that are combining to result in system change and a heightened focus on technology and business model innovations in regulated public utility industries. Almost every regulatory jurisdiction is home to at least some kinds of organizations and functions that support innovations, and participants often include one or more government agencies. But not every innovations platform focuses on or includes regulatory innovations. At least some innovations in the realm of public utility services could possibly be associated with, or even necessitate changes in, long-standing regulatory practices. Therefore, industry participants might have a special interest in mechanisms that can allow regulatory flexibility, at least to enable innovations trials. The regulatory innovations platforms in a dozen key states and the District of Columbia are reviewed and summarized, and an Appendix includes a review and summary of similar systems in place in 15 other countries.

A literature review studies why researchers believe that new approaches to regulatory innovation deserve consideration, and what approaches are recommended to help guide analysis and testing of potential innovations. Innovations platforms typically include:

1. Public announcement of the activity, inviting innovators to apply to participate.
2. Multiple interested parties working together under supervision by the regulatory agency to consider innovations, to investigate how the innovations might interact with preexisting regulatory provisions, and to consider whether and how the innovations might be subjected to rapid testing.
3. Innovations that pass muster are then subjected to experimental design. Planned experiments are bounded, well-structured tests that are limited in duration, expense, and numbers of participating customers, and are rigorously monitored and evaluated.
4. Prior to the experiments being implemented, participating parties anticipate at least preliminary pathways, depending on the experimental results, for both next steps toward broader implementation in the event of successful trials and for exit strategies in the event of less-than-satisfactory outcomes.

The literature review also reveals challenges and potential pitfalls that can be associated with regulatory innovations platforms. These include:

1. The potential for incumbent utilities to exercise their inherent asymmetry in information and potential market power to limit innovations to those that directly support the utility and its financial incentives
2. A perceived lack of public or consumer interest in some innovations, because potential users can be unaware of why and how the innovations might prove beneficial
3. A lack of expertise in state public utility regulatory agencies, related to guiding and managing innovation
4. A lack of clarity about existing regulatory authority to provide opportunities to test innovations that could require waivers or exemptions from existing regulatory practices

5. A general lack of evaluations and reporting on the benefits and costs associated with existing regulatory innovations practices

Preliminary observations are provided for ideas to include in the design and implementation of successful regulatory innovations platforms. These include:

1. Coordinating regulatory innovations activities with the existing innovations efforts that are being led by nonregulatory state agencies, state universities, and other stakeholders
2. Inviting participation by soliciting innovations in response to agreed-upon topics or areas of interest
3. Increasing the rate of learning on the part of regulators, regulated industries, and all interested parties by using rapid yet well-designed experiments

Table of Contents

Tables and Figures

Acknowledgments

Many colleagues deserve special mention for the assistance they provided in helping to bring this report to completion. This is my final research report completed for the National Regulatory Research Institute (NRRI), which ceased operations on June 30, 2022.

First, I wish to thank my former colleagues and the leadership team at NRRI. I feel very fortunate to have worked for NRRI from October 2021 through June 30, 2022. I benefited greatly from conversations with and guidance from my NRRI colleagues and thank them for that support. I have also benefited greatly from my participation in activities associated with the National Association of Regulatory Utility Commissioners (NARUC), including national and regional meetings, both in person and virtual, of several committees and staff subcommittees. In particular, I wish to recognize and thank all the participants in the November 2021 NARUC Annual Meeting in Louisville, Kentucky, where Chairman Gladys Brown Dutrieuille, Pennsylvania Public Utility Commission (PUC); Chairman Emile C. Thompson, District of Columbia Public Service Commission (PSC); Commissioner Mark R. Thompson, Oregon PUC; and Commissioner Jay Balasbas, Washington Utilities and Transportation Commission (UTC); participated in a forum about *Emerging Trends and Best Practices in Accelerating Successful Regulatory Innovation*. Their insights and frank discussion of regulatory innovation helped me to shape this research project.

I wish to thank the Advanced Energy Group Chicago for inviting me to their inaugural meeting, where I was first introduced to this topic by Brien Sheahan, former chairman of the Illinois Commerce Commission, and former chairman of the NARUC Presidential Task force on Innovation.

In addition, I consulted many other researchers who have been working in the realm of public utility regulatory innovation. These include participants in the NRRI webinar, held in November 2021, on *Accelerating Regulatory Innovation*. Presenters included: Mark B. Glick, energy and policy innovation specialist at the Hawaii Natural Energy Institute, University of Hawaii at Manoa; Chairman Emile C. Thompson, DC PSC; Joshua Ryor, director, Office of Utility Programs and Initiatives, Connecticut Public Utilities Regulatory Authority; and Brien Sheahan. All four have studied regulatory innovation extensively, and all four are engaged in working to facilitate regulatory innovation. Their guidance and insights were invaluable in helping me to complete this research project.

The Michigan Public Service Commission (MPSC) also invited my participation in its MI Power Grid initiative, where I was asked to present on the topic of regulatory innovations practices. I wish to thank Commissioner Tremaine Phillips, and MPSC staff members Anne Armstrong, Julie Baldwin, Jesse Harlow, Patrick Hudson, Ryan Laruwe, and Joy Wang for their encouragement and for leading the MI Power Grid meetings. Dr. Ahmad Faruqui of the Brattle Group also participated in one of the MI Power Grid sessions, providing a detailed critique of traditional regulatory innovations practices. And researchers from Lawrence Berkeley National

Laboratory, Peter Cappers and Annika Todd-Blick participated in these workshops, providing analysis of best practices in public utility pilot projects.

Many other representatives from different states helped me to verify details of the practices I learned about from my research. They include: Jennifer Burdette, Minnesota; Tenley Dalstrom, California; Megan Levy, Wisconsin; Leslie Nash, Massachusetts; Taren O'Connor, Connecticut; David Parsons, Hawaii; Carrie Templeton, Wisconsin; Marty Turock, California; and Jimmy Zhang, Illinois.

In addition, Lisa Schwartz of Lawrence Berkeley National Laboratory and Sherry Lichtenberg (NARUC Regulatory Training Initiative) reviewed a draft of this research paper, providing a detailed review and excellent editorial recommendations.

Several representatives from the International Smart Grid Action Network (ISGAN) and Council of European Energy Regulators (CEER) helped me to complete my review of innovations platforms in other countries, which are described in the Appendix. They include: José Pablo Chaves Ávila, Spain; Therése Hindman Persson, Sweden; Melina Kotsinas, Sweden; Klaus Kubeczko, Austria; Rachel Levin, Canada; Helena Lindquist, Sweden; Mima Micic, Canada; and Luca Schiavo, Italy. I also owe a debt of gratitude to Google Translate, which enabled me to understand the essence of several documents available only in non-English languages.

Any remaining errors or omissions are my responsibility.

Tom Stanton, Former Principal Researcher, Energy and Environment

1. Introduction

Multiple observers characterize the state of regulated utilities today as one of major system change. For example, Soutar reviews more than 250 published reports from 2019 and 2020 and confirms that energy infrastructures throughout the world face "threats and opportunities" in four major areas: "decarbonization, decentralization, digitalization, and democratization."[1] He notes that the associated system changes could

> disrupt traditional utilities . . . provide market entry points for new actors offering new value propositions . . . [and] present considerable challenges to government actors responsible for managing energy transitions while regulating against negative impacts to consumers.[2]

In a similar vein, Fox-Penner explores the future of energy utilities, visualizing a potential for expansive changes in both technologies and institutions.[3]

In its review of the future US electricity system, the National Academies of Sciences, Engineering, and Medicine (NASEM) identifies "a number of driving forces – social, technical, and economic – that are likely to alter the landscape of the US power system."[4] NASEM concludes,

> Creating an environment that promotes innovation will be essential if the future power system is to do an adequate job of providing service that is safe and secure, clean and sustainable, affordable and equitable, and reliable and resilient.[5]

NASEM broadly supports innovations in technologies, business models, policy, and regulation, and recommends substantially increasing the rate of innovation and new technology deployment. NASEM recommends that many institutions take actions to advance energy innovation, including both federal and state utility regulatory authorities; academic researchers, research organizations, and research laboratories; foundations; national utility organizations; state energy offices; US Congress and state legislatures; and the US Department of Energy.[6]

Taeihagh, Ramesh, and Howlett note that regulators face serious challenges when presented with a "heightened pace of technological innovation . . . with disruptive speed and scope."[7] They note that policy makers often face decisions about appropriate responses, even though technologies "are still evolving with unclear trajectories."[8] With technological innovation, they explain, regulators must proceed in the face of "uninformed ignorance . . . [and] gaps in the information possessed by different actors . . . which advantage some actors over others."[9] They report:

> In the case of emerging disruptive technologies . . . uncertainty is . . . profound and pervasive. Governments are typically not entirely aware of the nature of the policy problem they are trying to address and are unsure of what a regulatory solution might look like.[10]

---

1 Iain Soutar, "Dancing with complexity: Making sense of decarbonisation, decentralisation, digitalisation and democratisation," *Energy Research & Social Science 80*, (2021: 1) ISSN 2214-6296, https://doi.org/10.1016/j.erss.2021.102230. Open access: https://www.researchgate.net/publication/353913111.

2 Ibid., p. 4.

3 Peter Fox-Penner, *Power after Carbon: Building a Clean, Resilient Grid* (Cambridge: Harvard University, 2020) https://www.hup.harvard.edu/catalog.php?isbn=9780674241077.

4 National Academies of Sciences, Engineering, and Medicine, *The Future of Electric Power in the United States*, Washington, D.C.: The National Academies Press, 2021,1, https://doi.org/10.17226/25968.

5 Ibid, p. 2.

6 Ibid., p. 8, 10, 11.

7 Taeihagh, Araz, M. Ramesh, and Michael Howlett. "Assessing the Regulatory Challenges of Emerging Disruptive Technologies." *Regulation and Governance* (March 2021): 1. doi:10.1111/rego.12392

8 Ibid., p. 1.

9 Ibid., p. 2.

10 Ibid., p. 3.

Learning curves for many new and emerging technologies are advancing rapidly, achieving lower costs and improved performance.[11] Associated changes could potentially touch on every public utility type (including broadband and telecommunications, electricity, natural gas, regulated modes of transportation, and water and wastewater systems). But several interrelated factors (reviewed in Part II of this report) are resulting in a pressing need for regulatory commissions, regulated utility companies, and other groups participating in regulatory proceedings to speed the process of learning from one another and to advance new technologies and possible new business models more quickly. One primary emphasis for energy systems innovation is the potential role that regulatory innovations platforms can play, in providing "a flexible, dynamic strategy to govern disruptive innovations in a way that balances costs and benefits in the market."[12]

Proponents also contend that innovations support platforms will foster economic development by attracting and supporting innovations business clusters. Buckley et al. describe the platforms as important signals to innovators and the public at large that the participating regulators are "flexible and open to innovation."[13] Zetzsche et al. report that regulators implementing such platforms generally define their objectives "in the context of support for innovation, market development and enhanced competition, and/or economic growth." Zetzsche et al. further explain that the platforms signal "a friendly regulatory view of innovation in general." They state, "[E]ntrepreneurs and established institutions may decide to locate their innovations and new jobs in these jurisdictions. This will enhance the cluster development necessary for innovation."[14]

Buckley et al. also cite the potential for innovations platforms to speed regulatory learning, while keeping costs low for any initial failures that do occur.[15] Similarly, Zetzsche et al. point to "mutual learning" and "knowledge exchange" among the participants, including regulators, incumbent businesses, and innovators.[16] Cross-Call, Gold, et al. point out, "[E]xperiments may reveal unanticipated outcomes or market behaviors, based on which further adaptation will be required."[17]

And Allen suggests, "[T]he understanding that regulators gain . . . about new technologies and new types of intermediaries . . . might be sufficient return on the investment of regulatory resources to justify" regulatory innovations support activities.[18]

This report reviews, in Part II, the many reasons why accelerating innovation management is needed now, and how new approaches to regulatory innovation are often seen as alternatives to long-standing practices associated with utility experimental and pilot programs. Included is a discussion about new objectives recently assigned to energy regulatory commissions by state legislatures and governors, which can act as motivators for rapid innovation. Part II concludes with a discussion of key research methods that are frequently used to study

---

11 See, for example: Jonas Grafstrom, and Rahmatallah Poudineh, report, *A critical assessment of learning curves for solar and wind power technologies*, for Oxford Institute for Energy Studies (February 2021) Report No. EL 43, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/02/A-critical-assessment-of-learning-curves-for-solar-and-wind-power-technologies-EL-43.pdf, Michael Grubb, et al., "Induced innovation in energy technologies and systems: a review of evidence and potential implications for CO_2 mitigation," *Environmental Research Letters 16 no. 4* (2021), https://iopscience.iop.org/article/10.1088/1748-9326/abde07; and Margaret Taylor, and K. Sydny Fujita, 2013, *Accounting for Technological Change in Regulatory Impact Analyses: The Learning Curve Technique*, Lawrence Berkeley National Laboratory (2013) LBNL-6185E, https://www.osti.gov/biblio/1171549.

12 Chang-hsien Tsai, et al. "The Diffusion of the Sandbox Approach to Disruptive Innovation and Its Limitations," *Cornell International Law Journal 53, no. 2* (2021): 5, https://cornelllilj.org/wp-content/uploads/2021/10/Tsai-et-al.-final.pdf.

13 Buckley, Ross P., et al., "Building FinTech Ecosystems: Regulatory Sandboxes, Innovation Hubs and Beyond", *Washington University Journal of Law and Policy, Vol. 61*, 2020, https://ssrn.com/abstract=3455872.

14 Dirk A. Zetzsche, et al., "Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation", *Fordham Journal of Corporate and Financial Law 31*, (2018): 68, 81, footnotes omitted, emphasis in original, https://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?article=1450&context=jcfl.

15 Buckley, et al., *Building FinTech Ecosystems*, 16-19.

16 Zetzsche et al., "Regulating a Revolution," 93, 101.

17 Dan Cross-Call, Rachel Gold, et al., *Reimagining the Utility: Evolving the Functions and Business Model of Utilities to Achieve a Low-Carbon Grid*, Boulder, CO: Rocky Mountain Institute, (2021): 21, www.rmi.org/reimagining_the_utility.

18 Hilary J. Allen, "Regulatory Sandboxes," *George Washington Law Review 87*, (June 25, 2019): 640-41, https://ssrn.com/abstract=3056993.

innovations practices, and how ongoing energy systems transformations could usher in new technologies and business models capable of disrupting the existing energy industry framework and its regulatory regimes.

Part III describes the functions and activities that are usually included in regulatory innovations platforms and discusses how the platforms can help to serve the goals and objectives of different industry participants.

Part IV includes brief summaries of US state-level energy regulatory innovations platforms that are already operating in a dozen states and the District of Columbia.

Part V reviews literature to identify the potential challenges, risks, obstacles, and tensions associated with regulatory innovations platforms, focusing on ideas about designing and implementing platforms to minimize potential problems.

Part VI provides concluding observations from this review and presents preliminary ideas about how state policy makers, including public utility regulatory commissions, might consider implementing such approaches.

An Appendix briefly summarizes examples and reports from existing and planned energy utility regulatory innovations platforms in other countries. Such platforms are already operating in Belgium, Canada, France, Germany, Italy, Lithuania, the Netherlands, Singapore, and the United Kingdom, and they are in exploratory or planning stages for Australia, Austria, and Sweden.

II. Accelerating Innovation Management Is Needed Now for Public Utilities and Their Regulatory Authorities

In the absence of updated, more rapid, and comprehensive regulatory innovations support, there is a risk that promising technologies and new business models will advance too slowly, if at all. A fear is that sluggish advancement of technology and business model innovations will risk increases in consumer costs resulting from lost opportunities and possible stranded investments, and also increase utility transition costs once the innovations do take hold.[19]

Carlson and Nciri observe that gaps remain "between the pace needed to achieve energy transition and meet carbon reduction targets, on the one hand, and the current pace of innovation and transformation of energy systems on the other." They explain,

> [E]nergy regulators, policymakers, and utility leaders . . . [report] that the current energy policy, market, and regulatory frameworks [are] not flexible enough and [do] not easily adapt to managing the kinds of changes coming forward.[20]

As Laing reports, "[P]olicymaking continues to lag technology capabilities and cannot keep up with the changing operational needs of the utility landscape."[21]

The National Academies of Sciences, Engineering, and Medicine (NASEM) describes the innovation process as "an ecosystem composed of interrelated steps ranging from research and development (R&D) to demonstration, manufacturing, and commercialization and deployment."[22] NASEM notes that technologies face substantial barriers in scaling up and achieving widespread market adoption. It calls such barriers "multiple 'valleys of death.'"[23] To guide technologies over these transitions, several participants in a NASEM Clean Energy Innovation Workshop stress the need for a comprehensive approach, emphasizing "the importance of developing a single holistic framework with interactive and coordinated components.[24]

A. Major Regulated Industry Changes Are Already Underway

There is much interest in innovation in public utility services, particularly for energy utilities but also for water and wastewater utilities.[25] The interest is triggered by combinations of:

- The looming need to replace or extensively repair "our nation's aging and deteriorating infrastructure,"[26] which is associated with Increasing concerns for system reliability and resilience in the face of potential service interruptions, which "can be the difference between life and death;"[27]

---

19 See: Kenneth Rose, *An Economic and Legal Perspective on Electric Utility Transition Costs*, National Regulatory Research Institute, The Ohio State University (1996) Report No. 96-15, https://ipu.msu.edu/wp-content/uploads/2016/12/Rose-Electric-Utility-Transition-Costs-96-15-July-96.pdf; and Stone, Clarifying (Opportunity) Costs, *The American Economist* 60, no. 1 (2015): 20-25, https://doi.org/10.1177/056943451506000103.

20 Richard Carlson and Aïda Nciri, *Enter the Sandbox: Developing Innovation Sandboxes for the Energy Sector*, (July 2020): 7, https://questcanada.org/wp-content/uploads/2020/07/Innovation-Sandboxes-Report-1-EN.pdf.

21 Genevieve Liang, "Commentary: It's time to tap potential of renewable community microgrids," *Energy News Network*, (February 2, 2021), electronic article, https://energynews.us/2021/02/02/national/commentary-its-time-to-tap-potential-of-renewable-community-microgrids/.

22 National Academies of Sciences, Engineering, and Medicine, *Enhancing Federal Clean Energy Innovation: Proceedings of a Workshop*, (Washington, D.C.: The National Academies Press, 2021): 2, https://doi.org/10.17226/25973.

23 Ibid.

24 Ibid.

25 Tim Woolf and Ben Havumaki, *The Role of Innovation in the Electric Utility Sector, for National Association of State Utility Consumer Advocates*, Lawrence Berkeley National Laboratory, 2022): 10-19 Future Electric Utility Regulation Report, Chapter 1, https://emp.lbl.gov/publications/role-innovation-electric-utility.

26 American Society of Civil Engineers, *2021 Report Card for America's Infrastructure*, https://infrastructurereportcard.org/about-asce/.

27 Op cit. Note 3, Fox-Penner, 2020: 78 and Chapter 5.

- The need for major, rapid changes in energy supplies and demands because of widespread public, formal climate-change commitments and related actions on the part of both government agencies and nongovernment entities, including utility companies themselves.[28, 29]
- Grid operational and stability challenges arising as a result of the increasing deployment of variable-output sources of generation, such as wind and solar.[30]
- New and emerging technologies for infrastructure modernization, energy storage, and distributed and renewable energy resources.[31]
- Prospects for fast-changing consumer interests and preferences, with increasing potential market segmentation and differentiation among consumers, and consumers acting as prosumers.[32]
- Ideas for changing both utility rate designs, intended to change consumer behaviors, and utility financial incentives and *Performance Based Regulation* (PBR), intended to change utility manager and employee behaviors.[33]
- Laws and executive directives in many jurisdictions, assigning new responsibilities to public utility regulatory commissions for addressing equity, environmental justice, objectives for major and rapid *Greenhouse Gas* (GHG) emissions reductions, and other "transformational values."[34]
- Concerns about the impacts of the energy transition on employment. Economic and *Resilience* plans for the many communities that will face potential economic and employment disruptions as older, inefficient, and GHG-emitting infrastructure (such as coal-burning power plants) are closed down, and transitions to new resources take place.[35]
- Flat or declining utility sales for traditional end uses, associated in large part with the increasing efficiency of end-use equipment and the gradual strengthening of appliance energy-efficiency standards and energy-efficiency building codes.[36]

---

28 National Regulatory Research Institute, *NRRI State Policies Tracker: Clean Energy and Climate Change Policies,* Washington, DC, April 2022, web accessed June 2022, https://www.naruc.org/nrri/nrri-activities/clean-energy-tracker/.

29 Op cit. Note 3, Fox-Penner, (2020): 3, 7-8, 22-27, and Chapter 6.

30 Semich Impram, Secil Varbak Nese, and Bülent Oral, "Challenges of renewable energy penetration on power system flexibility: A survey," *Energy Strategy Reviews 31*, (2020) https://doi.org/10.1016/j.esr.2020.100539.

31 US Department of Energy, Grid Modernization Initiative, *Grid Modernization Updated GMI Strategy 2020*, (2020) https://www.energy.gov/sites/prod/files/2021/02/f82/GMI_Strategy_FINAL%20as%20of%201.20.21.pdf.

32 US Department of Energy explains, "[A] prosumer is someone who both produces and consumes energy." See: US Department of Energy, Office of Energy Efficiency and Renewable Energy, *Consumer vs. Prosumer: What's the Difference?*, (May 11, 2017), electronic article, https://www.energy.gov/eere/articles/consumer-vs-prosumer-whats-difference.

33 The Behavior, Energy & Climate Change Conference (BECC) focuses on energy consumers and rate designs intended to change usage patterns (https://beccconference.org/about-becc/). For performance-based regulation, see: Jeffrey S. Logan, Owen R. Zinaman, et al., *Next-Generation Performance-Based Regulation: Emphasizing Utility Performance to Unleash Power Sector Innovation*, (Golden, CO: National Renewable Energy Laboratory, 2017), NREL/TP-6A50-68512, doi:10.2172/1392203, David E.M. Sappington, and Dennis L. Weisman, "Designing performance-based regulation to enhance industry performance and consumer welfare," *Electricity Journal 34*, no. 2 (2021), 106902, ISSN 1040-6190, https://doi.org/10.1016/j.tej.2020.106902; and Dennis Weisman, *A Report on the Theory and Practice of Performance-Based Regulation*, (2018), https://ssrn.com/abstract=3765691.

34 Robert J. Klee, and Sarah Baldinger, *Review of State Public Utility Commission Statutory Mandates*, r eport by Yale Center for Business and the Environment for the Institute for Market Transformation, (August 2021), https://drive.google.com/file/d/1bvQTifqgxGS5i7_CU1uj0HLPBQW5kjYV/view.

See also: Clean Energy States Alliance, *100% Clean Collaborative*, web page, accessed June 2022, https://www.cesa.org/projects/100-clean-energy-collaborative/; E9 Insight, *Pathways to Changing the PUC Mandate: A Regulatory Review*, https://drive.google.com/file/d/1c244_ryG4C15vnG1tuGu_1m8wgn9DwnK/view; E9 Insight, *PUC Mandate Database – Final*, compiled for Institute for Market Transformation, (July 2021), https://docs.google.com/spreadsheets/d/1acwblw_Q67d_bpdKxFQzJbsvP19WGj59/edit#gid=286574870; and J. Köhler, et al., "An agenda for sustainability transitions research: State of the art and future directions," *Environmental Innovation and Societal Transitions 31*, (2019): 16-18, https://www.sciencedirect.com/science/article/abs/pii/S2210422418303332?via%3Dihub.

35 Op cit., note 3, Fox-Penner, (2020): 150-56.

36 Op cit., note 3, Fox-Penner, (2020): 15-22.

- Proposals for electrifying transportation and selected thermal energy uses, employing low- or zero-emissions electricity as means for achieving GHG emissions reductions, resulting in a potential for large growth in future demand for electricity.[37]
- "A changing international environment including powerful market forces arising from globalization, shifts in the locus of electricity-relevant innovation, and growing concerns about state-sponsored competition and disruption."[38]

Various combinations of these major factors in different jurisdictions are sustaining interest in facilitating regulatory innovation. Many utility industry participants and observers are thinking seriously about and beginning to plan for innovations in both technologies and in business models, for both regulated utility companies and competitive service providers. At least some of the potential innovations could launch opportunities for new business models and new products and services that could challenge, and potentially even disrupt, long-standing industry structures and regulatory practices. Traditional industry participants, possible new industry participants, and at least to some extent legislators and other policy makers often rely on government regulatory agencies to consider and make determinations about such innovations.

The Council of European Energy Regulators reports,

> The economic regulation of energy services is characterized by a tension between the need for stability and predictability and the need to evolve over time to reflect the changing fundamentals of the energy system driven by climate change and technological innovation.[39]

B. Criticisms of Traditional Regulatory Innovations Approaches

Updated regulatory innovations platforms are frequently prescribed as a means for improving on the long-standing practice of regulated utilities designing, proposing, gaining regulatory approval for, and then engaging in experimental projects and pilot programs, before offering new products or services to larger numbers of customers.[40] Improved regulatory innovations platforms are intended, in part, to foster communications among parties that previously have not participated in regulatory proceedings,[41] and to speed innovation while reducing the risks of failure by limiting both numbers of customers participating in and the expenditures associated with trials. Collaborative innovations platforms hold some promise for

---

37 See: National Academies of Sciences, Engineering, and Medicine, *The Future of Electric Power in the United States*, (Washington, D.C.: The National Academies Press, (2021): 4, 9, 56-60, https://doi.org/10.17226/25968; and Tarekegne, B.W., K. Kazimierczuk, and R.S. O'Neil, *Coal-dependent Communities in Transition: Identifying Best Practices to Ensure Equitable Outcomes*, (Pacific Northwest National Laboratory, 2021), PNNL-31909, https://www.pnnl.gov/publications/coal-dependent-communities-transition-identifying-best-practices-ensure-equitable.

38 NASEM, *The Future of Electric Power in the United States*, 1, Chapter 4.

39 Ben Shafran, Hattie Slater, and Attila Hajos, *Dynamic NRAs to Boost Innovation: Report on Dynamic Regulation from the National Regulatory Authorities' Perspective*, report for Council of European Energy Regulators (CEER), (May 2022), No. C22-RBM-37-04, https://www.ceer.eu/2210.

40 Michigan Public Service Commission (PSC), in its October 29, 2020, Order in Case No. U-20645, addresses several challenges regarding utility pilot programs that were identified in a September 2020 Michigan PSC staff report, *Utility Pilot Best Practices and Future Pilot Areas*, for MI Power Grid: Energy Programs and Technology Pilots Workgroup, 11-12. See the order at https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000FU5HnAAL and the Michigan PSC staff report at https://www.michigan.gov/mpsc/0,9535,7-395-93307_93312_93593_95590_95594_95685-508663--,00.html. Cappers and Spurlock note that utility pilot programs have been criticized for failing to produce actionable outcomes, and for a lack of accuracy or bias in outcomes.

Peter Cappers, C. Anna Spurlock, *A Handbook for Designing, Implementing, and Evaluating Successful Electric Utility Pilots*, (Lawrence Berkeley National Laboratory, September 2020): 1, https://emp.lbl.gov/publications/handbook-designing-implementing-and.

Chang-hsien Tsai, et al., "The Diffusion of the Sand Box Approach to Disruptive Innovation and Its Limitations," 6, describe the "general inability of law and regulation to keep pace with the ever-changing and disruptive nature of technology and innovation."

41 Chandra Farley, John Howat, et al., *Advancing Equity in Utility Regulation*, (Berkeley, CA: Lawrence Berkeley Energy Laboratory 2021), Future Electric Utility Regulation Series, Report No. 12, https://emp.lbl.gov/projects/feur.

reducing total innovations costs, compared to traditional decision making via litigated case proceedings before public utility regulatory commissions.

Traditional regulated utility pilot programs, as a means of innovating, are subject to criticism on multiple grounds. Researchers cite, for example: (a) negative experiences associated with lengthy delays between decisions to test and readiness to implement successful innovations; (b) utility company biases associated with monopoly status; (c) experiments tainted by participant self-selection bias; (d) a general lack of rigor in pilot project design, implementation, monitoring, and evaluation; and (e) a lack of transparency in reporting about pilot project results and next steps.[42]

The overriding reasons for considering updates to previously existing regulatory innovations practices and support systems are:

- The rate of change in technology and possible associated changes in regulated utility and competitive service provider business models is potentially too rapid for the time needed to implement traditional regulatory innovations methods.
- Innovations often come from technologies and firms that have little if any prior experience engaging in energy regulatory proceedings.
- Many states have recently assigned to their utility regulators expanded policy goals and objectives that augment the need for rapidly assessing potential innovations. Examples include actions to achieve specific goals for renewable or clean resource portfolios, to reduce greenhouse gas emissions and help mitigate the effects of climate change, and the need to increase equity and provide assistance to previously disadvantaged and environmental justice communities in order to help stimulate the economy and employment.[43]

The Smart Electric Power Alliance notes:

> Regulatory proceedings on grid investments and customer programs often take so long that relevant technology providing customer benefit has advanced before a commission assessment can be completed or decision can be reached.[44]

As Cross-Call, Goldenberg, and Wang explain:

> The restrictive and often contentious nature of conventional regulatory processes make them inadequate to manage the scale, speed, and complexity of the historic transformation taking place in the electricity system. In response, regulators, utilities, and related stakeholders are increasingly employing broader, more participatory processes to consider investment decisions and rule changes . . . [T]he industry needs updated tools and methods to confront a growing and diversifying portfolio of proceedings while still ensuring diligent analysis and ratepayer protections.[45]

Carlson and Nciri note that government commitments to achieve rapid reductions in greenhouse gas emissions are necessitating energy systems innovations faster than any previous time period.[46] They report:

> [A] significant gap remains, between the pace needed to achieve energy transition and meet carbon reduction targets, on the one hand, and the current pace of innovation and transformation of energy

---

42 Michigan Public Service Commission staff, *Utility Pilot Best Practices and Future Pilot Areas*.

43 See: Carlson and Nciri, *Enter the Sandbox*, 6; National Regulatory Research Institute, *NRRI State Policies Tracker*; and Klee and Baldinger, *Review of State Public Utility Commission Statutory Mandates*; E9 Insight, *Pathways to Changing the PUC Mandate*; and E9 Insight, *PUC Mandate Database – Final*.

44 Smart Electric Power Alliance, *Renovate Initiative*, web page accessed June 2022, https://sepapower.org/renovate/.

45 Dan Cross-Call, Cara Goldenberg, and Claire Wang, *Process for Purpose: Reimagining Regulatory Approaches for Power Sector Transformation*, (Boulder, CO: Rocky Mountain Institute, 2019): 5, 7. https://rmi.org/insight/process-for-purpose/

46 Carlson and Nciri, *Enter the Sandbox*, (2020): 6.

> systems on the other . . . [E]nergy regulators, policymakers, and utility leaders . . . [report] that the current energy policy, market, and regulatory frameworks [are] not flexible enough and [do] not easily adapt to managing the kinds of changes coming forward.[47]

Cross-Call, Gold, et al. elaborate:

> The challenge for utilities and regulators is to address these needs and harness opportunities on the urgent timeline required to meet greenhouse gas abatement targets, while not abandoning long-standing requirements for affordable, universal energy supply and grid reliability.[48]

Nearly every US jurisdiction has already acted on at least some aspects of electric grid modernization, and several states have used open stakeholder proceedings as a means of informing and educating regulators and other participants about issues and to try to achieve consensus, where possible, about industry changes associated with grid modernization.[49] Many states are managing multi-issue, multi-year stakeholder procedures, with the projects name-branded by governors or regulatory commissions. The US Department of Energy reports that "38 states and the District of Columbia have completed or are undertaking some form of grid modernization activity that includes the deployment of smart grid technology, DERs, or both."[50] **Table 1** briefly summarizes major stakeholder proceedings in key states.

However, lengthy stakeholder proceedings present multiple obstacles to "equal participation," including "challenges for broad-participation [such as] powerful corporate voices . . . [and] "outsized utility influence."[51] Triedman et al. report that "resource and structural advantages allow utilities to dominate PUC processes."[52] They explain:

> PUCs pose significant technical and legal barriers to entry for many advocates, activists, [and\ the public. . . . [T]here are significant technical and legal barriers . . . [presenting] great challenges to participation in the regulatory process."[53]

47 Carlson and Nciri, *Enter the Sandbox*, (2020): 7.

48 Cross-Call, Gold, et al., *Reimagining the Utility*, (2018): 6.

49 See: Haynes Farinas, et al., *Utility Transformation Profile*, (Washington, DC: Smart Electric Power Alliance, 2021), https://sepapower.org/utility-transformation-challenge/; and North Carolina Clean Energy Technology Center, *50 States of Grid Modernization*, quarterly report series, 2020-2021, https://nccleantech.ncsu.edu/the-50-states-reports-downloads/.

50 US Department of Energy, Office of Electricity, 2020 *Smart Grid System Report*, (May 2022), https://www.energy.gov/oe/articles/2020-smart-grid-system-report.

51 Joel B. Eisen, and Shelley Welton, "Clean Energy Justice: Charting an Emerging Agenda," *43 Harvard Environmental Law Review*, (2019): 311, 343, 345-46, 355, https://harvardelr.com/wp-content/uploads/sites/12/2019/08/43.2-Welton-Eisen.pdf.

52 Cole Triedman, Eve Lukens-Day, Amanda Hinh, and Noah Ball-Burack, *Can State Utility Commissions Lead in the Clean Energy Transition? Lessons from Six States*, (Providence, RI: Brown University Climate and Development Lab, 2021): 3, http://www.climatedevlab.brown.edu/policy-briefings.html.

53 Ibid., p. 11.

Table 1: Summary of Key Jurisdictions' Broad Grid Modernization Stakeholder Proceeding

Jurisdiction (V or CC)[1]	Name of proceeding	Duration, with start and end dates, if known	Major factors included
Connecticut (CC)	Equitable Modern Grid Initiative	2019 start, with "multi-year" stakeholder proceedings and nine-year program plans	Four major objectives: 1. Support (or remove barriers to) the growth of Connecticut's green economy 2. Enable a cost-effective, economy-wide transition to a decarbonized future 3. Enhance customers access to a more resilient, reliable, and secure commodity 4. Advance the ongoing energy affordability dialogue in the State, particularly in underserved communities. Ongoing dockets include: advanced metering infrastructure; distributed energy resource analysis and program reviews; electric storage; energy affordability; innovations pilots; new rate designs; non-wires alternatives; resilience and reliability standards and programs; resource adequacy and clean electric supply; and zero-emissions vehicles;
District of Columbia (CC)	Modernizing the Energy Delivery System for Increased Sustainability (MEDSIS), superseded by Power Path DC	MEDSIS, June 2015 to April 2019; Power Path DC, January 2020 to "next five to ten years"	Over the next 5 to 10 years, the DC-PSC expects great strides to be made in the District's grid modernization efforts, including, but not limited to: • the integration of more non-wires alternatives through Pepco's improved distribution system planning process; • the deployment of more distributed energy resources on the distribution system from improved interconnection processes; • leveraging the lessons learned from the Pilot Projects approved in Phase 4 of the MEDSIS Initiative; • the expansion of electric vehicle and electric transportation enabling infrastructure; • greater data access by customers and third parties to enable targeted energy usage reduction measures, increased distributed energy resource deployment, and alternative technological advancements; • the implementation of new building codes and energy-efficiency standards that incentivize energy usage reduction for residential ratepayers in master-metered apartment buildings; and • the expansion and/or refinement of the Commission's jurisdiction over grid modernization-related matters, like microgrids.

1 See notes at end of table.

Jurisdiction (V or CC)[1]	Name of proceeding	Duration, with start and end dates, if known	Major factors included
Illinois (CC)	NextGrid – Utility of the Future Study	September 2017 – January 2019[2]	• New Technology Deployment and Grid Integration • Metering, Communications, and Data • Reliability, Resiliency, and Security • Customer and Community Participation • Electricity Markets • Regulatory, Environmental, and Policy Issues • Ratemaking
Ohio (CC)	PowerForward Collaborative	2017–2019, with continuing working groups in specific dockets in 2020 and annual collaborative and working group filings in 2021 and after	Focused on "innovation that will enhance the electricity experience for customers."[3] • Phase 1: A Glimpse of the Future • Phase 2: Exploring Technologies • Phase 3: Ratemaking and Regulation
Michigan (V)[4]	MI Power Grid	Planning processes.	• Customer engagement, including Customer Education and Participation, Demand Response, Energy Programs and Technology Pilots, and Innovative Rate Offerings • Integrating emerging technologies, including Interconnection Standards and Worker Safety, Competitive Procurement, New Technologies and Business Models, and Data Access & Privacy • Optimizing grid investment and performance, including Financial Incentives/ Disincentives, Grid Security and Reliability Standards, and Advanced Planning Processes
Minnesota (V)	e21 Initiative	2014 – present	• Phase 1: Consensus for Change • Phase 2: Implementation Plans • Phase 3: Ideas to Action

1,2,3,4 See notes at end of table.

Jurisdiction (V or CC)[1]	Name of proceeding	Duration, with start and end dates, if known	Major factors included
New York (CC)	Reforming the Energy Vision (REV)	2014 – present	• Affordability • Resilience • Empowering informed energy choices • Creating new jobs and business opportunities • Improving existing initiatives and infrastructure • Supporting cleaner transportation • Cutting GHG emissions 80 percent by 2050 • Protecting New York's natural resources • Helping to grow clean energy innovation
Rhode Island (CC)	Power Sector Transformation Initiative	2017 – present	"[A] more nimble electric grid that can strategically integrate clean energy resources and enable Rhode Islanders to take advantage of new clean energy technologies."[5] • Utility business models • Grid connectivity and functionality • Distribution system planning • Beneficial electrification – heating and transportation

1 States indicated "(V)" have what is generally considered a vertically integrated market structure. States indicated "(CC)" allow customer choice for electricity generation service. For more specific details of industry structure by state, see: National Governors Association, *Electricity Markets – 101*, web page, accessed May 2022, https://puco.ohio.gov/utilities/electricity/resources/ohio-grid-modernization.

2 Illinois court filing and settlement.

3 Public Utilities Commission of Ohio, *PowerForward: A Roadmap to Ohio's Electricity Future*, (2018): 4, https://puco.ohio.gov/utilities/electricity/resources/ohio-grid-modernization.

4 Michigan's electric utility market structure is unique, with regulated utilities owning both generation and distribution systems, and a separate investor-owned transmission company. Customer choice in Michigan is limited to not more than 10 percent of regulated utility company load.

5 Gov. Gina M. Raimondo, March 2, 2017, letter to Rhode Island Public Utilities Commission, Office of Energy Resources, and Division of Public Utilities and Carriers, http://www.ripuc.ri.gov/utilityinfo/electric/GridMod_ltr.pdf. See also State of Rhode Island, Office of Energy Resources, Power Sector Transformation, web page, accessed May 2022, http://www.energy.ri.gov/electric-gas/future-grid/.

C. States Are Assigning Transformational Values to Utility Regulatory Authorities

Many state utility regulatory authorities are faced with recently added policy goals and objectives. New assignments frequently include major climate action goals, along with "transformational values," such as equity, environmental justice, and support for previously disadvantaged communities.[54] In some jurisdictions, regulatory commissions have explicit responsibilities for considering the economic development implications of utility infrastructure decisions.[55] Innovation needs are likely to be triggered as utility companies and other industry and regulatory proceedings participants consider actions necessary to achieve the newly assigned regulatory objectives. **Table 2** lists the essential elements included in the mission statements for many state public utility regulatory authorities, and indicates recent additions to the goals and objectives. In many cases, the added goals and objectives apply to all state agencies, including state public utility regulatory agencies.

As shown in Table 2, many states have adopted major climate action goals or mandates, including several states calling for zero or net-zero GHG emissions. In most instances the state environmental regulators have primary responsibility for achieving the GHG emissions levels, but utility regulatory commissions will be asked to approve related utility company expenditures. In addition, many states have renewable energy requirements for electric utility companies, and some are also starting to include programming for renewable natural gas. In nearly half the states, renewable portfolio standards (RPS) encourage distributed generation, generally, or solar PV explicitly, and six states also include provisions for solar water heating. The policies vary: Some state RPSs have mandatory minimum percentages of qualifying renewable energy from distributed generation (DG) projects, some include specific percentages or capacity minimums from solar-electric generators, and others offer some form of extra credit for specific DG projects.[56]

Several states also direct utility regulators to include in their decisions objectives to achieve economic development. In several cases this means a specific focus on economic and employment transitions for communities where fossil fuel facilities were previously important contributors to the local economy. Other states explicitly mention previously disadvantaged or other disproportionately impacted communities. And as listed in Table 2, 15 states have begun mapping exercises to identify locations of particular focus for equity and environmental justice.

Many states have also initiated policies for utility regulators to base decisions in part on equity and energy and environmental justice concerns. Several of those states also explicitly address diversity, equity, and inclusion. Sometimes those goals are assigned explicitly to regulatory commissions themselves, but they can also apply to utility companies, to purchasing provisions for both state agencies and utilities, and to regulatory proceedings.

---

54 National Regulatory Research Institute, *NRRI State Policies Tracker*; Klee and Baldinger, *Review of State Public Utility Commission Statutory Mandates*.

55 Kiera Zitelman, and Jasmine McAdams, *The Role of State Utility Regulators in a Just and Reasonable Energy Transition – Examining Regulatory Approaches to the Economic Impacts of Coal Retirements*, (Washington, D.C.: National Association of Regulatory Utility Commissioners, 2021), https://pubs.naruc.org/pub/952CF0F2-1866-DAAC-99FB-0C6352BF7CB0.

56 North Carolina Clean Energy Technology Center, Database of State Incentives for Renewables & Efficiency (DSIRE), *Renewable Portfolio Standards with Solar and Distributed Generation Provisions*, (February 2017), https://www.dsireusa.org/resources/detailed-summary-maps/.

Table 2: Jurisdictions with Recently Added Public Utility Regulatory Commission Authorities

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Alabama	[S]afe, adequate and reliable services at rates that are equitable and economical	• Equity • Economic development
Arizona	[S]afe, reliable, and affordable utility services	• Renewable Portfolio Standard (RPS) with a requirement to include distributed generation. • Jobs and economic development
Arkansas	[S]afe, adequate and reliable utility service at just and reasonable rates	• Energy efficiency portfolio standard • Commission may approve qualifying economic development rates
California	[S]afe, clean, and affordable utility services and infrastructure	• 100 percent Clean and carbon neutral by 2045, with 50 percent renewable energy by December 31, 2026, and 60 percent by December 31, 2030 • Improve air quality and economic conditions in "disadvantaged" communities • Environmental and social justice • Mapping state environmental justice communities • Diversity, equity, and inclusion
Colorado	[S]afe, reliable, and reasonably priced services consistent with the economic, environmental and social values of our state	• 100 percent Clean energy by 2050 for large electric utilities; clean heat plans for natural gas utilities • Rps with dg and customer-sited requirements • Efficient, clean and renewable, with goals of 50 percent emissions reductions by 2030 and 90 percent by 2050, from 2005 levels • Equity, environmental justice and prioritizing benefits to "disproportionately impacted" communities • Mapping disproportionately impacted communities • 40 percent of renewable-energy programming must benefit low-income and disproportionately impacted communities

See sources at the end of the table.

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Connecticut	[S]afe, adequate and reliable utility service at reasonable rates	• Greenhouse gas levels at least 80 percent below 2001 levels by not later than 2050 • Member of the multi-state Regional Greenhouse Gas Initiative (RGGI) • RPS 40 percent by 2030, 100 percent by 2040 • Low-carbon heating-oil standard, not less than 50 percent by 2035 • Efficient, clean and renewable • Environmental equity and justice • Mapping environmental justice communities
Delaware	[S]afe, reliable and reasonably priced cable, electric, natural gas, wastewater, water and telecommunications services	• Governor's commitment to meet Paris Agreement standard of 26-28% below 2005 levels by 2025 • State climate action plan • Member of RGGI • Justice 40 Oversight Committee • Coastal inundation mapping
District of Columbia	[S]afe, reliable and quality utility services at reasonable rates . . . while fostering grid modernization, conservation of natural resources, preservation of environmental quality, and advancement of the District's climate policy commitments	• 100% clean by 2032, economy-wide including transportation energy • Carbon neutral by 2050 • RPS 80% by 2029 and 100% by 2032, with solar and DG provisions
Guam	[J]ust and reasonable rates.	• RPS 50% by 2035, 100% by 2045
Hawaii	[S]afe, reliable, economical, and environmentally sound	• Carbon neutral by 2045 • 100% Renewable by 2045 • Legislative declaration of climate emergency, "requesting statewide collaboration toward an immediate just transition and emergency mobilization effort to restore a safe climate" • Mandatory energy-efficiency resource standard • Transportation electrification

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Idaho	[F]air, just, reasonable and nondiscriminatory rates and utility practices . . . safe, reliable and efficient utility services . . . secure and promote the general safety, health and public welfare	• public health
Illinois	[A]dequate, efficient, reliable, safe and least-cost public utility services	• 100% renewable by 2050, including a goal to "electrify and decarbonize" the state's transportation sector • RPS, with solar PV and DG requirements, calls for 40% clean and renewable energy supply by 2040 for retail electric suppliers • mandatory energy efficiency resource standard • environmental justice communities, including benefits from solar energy and transportation electrification • mapping environmental justice communities • diversity, equity, and inclusion
Indiana	[S]afe and reliable service at just and reasonable rates	• climate action goal
Iowa	[R]easonably priced, reliable, environmentally responsible, and safe utility services . . . available to all	• climate action goal
Maine	[S]afe and reliable utility services at rates that are just and reasonable for all	• GHG emissions 80% below 1990 levels by 2050 • member of RGGI • RPS of 80% by 2030 and 100% by 2050 • mandatory energy efficiency resource standard • equity, environmental justice, including "environmental justice populations" and "frontline communities"

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Maryland	[S]afe, reliable, and economic service … just, reasonable, and transparent … explore innovation that will encourage the efficient delivery of public utility services; consider the economic and environmental impacts of all matters before the Commission; [and] encourage the conservation of natural resources and environmental preservation	• Achieve state climate commitments, including GHG emissions 60 percent below 2006 levels by 2030, net-zero state-wide by 2045 • Member of RGGI • A 2030 state plan calls for GHG reductions of "nearly 50 percent by 2030, and … net-zero economy wide … by 2045" • Protection from global climate change • RPS 40 percent by 2025 and 50 percent by 2030, including solar-electric provisions • Energy efficiency standard of 2 percent annual savings beginning in 2024, increasing to 2.7 percent Annual by 2027 and thereafter • Energy performance targets for low-income households, achieving gross energy savings of 0.4 percent For 2023, increasing to 1.0 percent In 2026 • Fair and stable labor standards • Environmental justice and sustainable communities • Efficiency standards for new and existing buildings • Identify communities disproportionately affected by climate change and develop strategies for environmental justice, climate equity, and resilience • Mapping environmental justice, climate, and health equity communities
Massachusetts	[E]nsure … the most reliable service at the lowest possible cost, to protect the public safely … and to ensure that residential ratepayers' rights are protected	• Economy-wide state climate action plan, with interim goals every five years from 2025 through 2050, to "achieve net-zero" and reduce GHG emissions by at least 85 percent below 1990 levels by 2050 • Member of RGGI • Mandatory clean energy and clean peak resource standards • Energy-efficiency initiatives benefit-cost calculations include "the social value of greenhouse gas emissions reductions." • RPS of 35 percent by 2030 plus 1 percent each year thereafter, including solar PV provisions • Environmental justice, including "overall societal benefits, … Diversification of energy sources and other benefits to the economy, environment, and public health" • Mapping environmental justice communities

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Michigan	[S]afe, reliable, and accessible … services at reasonable rates	• 100 percent renewable by 2050 • RPS with solar multiplier provisions • Mandatory energy-efficiency resource standard • Governor's executive order calls for economy-wide carbon neutrality by 2050 • Utilities must file GHG reduction plans in future IRPs • Environmental justice • Mapping environmental justice communities • Diversity, equity, and inclusion • Energy affordability and accessibility
Minnesota	[S]afe, adequate and efficient utility services at fair, reasonable rates	• GHG 80 percent below 2005 levels by 2050 • Governor's policy proposal for 100 percent clean energy for electricity by 2050 • RPS with PV and DG provisions • Mandatory energy-efficiency resource standard • Environmental justice • Mapping areas of environmental justice concern • Diversity, equity, inclusion
Missouri	[S]afe and reliable utility services at just reasonable, and affordable rates [and] support economic development	• RPS 15 percent by 2021 and thereafter, with solar-electric provisions • jobs and economic development
Nevada	Provide for fair and impartial regulation of public utilities [and] provide for the safe, economic, efficient, prudent, and reliable operation and service of public utilities	• Net-zero or near-zero GHG by 2050 • RPS not less than 50 percent by 2030 and a goal of 100 percent carbon free by 2050, with solar-electric, PV, and energy-efficiency provisions • State climate action plan

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
New Hampshire	[S]afe, adequate and reliable service at just and reasonable rates; to foster competition where appropriate; to provide necessary customer protection; and, to provide a thorough but efficient regulatory process that is fair, open and innovative	• State climate action plan • Member of RGGI • RPS 25.2 percent by 2025, 50 percent target by 2030
New Jersey	[S]afe, adequate, and proper utility services . . . provided at reasonable, non-discriminatory rates [and] a competitive, economically cost effective energy policy that promotes responsible growth and clean renewable energy sources while maintaining a high quality of life in New Jersey	• GHG emissions 80 percent below 2006 levels by 2050 • Member of RGGI • State climate action plan • RPS 25 percent by 2025 and 50 percent by 2030, with solar-electric provisions, plus a governor's goal of 100 percent clean energy by 2050 • Protection against climate threats • Environmental justice, "overburdened" communities • Mapping environmental justice communities
New Mexico	[E]nsure fair and reasonable rates, and to assure reasonable and adequate services to the public	• GHG executive order calls for 45 percent below 2005 levels by 2030 • RPS for retail electricity sales of 40 percent by 2025, with solar electric and DG provisions; 80 percent clean energy by 2040 for IOUs and by 2050 for cooperatives • 100 percent zero-carbon resources by 2045 • Support for apprentiseships and job training and workforce development in previously disadvantaged communities• Environmental justice • Open environmental mapping system

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
New York	[A]ffordable, safe, secure, and reliable access to [utility services] while protecting the natural environment	• GHG emissions 15 percent of 1990 levels by 2050; 40 percent reductions by 2030 and net-zero GHG emissions "from all anthropogenic sources" by 2050 • Member of RGGI • State climate action plan, slated for year-end 2022 final approval, includes "reducing 100 percent of the electricity sector's greenhouse gas emissions by 2040" • State law provides for the use of GHG offsets, under certain conditions • RPS with customer-sited renewables provisions, reaching 70 percent renewable by 2030 and statewide electric system zero GHG emissions by 2040 • Environmental justice • Disadvantaged communities, including provisions for a minimum of 35 percent of the benefits of clean energy and energy-efficiency programs to accrue to disadvantaged communities • Disadvantaged communities mapping, maps, and GIS tools for environmental justice
North Carolina	Promote adequate, reliable, and economical utility service; Provide just and reasonable rates and charges for public utility services and promote conservation of energy; Encourage and promote harmony between public utilities, their users and the environment; [and] [p]romote the development of renewable energy and energy efficiency through the implementation of a Renewable Energy and Energy Efficiency Portfolio Standard	• GHG emissions executive orders call for 40 percent below 2005 levels by 2025, 50 percent by 2030, and net zero by 2050 • State climate action plan • RPS with solar-electric provisions calls for 12.5 percent by 2021 • Environmental justice and equity in cabinet agencies, including clean energy economic development • Community mapping system

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Oregon	[E]nsure Oregon utility customers have access to safe, reliable, and high quality utility services at just and reasonable rates	• GHG emissions legislation calls for 75 percent below 2020 levels by 2050 • "Cap and reduce" climate plan starts in January 2022 • Rules are being developed to limit GHG emissions from fossil fuels, including transportation fuels and other gaseous and liquid fuels, including natural gas • RPS, with solar PV provisions, directs retail electricity providers to reduce GHG emissions: 80 percent by 2030, 95 percent by 2035, and 100 percent by 2040 • Eliminate coal power by 2035 and double the amount of clean, renewable energy to 50 percent by 2040 • Environmental justice, including social equity and affordability • Diversity, equity, and inclusion
Oklahoma	Ensuring responsible development of oil and gas resources, reliable utility service at fair rates, . . . prevention and remediation of energy related pollution . . . [and] development and enforcement of regulations in an open, transparent, ethical, and just manner	• State climate action plan • Equity
Pennsylvania	[E]nsure safe and reliable utility service at reasonable rates; protect the public interest; . . . further economic development; and foster new technologies and competitive markets in an environmentally sound manner	• Governor's executive order calls for 80 percent below 2005 levels by 2050 • RPS, with solar PV provisions, calls for 18 percent by 2021 • State climate action plan • Participating in RGGI • Economic development • Environmental justice areas mapping
Puerto Rico	[A]chieve a reliable, efficient and transparent electric system, which provides power services at reasonable prices . . . [and] guarantee the capacity, reliability, safety, efficiency, and reasonability of electricity rates	• GHG emissions reductions of 50 percent by 2024 • RPS 40 percent by 2025, 60 percent by 2040, and 100 percent by 2050

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Rhode Island	[E]nsure just and reasonable rates; ensure sufficient utility infrastructure to promote economic development	• State climate action law calls for 45 percent below 1990 emissions levels by 2030, 80 percent by 2040, and net zero by 2050 • State climate action plan updated every five years to reach net-zero by 2050 • RPS of 38.5 percent by 2030, with goal of 100 percent by 2030 • Published plan for pathways and policies to achieve 100 percent electricity demand from renewables by 2030 • State heating oil standard for biodiesel blends, minimum 10 percent by 2023, 20 percent by 2025, and 50 percent by 2030 • Member of RGGI • Economic development • Environmental justice focus areas • Open environmental resources mapping
Vermont	[E]nsure the provision of high-quality public utility services in Vermont at minimum reasonable costs, consistent with the long-term public good of the state	• GHG goals in law of 26 percent reductions by 2025 (2005 baseline), 40 percent by 2030 (1990 baseline), and 80 percent by 2050 (1990 baseline) • Climate action plan with updates every four years • Member of RGGI • RPS calls for 55 percent Tier One renewables by 2017, increasing 4 percent per every three years until reaching 75 percent on and after January 1, 2032
Virginia	[A]pply law and regulation to balance the interests of citizens, businesses, and customers in regulating Virginia's business and economic concerns and work] continually to improve the regulatory and administrative processes	• GHG reductions to zero-carbon electric generation by year-end 2045 • Member of RGGI • RPS mandatory targets for electric utilities to achieve 100 percent renewables; for Phase I utilities, 14 percent by 2025, 30 percent by 2030, 65 percent by 2040, and 100 percent by 2050; and Phase II utilities, 26 percent by 2025, 41 percent by 2030, and 100 percent by 2045

Jurisdiction	Essential elements in the state utility regulatory commission mission statement	Transformational values recently added
Washington	[P]rotect the people of Washington by ensuring that investor-owned utility and transportation services are safe, available, reliable, and fairly priced	• GHG law to reduce statewide GHG emissions, economy-wide, to 1990 levels by 2020, then reduce by another 45 percent by 2030, 70 percent by 2040, and 95 percent GHG reduction AND "net zero" both by 2050 • Eliminate coal-fired electricity, transition the state's electricity supply to 100 percent carbon neutral by 2030, and 100 percent carbon free by 2045 • RPS with DG provisions • Renewable natural gas (RNG) and renewable hydrogen, including voluntary RNG tariffs • Electric utilities to "pursue all available conservation that is cost-effective, reliable, and feasible" • Incorporate social cost of carbon in regulatory impact analyses • Electric utilities shall eliminate coal-fired generation by 2025, greenhouse gas neutral by 2030, wiith zero-carbon electricity market by 2045 • Diversity, equity, and inclusion • Environmental justice, overburdened communities, and native tribes • Environmental health disparities mapping • Equitably distribute clean energy benefits
West Virginia	[A]dequate, economical and reliable utility services [and] appraise and balance the interests of current and future utility service customers with the general interest of the state's economy and the interests of the utilities	• Economic development
Wisconsin	[S]afe, reliable, affordable, and environmentally responsible utility services and equitable access to telecommunications and broadband services	• Governor's goal for 100 percent carbon-free electricity by 2050 • Environmental justice • Environmental equity mapping tool

Table 2 Sources: All web pages accessed May 2022.

Clean Energy States Alliance, 100% Clean Energy States Project, web page, https://www.cesa.org/projects/100-clean-energy-collaborative/guide/table-of-100-clean-energy-states/

Climate Xchange, State Climate Policy Tracker, web page, https://climate-xchange.org/network/map/, and Climate Xchange, State Climate Polity Tracker, spreadsheet, version 1.3, https://docs.google.com/spreadsheets/d/1t912_uR-x8DeMTDNCm6y9nb6QLiiLDAdWNciteu1rOU/edit#gid=951166054.

Colorado State University, Center for the New Energy Economy and The Nature Conservancy, State Policy Opportunity Tracker (SPOT) for Clean Energy, web site, https://spotforcleanenergy.org/about/.

E9 Insight, *A Regulatory Review of Pathways to Changing the PUC Mandate*, https://drive.google.com/file/d/1c244_ryG4C15vnG1tuGu_1m8wgn9DwnK/view.

E9 Insight, PUC Mandate Database – Final, compiled for Institute for Market Transformation, (July 2021) https://docs.google.com/spreadsheets/d/1acwblw_Q67d_bpdKxFQzJbsvP19WGj59/edit#gid=286574870.

R. Klee and S. Baldinger, *Review of State Public Utility Commission Statutory Mandates*, report by Yale Center for Business and the Environment for Institute for Market Transformation, (2021) https://drive.google.com/file/d/1bvQTifqgxGS5i7_CU1uj0HLPBQW5kjYV/view.

NRRI State Clean Energy Policy Tracker, web page, https://www.naruc.org/nrri/nrri-activities/clean-energy-tracker/.

Kiera Zitelman and Jasmine McAdams,*The Role of State Utility Regulators in a Just and Reasonable Energy Transition – Examining Regulatory Approaches to the Economic Impacts of Coal Retirements*, National Association of Regulatory Utility Commissioners, (2021) https://pubs.naruc.org/pub/952CF0F2-1866-DAAC-99FB-0C6352BF7CB0.

D. Researchers Are Studying the Role of Innovations in Energy Systems Transitions

The multi-level perspective (MLP) is a research framework frequently used to study innovations and the role of innovations in socio-technical transformations.[57] As Geels describes, innovations in energy systems are likely to result in "systemic . . .socio-technical transformations . . . entail[ing] changes in technology, policy, markets, consumer practices, [and] infrastructure."[58] In particular, Geels says, MLP is used to study how innovations affect the relationships and "interplay" among three analytical levels, which are commonly labeled: (1) landscape; (2) regime; and (3) niche.[59]

In the context of energy regulatory innovations, the landscape level refers to high-level, long-standing constructs that help define the general context and environment for federal and state energy markets and regulations. Kern explains, "The landscape level comprises slowly changing external factors such as climate change, which influence the development of the energy system but are beyond the control of individual actors."[60] Smith, Voss, and Grin, describe landscape level "processes includ[ing] environmental and demographic change,

57 OKöhler et al., "An agenda for sustainability transitions research."
Multiple researchers have also explored other approaches to supplement MLP with the goal of providing more comprehensive understandings of innovations processes. These include, for example, diffusion of innovations theory (D. Keppler, "Characterization of Innovations within the Multi-Level Perspective with Diffusion Typology of Innovations: A Fruitful Combination," *Journal of Innovation Management, nno.* 2 (2019), 15-37, ISSN 2183-0606, https://doi.org/10.24840/2183-0606_007.002_0003); social practice theory (T. Hargreaves, N. Longhurst, and G. Seyfang, *Understanding Sustainability Innovations: Points of Intersection between the Multi-Level Perspective and Social Practice Theory*, 3S Working Paper 2012), 03, (Norwich, UK: Science, Society and Sustainability Research Group, School of Environmental Sciences, University of East Anglia, 2012), https://www.researchgate.net/profile/Tom-Hargreaves/publication/266486401); and theories of socio-technical transformation (Harald Rohracher, "Analyzing the Socio-Technical Transformation of Energy Systems: The Concept of 'Sustainability Transitions,'" Chapter 18 in *Oxford Handbook of Energy and Society,* 2018), Debra J. *Davidson* and Matthias Gross, eds., https://doi.org/10.1093/oxfordhb/9780190633851.013.3).

58 F.W. Geels, "The multi-level perspective on sustainability transitions: Responses to seven criticisms," *Environmental Innovation and Societal Transitions*, 1, no. 1 (2011): 24-40. https://doi.org/10.1016/j.eist.2011.02.002.

59 Ibid., p. 26.

60 Florian Kern, "Using the multi-level perspective on socio-technical transitions to assess innovation policy," *Technological Forecasting and Social Change 79*, no. 2, 2012): 299, https://doi.org/10.1016/j.techfore.2011.07.004.

new social movements, shifts in general political ideology, broad economic restructuring, emerging scientific paradigms, and cultural developments."[61] They explain:

> Landscape changes are a source of pressures for change on the regime level; they prompt responses from within the regime; and they generate opportunities for niches. At times, landscapes can work to reinforce regime trajectories. At other times, landscape developments place some regimes under considerable stress in ways that undermine satisfaction with their performance, and prompt consideration of niche alternatives.[62]

Blackhall et al. describe the landscape level as reflecting "national electricity objectives."[63] They explain, "[A] national electricity objective should provide a measure against which all technology, policy, regulations and opportunities for enhanced consumer participation can be assessed."[64]

The regime level refers to socio-technical rules that help orient and coordinate groups and serve to establish stable cultural, political, technical, market, and industrial dimensions. With respect to regulatory innovation, the regime level reflects the existing industry structure with roles and relationships defined among customers, providers, and regulators. The US has several different kinds of industry structures at both the wholesale and retail levels of energy markets, which means that the regime level actors, rules, and relationships differ in important ways, by jurisdiction.[65] Regimes differ substantially, according to each jurisdiction's industry structure and roles for regulated utilities and possible competitive non-utility service providers, in both wholesale and retail electricity markets.[66] Cross-Call, Gold, et al., note, "The choice of which path to follow, and application of the models, will . . . vary based on the existing policy context and market structure of each state."[67]

Kern describes the regime level as "relatively stable" and notes that the regime "alignment provides stability for technology development."[68] However, countervailing observations, from Smith, Voss, and Grin, include: (1) Regimes are increasingly confronted with new sustainability criteria which were never considered during their installation; and (2) changes in regimes "can prove quite influential upon broader landscape developments."[69]

---

61 Adrian Smith, Jan-Peter Voss, and John Grin, "Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges," *Research Policy 39*, no. 4, (2010): 441, https://doi.org/10.1016/j.respol.2010.01.023.

62 Ibid.

63 Lachlan Blackhall, Gabrielle Kuiper, Larissa Nicholls, and Paul Scott, "Optimizing the value of distributed energy resources," *Electricity Journal 33*, no. 9 (2020): 2, 106838, https://doi.org/10.1016/j.tej.2020.106838. Open access link: http://users.cecs.anu.edu.au/~pscott/extras/papers/blackhall2020.pdf.

64 Ibid.

65 A two-year task force on comprehensive electricity planning includes representatives from the regulatory commissions and energy offices for 15 US jurisdictions. National Association of Regulatory Utility Commissioners, *Task Force on Comprehensive Electricity Planning*, web page, accessed June 2022, https://www.naruc.org/taskforce/.

66 National Association of Regulatory Utility Commissioners, *Task Force Cohort Roadmaps*, web page, accessed June 2022, https://www.naruc.org/taskforce/resources-for-action/roadmaps/. See also National Association of Regulatory Utility Commissioners and National Association of State Energy Offices, *Task Force on Comprehensive Electricity Planning*, fact sheet, https://pubs.naruc.org/pub.cfm?id=154861E5-155D-0A36-3185-2E12B33288BC.

Even more variability in regimes exists across the US because many utility providers are not subject to state public utility regulations. For example, most municipal utilities are regulated by local government boards of commissioners, and cooperative utilities are often regulated by directors selected from among the utility membership. In addition, there are already thousands of small, often remote utility systems that are privately owned and operated. Regulatory oversight for them varies widely: Efforts are underway in many jurisdictions to establish regulatory frameworks for such systems. See, for example: Meister Consultants Group, *Practical Guide to the Regulatory Treatment of Mini-Grids*, report for National Association of Regulatory Utility Commissioners and United States Agency for International Development, (2017), https://pubs.naruc.org/pub/E1A6363A-A51D-0046-C341-DADE9EBAA6E3; and World Bank Energy Sector Management Assistance Program, 2019, *Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers*, ESMAP Technical Report 014/19, https://openknowledge.worldbank.org/handle/10986/31926.

67 Cross-Call, Gold, et al., *Reimagining the Utility,* 19.

68 Kern, "Using the multi-level perspective on socio-technical transitions to assess innovation policy," 299.

69 Smith, Voss, and Grin, "Innovation studies and sustainability transitions," 441.

A key topic of study about public utility regulatory industry regimes is the extent to which technologies and participant relationships can get locked in and be resistant to change.[70] Kern calls this "entrapment."[71] Köhler et al. observe that "incumbent regime actors" sometimes exhibit "active resistance to transitions."[72] Geels summarizes the challenges presented by long-established regimes with politically powerful incumbents, like monopoly utility company providers:

> [S]ustainability transitions are necessarily about interactions between technology, policy/power/politics, economics/business/markets, and culture/discourse/public opinion. Researchers therefore need theoretical approaches that address, firstly, the multi-dimensional nature of sustainability transitions, and, secondly, the dynamics of structural change . . . [L]ock-in mechanisms create path dependence and make it difficult to dislodge existing systems. So, the core analytical puzzle is to understand how environmental innovations emerge and how these can replace, transform or reconfigure existing systems.[73]

These concerns about lock-in and path dependence are primary reasons for the attention focused by multiple regulatory community participants on regulated utility financial incentives.[74] Possibilities for performance-based regulation (PBR) are integral to these considerations, with defined performance metrics and performance incentive mechanisms (PIMs) designed to best align regime-level utility financial incentives with landscape-level societal goals and objectives.

The niche level is generally described as the level at which innovations are initially introduced and tested. Lee, Glick, and Lee call the niche level the "locus of innovation" for experiments in "cutting edge technologies, user experience, and co-evolution of structure."[75] Köhler et al. explain that, the niche is "where new entrants (pioneers, entrepreneurs) nurture the development of alternatives."[76] The study of energy regulatory innovation often includes, as Köhler et al. describe, "the role of business actors in creating novel technologies and industries, their role in facilitating institutional change and the relations and struggles between newcomers and incumbent actors."[77] Kern explains:

> On the niche level new energy practices and technological innovations . . . emerge in protected spaces . . . evolve over time and possibly may start to compete with the dominant regime and eventually "overturn" it.[78]

Walgrave et al. report that the niche level is not composed of single actors. Rather, they say, it "constitutes a system level that is located between the single actors . . . and the broader environment dominated by a prevailing socio-technical regime."[79] They identify the niche as "an emerging industry, characterized by great uncertainty about the technology and market, which results in a wide diversity of technological and market

---

70 Köhler et al., "An agenda for sustainability transitions research," 6.

71 Kern, "Using the multi-level perspective on socio-technical transitions to assess innovation policy," 299.

72 Köhler et al., "An agenda for sustainability transitions research," 5.

73 Geels, 2011, "The multi-level perspective on sustainability transitions," 25.

74 Logan, Zinaman, et al., *Next-Generation Performance-Based Regulation*; Sappington and Weisman, "Designing performance-based regulation to enhance industry performance and consumer welfare,"; and Weisman, *A Report on the Theory and Practice of Performance-Based Regulation*.

75 Taedong Lee, Mark B. Glick, and Jae-Hyup Lee, "Island energy transition: Assessing Hawaii's multi-level, policy-driven approach," *Renewable and Sustainable Energy Reviews*, 118, (2020): 20, https://doi.org/10.1016/j.rser.2019.109500.

76 Köhler et al., "An agenda for sustainability transitions research," 4.

77 Ibid., p. 12.

78 Kern, 2012, "Using the multi-level perspective on socio-technical transitions to assess innovation policy," 299.

79 Walgrave et al., "A multi-level perspective on innovation ecosystems for path-breaking innovation," *Technological Forecasting and Social Change 136* (2018): 13-15, https://doi.org/10.1016/j.techfore.2017.04.011.

approaches adopted by the actors within the niche."[80] Walgrave et al. identify "four strategic principles to develop and commercialize path-breaking innovations." They propose,

> [N]iche actors should: (1) engage in socio-technical experimentation; (2) maintain a collective knowledge base; (3) converge their efforts in getting the technology widely adopted; and (4) achieve and take advantage of protection measures that help sustain the niche and its participants."[81]

Geels explains that MLP is particularly suitable for studying sustainability transitions, because such transitions are generally "goal oriented," with goals focused on collective rather than individual ends, and because different definitions of sustainability result in disagreement and debate about "particular solutions and the most appropriate policy instruments or packages."[82]

MLP has already been applied to studies of:

- the transition to low-carbon power systems;[83]
- hydrogen and battery-electric vehicles;[84]
- microgrids and decentralized energy systems in the US;[85]
- solar prosumers in Germany;[86]
- wind energy development, especially in Denmark,[87] and
- US cities that are obtaining 100 percent of their energy needs from renewable sources.[88]

In addition, Soutar applies MLP analysis to the study of broad energy system transitions[89] and Lee, Glick, and Lee apply MLP analysis to a case study of energy regulatory innovation in Hawaii.[90] Woolf and Havumaki explain, "[C]hanges in technology and policy operate symbiotically, with grid advances driving changes in policy, and the grid also evolving with new policies."[91]

---

80 Ibid., p. 14.

81 Ibid., p. 15.

82 Geels, "The multi-level perspective on sustainability transitions," 25.

Similarly, Weber and Rohracher agree that MLP can be used to study "goal-oriented system transformation," but argue that approach needs to be supplemented by the "complementarities and potential synergies" provided by the study of "transformation oriented innovation policies." K. Matthias Weber, and Harald Rohracher, "Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework," *Research Policy 41*, no. 6, (2012): 1038-41, https://doi.org/10.1016/j.respol.2011.10.015.

83 Martin E. Wainstein, and Adam G. Bumpus, "Business models as drivers of the low carbon power system transition: A multi-level perspective." *Journal of Cleaner Production 126* (2016): 572-585. https://doi.org/10.1016/j.jclepro.2016.02.095. Open source: https://minerva-access.unimelb.edu.au/bitstream/handle/11343/91562/Wainstein_Bumpus_2016%20Pre-Acceptance%20Version.pdf.

84 Bas Van Bree, Geert PJ Verbong, and Gert Jan Kramer, "A multi-level perspective on the introduction of hydrogen and battery-electric vehicles," *Technological forecasting and social change* 77, no. 4 (2010): 529-540. https://doi.org/10.1016/j.techfore.2009.12.005. Open source: https://www.academia.edu/36906565/A_multi_level_perspective_on_the_introduction_of_hydrogen_and_battery_electric_vehicles

85 Warda Ajaz, and David Bernell, "Microgrids and the transition toward decentralized energy systems in the United States: A Multi-Level Perspective." *Energy Policy* 149 (2021), 112094, https://doi.org/10.1016/j.enpol.2020.112094.

86 Raphael Moser, Chun Xia-Bauer, Johannes Thema, and Florin Vondung, "Solar Prosumers in the German Energy Transition: A Multi-Level Perspective Analysis of the German 'Mieterstrom'Mode," *Energies* 14, no. 4 (2021): 1188. https://doi.org/10.3390/en14041188

87 Harald Rohracher, "Analyzing the Socio-Technical Transformation of Energy Systems: The Concept of 'Sustainability Transitions,'" Chapter 18 in *Oxford Handbook of Energy and Society*, (2018), Debra J. Davidson, and Matthias Gross, eds., https://doi.org/10.1093/oxfordhb/9780190633851.013.3.

88 Adewale A. Adesanya, Roman V. Sidortsov, Chelsea Schelly, "Act locally, transition globally: Grassroots resilience, local politics, and five municipalities in the United States with 100% renewable electricity," *Energy Research & Social Science 67*, (2020), 101579, ISSN 2214-6296, https://doi.org/10.1016/j.erss.2020.101579.

89 Soutar, "Dancing with complexity: Making sense of decarbonisation, decentralisation, digitalisation and democratisation," *Energy Research & Social Science 80*, (2021: 1) ISSN 2214-6296, https://doi.org/10.1016/j.erss.2021.102230.,

90 Lee, Glick, and Lee, "Island energy transition."

91 Woolf and Havumaki, *The Role of Innovation in the Electric Utility Sector*, Chapter 1, 2.

Soutar explains, MLP helps clarify how changes at the landscape level, like recently adopted renewable energy and climate action policies, have the function of "perturbations . . . which can only be solved through the modification of regime dimensions – technologies, markets, user practices, policies, and so on."[92] Soutar notes,

> [P]olicymakers and regulators are . . . charged with managing the speed and direction of energy system change and associated social, economic and environmental outcomes. Herein lies a central challenge for policy and regulatory actors – how to establish coherent policy mixes or electricity markets that provide stability and certainty, but which also provides [sic] an enabling environment for accelerated change and the inevitable instability acceleration brings.[93]

Changes in the landscape and regime levels are already observable, as climate action and decarbonization goals are taking hold. At the landscape level, hundreds of governmental entities, corporations, and non-government organizations are taking actions to reduce greenhouse gas emissions.[94] For example, states that together account for about a third of the US population and a quarter of total US electricity sales have already adopted public commitments for achieving 100% clean energy sources by not later than 2050. Many large corporations, hundreds of cities and counties, universities, and others have similar, publicly announced commitments. Notably, the growing list of corporations with major climate commitments already includes several of the largest US electric and natural gas utility companies.[95] Regardless of federal requirements for climate change mitigation or adaptation, so many other entities already have made climate action commitments that there are growing pressures for utilities to cooperate and participate in achieving climate goals.

E. Innovations Could Disrupt Existing Frameworks and Regimes

A serious challenge for regulatory innovations platforms in the US is that new technologies and new business models could prove disruptive to the existing regulatory regime, and there is presently no consensus about the best direction for progress in the regulated energy industries. Walgrave et al. report, "[M]ost path-breaking innovation ecosystems need an entity that orchestrates the process of integrating the ecosystem . . . [and the] orchestrating position is often assumed by a central innovator in the ecosystem – the so-called focal actor."[96] However, in the realm of energy transitions the pace of energy innovation could be slower than needed to meet pressing needs, because there is not yet any consensus about how to apportion the major responsibilities for such orchestrating among regulated utility companies, competitive service providers, or other as-yet undetermined innovators.

Fox-Penner explains, many observers, including leaders in the regulated utilities themselves, foresee major changes in utility business models in the not-too-distant future, but there is no agreement at either the landscape or regime level about any particular business model approach. Fox-Penner visualizes what he describes as a "rainbow" of choices, on a continuum from what he calls the "smart integrator" to the "energy service utility."[97] Smart integrators would provide the service platform through which "a thriving ecosystem of unregulated

---

92 Soutar, "Dancing with complexity," 3

93 Ibid, p. 11

94 National Regulatory Research Institute, Clean Energy Policy Tracker, web page, accessed June 2022, https://www.naruc.org/nrri/nrri-activities/clean-energy-tracker/. See also: Lori Bird and Tyler Clevenger, World Resources Institute, *2019 Was a Watershed Year for Clean Energy Commitments from US States and Utilities*; and UCLA Luskin Center for Innovation, *Progress toward 100% Clean Energy in Cities & States across the US* (2019) https://www.wri.org/blog/2019/12/2019-was-watershed-year-clean-energy-commitments-us-states-and-utilities.

95 Sophia Ptacek-Alum, and Sheryl Carter. 2019. *More Utilities Make Big Commitments to Climate Action,* Natural Resources Defense Council, (2019), electronic article, accessed March 5, 2019, https://www.nrdc.org/experts/sophia-ptacek/more-utilities-make-big-commitments-climate-action.

96 Bob Walrave, et al., "A multi-level perspective on innovation ecosystems for path-breaking innovation," *Technological Forecasting and Social Change 136*, (2018): 8, https://doi.org/10.1016/j.techfore.2017.04.011.

97 Fox-Penner, *Power After Carbon,* Chapter 9, and Peter Fox-Penner, *Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities*, (Washington, D.C.: Island Press, 2014) https://islandpress.org/books/smart-power-anniversary-edition.

energy service firms" would offer consumers multiple different products and services. In this model, regulated utilities make money by providing access to open systems platforms through which competitive suppliers provide services. At the other extreme, Fox-Penner explains, the distribution utility company expands its role as a provider of services to its customers, with the utility company curating and deciding what services to offer and to whom.[98] However, Fox-Penner observes, "'[W]e don't know yet whether any of the business models . . . will systematically yield the best combination of low cost and great service or whether the outcome will vary across utilities, states, and countries."[99]

Similarly, Cross-Call, Gold, et al. envision a broad spectrum of services and functions for the utility of the future, from (a) "expanded monopoly services with utility ownership or financing of all new assets and services" to (b) "transformed platform operator, where the utility serves as a neutral asset integrator and host for market activity."[100] And, between these models, "numerous hybrid options exist."[101] Cross-Call, Gold, et al. provide many examples of innovative practices in utilities around the country, ranging from one end of the spectrum to the other.[102] They caution, however, that:

- third parties should be given opportunities to participate and deliver their services for those distribution functions where natural monopoly conditions no longer hold;
- [t]he competitive marketplace has inherent advantages for innovation and generating new sources of value that should be allowed space to grow;
- codes of conduct between regulated utilities and their affiliates are needed to ensure that utilities and their sister companies do not enjoy unfair advantage over competitors;
- [an] expanded utility with a broadly granted monopoly risks crowding out innovation and leading to major inefficiencies;
- a utility-centric approach to roles may cement monopoly functions, creating a self-limiting, inefficient approach;
- limiting utilities strictly to playing the role of a platform host for competitive services could result in failures well known to the competitive market, including inequities and reduced service quality to vulnerable populations; and
- there are specialized functions or service innovations that utilities need to incorporate to better serve their public interest obligations.[103]

Lovell observes,

> [E]nergy innovation [is] a messy process – a complex mix of technological advances, politics, and social learning and adaptation . . . involv[ing] . . . policy networks of smart grid innovation comprising entrepreneurs, companies, governments, smart grid projects, and technologies.[104]

Innovators can hope that today's policy drivers and the many existing examples from multiple jurisdictions might motivate policy makers and public utility regulators to explore possible novel approaches to decision making about innovations, and to ask interested parties to help with this process. Such efforts are occurring

98 Fox-Penner, *Power After Carbon*, Chapter 9.

99 Fox-Penner, *Power After Carbon*, 189.

100 Cross-Call, Gold, et al., *Reimagining the Utility*, 13.

101 Ibid., p. 13.

102 Ibid., p. 14-17.

103 Ibid., p. 15-20.

104 Heather Lovell, *Understanding Energy Innovation: Learning from Smart Grid Experiments*, pp. 91, 97, (Singapore: Palgrave Macmillan, 2022) https://doi.org/10.1007/978-981-16-6253-9.

in part because of perceptions that the traditional adversarial administrative law procedures are too slow and cumbersome to accommodate the rapid rates of potential change in regulated industries. There is also a concern on the part of some parties that the traditional procedures might confine decision making to the context of the previous century's regulatory regime, based on now-outmoded ideas about what might or might not constitute a natural monopoly for energy services.[105]

III. What Are Regulatory Innovations Platforms?

Regulatory innovations platforms in different jurisdictions vary in design and function. There is no single approach.[106] However, several salient characteristics generally apply to their goals, objectives, and operations. The most important feature that distinguishes regulatory innovations platforms from other technology innovations activities is the opportunity for at least some flexibility in regulations themselves. Existing rules and regulations might need some limited exemption or waiver, for the purposes of a trial. For example, the United Nations Secretary General's Special Advocate for Inclusive Finance for Development (UNSGSA) describes such platforms as:

- a regulatory approach, typically summarized in writing and published, that allows live, time-bound testing of innovations under a regulator's oversight . . . [where] novel . . . products, technologies, and business models can be tested under a set of rules, supervision requirements, and appropriate safeguards;
- creat[ing] a conducive and contained space where incumbents and challengers experiment with innovations at the edge or even outside of the existing regulatory framework; and
- bring[ing] down the cost of innovation, reduc[ing] barriers to entry, and allow[ing] regulators to collect important insights before deciding if further regulatory action is necessary.[107]

UNSGSA adds, "A successful test may result in several outcomes, including full-fledged or tailored authorization of the innovation, changes in regulation, or a cease-and-desist order."[108]

According to Jenik and Lauer, regulatory innovations platforms are set up by regulators,

> to allow small scale, live testing of innovations by private firms in a controlled environment (operating under a special exemption, allowance, or other limited, time-bound exception) under the regulator's supervision.[109]

Chen says these approaches enable "structured experimentalism."[110] He explains:

> Regulated and unregulated entities have opportunities to test, pursuant to a testing plan agreed and monitored by the regulator, innovative products or services, business models, or delivery mechanisms. . . . Regulators may require applicants to incorporate appropriate safeguards to insulate the market from the risks associated with their innovative business.[111]

---

105 Cross-Call, Gold, et al., *Reimagining the Utility*, 9.

106 Zetzsche et al., "Regulating a Revolution," 100.

107 United Nations secretary-general's Special Advocate for Inclusive Finance for Development, *Briefing on Regulatory Sandboxes by the UNSGSA's FinTech Subgroup on Regulatory Sandboxes*, June 2018, electronic document, accessed June 2022, https://www.unsgsa.org/files/1915/3141/8033/Sandbox.pdf.

108 Ibid.

109 Ivo Jenik, and Kate Lauer, *Regulatory Sandboxes and Financial Inclusion*, working paper for Consultative Group to Assist the Poor (CGAP), a World Bank Agency, (2017) www.cgap.org.

110 Christopher C. Chen, "Regulatory Sandboxes in the UK and Singapore: A Preliminary Survey" in *Regulating FinTech in Asia: Global Context, Local Perspectives*, Mark Fenwick, Steven Van Uytsel and Bi Ying, eds., (September 6, 2019): 4, forthcoming, August 2020, available at SSRN: https://ssrn.com/abstract=3448901 or http://dx.doi.org/10.2139/ssrn.3448901.

111 Ibid.

Jurisdictions use a variety of names to describe their approaches to encouraging experimentation and innovation. Platforms are variously called innovation accelerators, facilitators, greenhouses, hubs, pilots, and test beds.[112] European energy regulators have started calling these approaches "dynamic regulation."[113] However, it is important to note taht some of these approaches focus more exclusively on technological innovation, as opposed to possible regulated company and competitive supplier business models. And, in testing potential innovations, some do not include any specific opportunities for regulatory flexibility.[114]

Sidebar: What Might Constitute a "Regulatory Greenhouse"?

Sweden's Committee for Technological Innovation and Ethics (KOMET) names its proposed framework "regulatory greenhouse." The committee recognizes "greenhouse" as a metaphor, implying transparency and visibility for what is happening inside, and a having the "purpose to promote cultivation and growth in an orderly manner." KOMET explains that regulatory greenhouse testing includes: (a) developing or adapting regulatory frameworks while new products, technologies, services, processes, working methods, or business models are tested in temporally and spatially limited but real environments; (b) increasing knowledge of how existing regulatory frameworks relate to a situation that has changed as a result of technological development; (c) granting exemptions from – or specifically adapting – certain regulatory frameworks; and (d) raising the knowledge level of regulators by providing the opportunity to test a new solution together with those who will later use it.

Source: Swedish Committee for Technological Innovation and Ethics (KOMET), *Testing – A working method for quicker learning*, Komet information 2020:33E, published 2021-02-10, https://www.kometinfo.se/wp-content/uploads/2021/02/Testing_a_working_method_for_quicker_learning_2020_33_E-1.pdf.

As Jenik and Lauer point out, "innovation facilitators," housed within the regulatory agency or another agency, can support and complement other regulatory innovations activities. The innovations facilitating functions can be "part of a broader ecosystem for innovation" with a "potential to inform . . . policy development."[115] Jenik and Lauer caution that regulatory innovations platforms should not be considered an "exclusive entry point" for all innovations.[116]

Carlson and Nciri identify four major functions of regulatory innovations platforms. In this taxonomy:

1. **Innovation hubs** enable open communications and collaborations among diverse stakeholders. Participants can include any combinations of new technology or service inventors or developers, including manufacturers, utilities, consumer advocates, and public interest groups. The related goals include knowledge and information exchange with deliberate transparency and targeted assistance for and the cooperative design and conduct of trials under existing rules and regulations.

2. **Inquiry service** represents expedited consideration and customized guidance from regulators or regulatory staff about whether and how a planned technology or business model might be tested within the context of existing rules and regulations. Innovators can receive help navigating the current system and sometimes guidance about how perceived barriers might be overcome. In some instances regulators might provide written assurances that a particular project does not raise compliance concerns.

3. **Regulatory trials** involve time-limited exceptions to or exemptions from existing rules while trials are under way. Such relief takes place under flexible yet rigorous regulatory oversight, enabling innovative

112 See Part IV and the Appendix of this report.

113 Shafran et al., *Dynamic NRAs to Boost Innovation*

114 Jenik and Lauer, *Regulatory Sandboxes and Financial Inclusion*, 1.

115 Ibid., p. 1.

116 Ibid., p. 10.

solutions an opportunity to demonstrate their efficacy and potential advantages under conditions that limit the risks associated with the trial. These trials include formal and publicly available assessments and evaluations. Then, depending on the outcome, regulatory trials can lead to new rules or changes in existing rules.

4. **Regulatory and policy learning** means that the results and outcomes from any or all of the previous three functions will be used by regulators and policy makers and will inform discussions of innovations in regulated industry transitions.[117]

Four major features that are usually present in regulatory innovations platforms include:

1. Public announcement of the activity, inviting innovators to apply to participate.
2. Multiple interested parties working together under supervision by the regulatory agency to consider innovations, investigate how the innovations might interact with preexisting regulatory provisions, and consider whether and how the innovations might be subjected to rapid testing.
3. Innovations that pass muster are then subjected to experimental design. Planned experiments are bounded, well-structured tests that are limited in duration, expense, and numbers of participating customers, and are rigorously monitored and evaluated.
4. Prior to the experiments being implemented, participating parties anticipate at least preliminary pathways, depending on the experimental results, for both next steps toward broader implementation in the event of successful trials and for exit strategies in the event of less-than-satisfactory outcomes.

These innovations activities typically invite participation by multiple parties, including regulated industry incumbents, regulators and regulatory staff, technology and business innovators, consumer advocates, and others. The parties work together, under the watchful eye of the established regulatory authorities and sometimes alongside other government agencies, to design and implement methods for rapidly testing new technologies and novel business approaches. These practices afford opportunities to test and evaluate innovations at a small scale and under conditions designed to reduce risks. The application details differ by jurisdiction. Major differences center on:

- What entities are eligible to apply and participate?
- What is the timing and schedule for participation?
- What are the sources of ideas for innovation? Does the regulatory authority or the regulated industry identify topics and issue solicitations inviting participation? And, if topical solicitations are issued, is there a known schedule for issuing solicitations, that innovators can anticipate and thereby prepare for participating?
- What is the legal framework for the activities, and is the regulator's participation more active or passive? What authority does the regulatory authority have to allow flexibility in, loosen, or waive existing rules during experimental trials? And are additional forms of regulatory relief available in addition to or instead of experimental trials (such as waivers of specific rules, or no-action letters)?[118]

---

117 Carlson and Nciri, *Enter the Sandbox*, 1214, Carlson and Nciri review regulatory innovations platforms in 10 countries, noting which of the four functions are included.

118 Allen, "Regulatory Sandboxes," 596-97. For example, in the UK, the Financial Conduct Authority (FCA) has authority to grant waivers or issue letters indicating the FCA will not enforce actions against firms that participate in its innovations support activities. If a participating firm is "granted a restricted authorization" for an innovation trial, the FCA can issue a "no enforcement action" letter, confirming that the FCA will not take disciplinary action, even if unexpected issues arise during testing, as long as the firm: (a) maintains open communications with the FCA; (b) keeps to the agreed testing parameters; and (c) treats customers fairly.

See also: Daniel Walters, Cary Coglianese, and Gabriel Scheffler, "Unrules," 73 *Stanford Law Review*, (2021): 885, https://elibrary.law.psu.edu/fac_works/427/.

- What information is publicly shared and how transparent is the innovation platform deliberative process itself? Does the innovation platform decision-making process allow observation and review by all interested parties? Are innovators able to participate in at least some aspects of the platform without having to divulge their intellectual property?

Such activities are typically intended to achieve several broad goals and objectives, all designed to help increase the speed of and best manage potentially disruptive innovations. Practices frequently include:

- inviting multiple diverse parties to join in discussions about and planning for possible pathways to enable innovations, thus improving "cross-talk," and allowing for open communications;
- enabling rapid testing of innovations on a relatively small scale, intended to achieve small risks, quick learning, and small failures (if and when failures do occur);
- replicating examples of historical innovations successes that were aided by organizational structures and cultures, architectural design, and even happy accident;[119] and
- preventing repetitions of historical innovations failures, where innovations "have been underwhelming" and the existing regulatory system "has stumbled."[120]

Figure 1 lists several of the important functions that policy makers consider when designing a regulatory innovations platform.[121] Typically, implementing each function requires defining and delineating the roles of the participating parties, including regulators.

Table 3 lists examples of the kinds of concerns different interest groups might hold with respect to implementing a regulatory innovations platform. This is a tentative, provisional list, subject to validation by information gathering as any jurisdiction undertakes discussions about planning and implementing its own public utility regulatory innovations platform. As a preliminary matter, it demonstrates that the many participants in the process may have differing goals, objectives, and priorities for innovations in utility services. Two other goals, in addition to those listed in Table 3, are of nearly universal appeal to all interested parties. They are: (1) decreasing the time needed to obtain required regulatory determinations so that potentially successful innovations can be tested and verified rapidly, and successful ones adopted quickly, and (2) enabling sufficient regulatory flexibility to allow for testing of new technologies and business models that sometimes chafe against the long-standing industry structure that includes monopoly service providers and barriers to entry for new market participants.

---

119 Eliza Brownfield, "The Elements of an Innovation Ecosystem," in *Proceedings of the National Conference on Undergraduate Research*, (Edmund, Oklahoma, 2018): 604-06, https://www.ncurproceedings.org/ojs/index.php/NCUR2018/article/view/2591/1378.

120 Included quotations are from Allen, "Regulatory Sandboxes," 613-15. See also: Brownfield, "The Innovations of an Innovation Ecosystem," and Thomas Philippon, "The FinTech Opportunity 2 (National Bureau of Economic Research, Working Paper No. 22476, 2018): 14-16, http://pages.stern.nyu.edu/~tphilipp/papers/FinTech.pdf, https://perma.cc/6G3Y-GCBA. Philippon explains that there are broad, deep, and complex "distortions" embedded in existing regulatory structures, which "protect powerful incumbents." He notes, "[T]here are many regions … where incumbents are entrenched and [market] entry is difficult."

121 Among regulatory innovations platforms is a type that is popularly called "regulatory sandbox." Several jurisdictions use this term to refer to any type of legal innovation and regulatory reform efforts. See American Bar Association, Center for Innovation, *Legal Innovation Regulatory Survey*, web page, accessed June 2022, http://legalinnovationregulatorysurvey.info/author/sglassmeyer/.

Philipsen, Stamhuis, and de Jong explain that the concept originated in the field of computer software and game developers, referring to a kind of "demarcated digital playpen where an intermediate version of [a] new game is released." Stefan Philipsen, Evert F. Stamhuis, and Martin de Jong, "Legal Enclaves as a Test Environment for Innovative Products: Toward Legally Resilient Experimentation Policies," *Regulation and Governance*, (March 2021): 5, doi 10.1111/rego.12375.

This report uses the name "sandbox" only minimally, for jurisdictions using that name to describe their innovations activities. Readers are cautioned to consider the potential for the term "sandbox" to be confusing and misleading, because: (a) the term is used inconsistently, describing different activities in different jurisdictions; (b) many other names to refer to similar activities; and (c) the term could be misunderstood, implying a childish, playful, and less-than-serious approach to what is ultimately a vitally important regulatory activity.

Figure 1: Basic Specifications For Instituting Regulatory Innovations Platforms

- Set and share publicly the objectives for the innovations platform.
- Clarify eligibility requirements for participating.
- Establish criteria for applications, including information about risks, provisions for safeguards, and other considerations.
- Clarify the timing for applications, application reviews, and time limits for initial trials.
- Establish mechanisms to monitor and evaluate costs and benefits, both to the regulator and to other trial participants.
- Delineate the types of actions that can be taken by the various trial participants including innovators, regulated entities, and the relevant regulatory authorities, before, during, and after trials, depending on their results.
- Provide for maximum practical transparency in innovations support systems activities and outcomes.

Sources: Author's adaptation, based on: Hilary J. Allen, "Regulatory Sandboxes," *George Washington Law Review* 87, (June 25, 2019); Ivo Jenik and Kate Lauer, 2017, "Regulatory Sandboxes and Financial Inclusion" working paper; and, Chang-hsien Tsai, et al., "The Diffusion of the Sandbox Approach to Disruptive Innovation and Its Limitations," *Cornell International Law Journal* 53 no. 2 (2021).

Table 3: Provisional List of Major Participating Interest Groups and Their Preliminary Goals, Objectives, and Priorities for Public Utility Regulatory Innovations Platforms

Interest group	Preliminary list of major goals and objectives
Regulatory authorities	• Traditionally: safe, reliable, accessible regulated services at reasonable rates • Recent additions in many jurisdictions: utility policies and services that are equitable, using resources that are environmentally benign or restorative, resilient, and that support economic development*
Innovators	• Opportunity to showcase and potentially help to legitimize new products and services • Access to public utility network services, and often to data that is possibly accessible only from regulated utilities • Sufficient short-term access to markets, for the purpose of experimental trials to demonstrate proofs of concepts • Long-term access to markets for potentially profitable innovations that prove capable of producing important benefits for utility systems and consumers
Utilities	• Improving operations and reducing operations and maintenance (O&M) costs • Improving customer service • Managing future competitive and potentially disruptive threats • Gaining experience with and insights about possible future business models and investment opportunities

Interest group	Preliminary list of major goals and objectives
Consumer advocates	• Consumer privacy protections and preventing unwarranted access to consumer data by utilities and third parties • Consumer protections and limiting consumer risk, including oversight of and input into decisions about utility cost allocation and rate design • Well-designed performance metrics and assessment tools • Visibility and transparency of innovations processes
Participating customers	• Better managing bills and payments and reducing bills where practical • Being innovators or early adopters • Meeting public commitments for obtaining and using clean, renewable, or low- or no-emissions energy sources

*Source: Author's construct, based on inputs from: Robert J. Klee, and Sarah Baldinger, *Review of State Public Utility Commission Statutory Mandates*, report by Yale Center for Business and the Environment for Institute for Market Transformation, (2021), https://drive.google.com/file/d/1bvQTifqgxGS5i7_CU1uj0HLPBQW5kjYV/view.

In addition to the state-sponsored activities listed in **Table 4**, innovations institutions of various stripes are affiliated with many other entities, including economic development authorities, research universities, and utility industry trade associations.[122] The Electric Power Research Institute (EPRI) brands its platform Incubatenergy Labs and touts an Incubateenergy Network of facilities throughout the US[123] Similarly, the Gas Technology Institute (GTI) is devoted to the research and development and commercialization of new natural gas-fueled technologies.[124] And the water industry has its own collaborative research foundation and a National Alliance for Water Innovation research consortium that is supported by US DOE, national laboratories, industry, and university partners.[125] And, American Energy Innovation Council supports innovations on behalf of several major utility companies, whose current or former officers serve as principals.[126] Several individual utility companies tout their own innovations activities, and in recent years more and more utilities are including innovations officers in their corporate management teams.[127]

The Smart Electric Power Alliance is also leading a broad coalition of industry, governmental, and environmental groups in addressing what it calls the Renovate Initiative.[128] The Renovate Initiative states its mission is:

122 A National Renewable Energy Laboratory report compares and contrasts clean technology incubators supported by both public and private interests. See: David J. Garfield, Kate E. Moore, and Richard Adams, *New Approaches to Energy Hardware Innovation and Incubation*, report for National Renewable Energy Laboratory by Alliance for Sustainable Energy, LLC, (April 2019), Joint Institute for Strategic Energy Analysis, NREL/MP-6A70-73438, https://www.nrel.gov/docs/fy19osti/73438.pdf. See also: National Renewable Energy Laboratory, News & Feature Stories, *New Study Compares, Contrasts Cleantech Incubators and Accelerators*, (May 9, 2019), https://www.nrel.gov/news/program/2019/new-study-compares-and-contrasts-cleantech-incubators-and-accelerators.html

123 Incubatenergy Labs, *Welcome to Incubatenergy Labs*, web page, accessed June 2022, https://labs.incubatenergy.org/en/. US Department of Energy, Office of Energy Efficiency & Renewable Energy, *National Incubator Initiative for Clean Energy (NIICE)*, web page, accessed June 2022, https://www.energy.gov/eere/technology-to-market/national-incubator-initiative-clean-energy-niice-0.

124 Gas Technology Institute, *Innovative Technology Solutions*, web page, accessed June 2022, https://www.gti.energy/.

125 See: National Alliance for Water Innovation, *About Us*, web page, accessed June 2022, https://www.nawihub.org/about; and Water Research Foundation, *About Us*, web page, accessed June 2022, https://www.waterrf.org/about-foundation.

126 American Energy Innovation Council, *Who we are*, web page, accessed June 2022, https://americanenergyinnovation.org/who-we-are/. Represented utility companies include Dominion Energy, Pacific Gas & Electric, Sempra, Southern Company, and Xcel Energy.

127 A preliminary list Includes: Dominion in multiple states, https://quarterly.insigniam.com/innovation/dominion-energys-innovation-push/; Exelon in multiple states, https://www.cio.com/article/3289628/even-utilities-look-to-innovate-and-transform-processes.html, Exelon subsidiary PEPCo in the Delmarva Peninsula, https://www.pepco.com/AboutUs/Pages/LeadershipValues.aspx; Green Mountain Power in Vermont, https://greenmountainpower.com/about/josh-castonguay-bio/; and Southern Company in Georgia, https://www.southerncompany.com/innovation.html.

128 Smart Electric Power Alliance, *Renovate Initiative*, Op cit., note 44.

to spur the evolution of state regulatory processes and practices to enable innovation, with a focus on scalable deployment of new technologies and operating models, to meet customer needs and increasing expectations while continuing to provide all with clean, affordable, safe, and reliable electric service.[129]

The US Department of Energy (DOE) is also home to multiple innovations support activities.[130] Primary DOE innovations support efforts include the Advanced Research Projects Agency-Energy (ARPA-E) program and extensive research activities at the National Laboratories. ARPA-E specializes in support for "game-changing energy technologies that are typically too early for private-sector investment."[131] The 17 DOE National Laboratories are generally engaged in "large scale, complex research and development challenges with a multidisciplinary approach . . . translating basic science to innovation."[132] Of particular importance to energy regulatory authorities are the innovations initiatives under the auspices of the DOE Grid-Modernization Laboratory Consortium, and at Lawrence Berkeley Laboratory (LBL), the National Renewable Energy Laboratory (NREL), and Pacific Northwest National Laboratory.[133]

In 2019 a University Energy Institute Collaborative was formed, to advance energy and climate education, training, and research. Over 150 energy institutes at higher-education facilities in the US are participating.[134]

In addition, there are worldwide energy innovation efforts, including Mission Innovation, an association of 22 countries so far, which is an outgrowth of the Paris Climate Agreement in 2015. Mission Innovation is "a global initiative to catalyze action and investment in research, development and demonstration to make clean energy affordable, attractive and accessible to all this decade."[135] And the World Bank Group's Innovate4Climate, since 2017, is an annual global conference on climate finance, that "brings together thought leaders interested in linking climate innovation with investment opportunities – transforming dialogue into action."[136]

An international Regulatory Energy Transition Accelerator also was established during the COP26 meeting in Glasgow, Scotland, in 2021, with leadership from the UK Office of Gas and Electricity Markets (OFGEM), International Energy Agency (IEA), International Renewable Energy Agency (IRENA), and World Bank. Early endorsing agencies include regulators from Australia, the Cayman Islands, Egypt, France, Georgia, Great Britain, Indonesia, Israel, Italy, Kenya, Morocco, New Zealand, Norway, Peru, Saint Lucia, Singapore, the US Federal Energy Regulatory Commission, the US State Regulatory agencies from California and Hawaii, and Vanuatu.[137]

---

129 Ibid.

130 US Department of Energy, *Science & Innovation*, web page, accessed June 2022, https://www.energy.gov/science-innovation.

131 US Department of Energy, *Advanced Research Projects Agency-Energy (ARPA-E)*, web page, accessed June 2022, https://www.energy.gov/science-innovation/innovation/arpa-e.

132 US Department of Energy, *National Laboratories*, web page, accessed June 2022, https://www.energy.gov/national-laboratories.

133 See US Department of Energy, *Grid Modernization Initiative*, web page, https://www.energy.gov/grid-modernization-initiative; US Department of Energy, Office of Energy Efficiency & Renewable Energy, *Lab-Embedded Entrepreneurship Program – Advanced Manufacturing* [Web page], https://www.energy.gov/eere/amo/lab-embedded-entrepreneurship-program; LBL Electricity Markets & Policy, *Future Electric Utility Regulation Series (FUER)* [Web page], https://emp.lbl.gov/projects/feur, and LBL *Innovations and Partnership Office*, web page, https://ipira.berkeley.edu/lbnl-innovations-and-partnership-office; NREL *Innovation & Entrepreneurship Center*, web page, https://www.nrel.gov/innovate/index.html; and Pacific Northwest National Laboratory, *Licensing & Technology Transfer* [Web page], https://www.pnnl.gov/licensing-technology-transfer. All web pages accessed July 2022.

134 University Energy Institute Collaborative, *What is the current energy institute landscape and opportunities for collaboration?*, web page, accessed June 2022, https://www.ueic.org/research.

135 Mission Innovation, *Overview*, web page, accessed June 2022, http://mission-innovation.net/about-mi/overview/.

136 Innovate4Climate, *About Innovate4Climate* (I4C), web page, accessed June 2022, https://www.innovate4climate.com/about.

137 Regulatory Energy Transition Accelerator, *About the Accelerator*, web page, accessed June 2022, https://www.retatheaccelerator.org/. See also OFGEM, *The Regulatory Energy Transition Accelerator: Joint Statement of Energy Regulators and Partners*, (November 2021), https://uploads.strikinglycdn.com/files/c8aca74e195d-4123-9274-14cd025f7949/Joint%20statement%20Regulatory%20Energy%20Transition%20Accelerator.pdf/.

IV. State Energy Regulatory Innovations Platforms

The following list is not exhaustive. It presents summaries of innovations platforms that are operating in several US jurisdictions that are actively engaged in the pursuit of technological and business model innovations for regulated utility industries. These were identified through literature and internet searches, and by reports from state public utility regulatory commissioners and commission staff.

Nearly every state and major jurisdiction has implemented some innovations support functions. This report focuses on identifying and describing regulatory innovations platforms that include three major features:

1. Public announcement of the innovations support activities, including a broad invitation for participation by anyone seriously interested in potentially viable innovations
2. At least some focus on regulatory innovation, which sometimes also includes innovation in business models for both regulated utility companies and competitive providers of innovative technologies
3. A prominent role for the utility regulatory authority in the design and implementation of trial projects intended to validate innovations

Examples of existing state innovations activities are briefly summarized in **Table 4** and are described in more detail after the table.

Table 4: Descriptions of Selected Jurisdictions' Energy Regulatory Innovations Platforms

Jurisdiction	Major features of innovations platform
California	• California Energy Commission launched the California Energy Innovation Ecosystem in 2016. Funding comes from a system benefits fund called the Electric Program Investment Charge (EPIC) program. • CalTestBed – "Funded by the California Energy Commission, provides . . . vouchers to clean energy innovators," which can be used at any of roughly 30 pre-authorized test bed facilities, that are set up at California state university campus facilities. • California is home to multiple regional energy innovation cluster (REIC) partners.
Connecticut	• Connecticut is home to a series of public utility regulatory authority (PURA) "Equitable Modern Grid" investigations, including Docket No. 17-12-03RE05, PURA Investigation into Distribution System Planning of the Electric Distribution Companies – Innovative Technology Applications and Programs (Innovation Pilots). Strategen Consulting is providing support to PURA staff for designing the state's innovation program. Strategen states it will "help design and implement a regulatory framework and process . . . for innovation." The Connecticut Innovative Energy Solutions Program is set to launch in January 2023. • The commission is also using "100-day Sprint Dockets" to address particularly pressing issues. • Connecticut Department of Energy and Environmental Protection (DEEP), Integrated Resources Planning, "focuses in the near term on areas of reform essential to facilitating the transition to a zero carbon electric sector; to ready the grid with modernized transmission systems, to reform the regional wholesale market, and to implement and synchronize policies and programs that promote affordability and equity." • Connecticut Energy Efficiency & Renewable Energy Technology Test Bed Program provides for "feasible" technologies to be tested and validated in state facilities.

Jurisdiction	Major features of innovations platform
District of Columbia	• DCPSC is establishing a Pilot Projects Governing Board as part of its Modernizing the Energy Delivery System for Increased Sustainability (MEDSIS) proceeding. MEDSIS Working Group 6 proposed a pilot projects governance model, including a list of stakeholders to participate and project selection criteria, screening methods, monitoring, and evaluations protocols. These ongoing activities are part of what is now being called "Power Path DC."
Hawaii	• The Hawaii Energy Policy Forum (HEPF) was established in 2002. A 2003 report included an extensive set of recommendations for both legislative and regulatory options and actions. • The Hawaii Clean Energy Initiative (HCEI) includes support services for project developers and investors, and multiple testbed facilities serving as proving grounds for technological innovation. HCEI aims to foster and demonstrate innovation, including in "public policy," and to "[e]stablish an 'open source' learning model." • Hawaii PUC's Commission's Inclinations on the Future of Hawaii's Electric Utilities was published in 2014. That document cited the need for innovations in utility business models, financial incentives, planning, rate structures, utility programs, and infrastructure, and for optimizing the state's electricity systems for distributed energy resources. • A December 2020 Hawaii PUC Order authorizes a process for "expedited implementation" for testing "new technologies, programs, business models, and other arrangements." The order establishes an open collaborative stakeholder process for determining subject areas or concepts for innovation and pre-approves, with ongoing commission oversight, utility expenditures of up to $10 million per year on the selected projects.
Massachusetts	• Massachusetts Clean Energy Center (MassCEC) is engaged in multiple program activities supporting innovations in the fields of clean energy and water. The InnovateMASS program can provide grant awards in the four areas of: (1) high-performance buildings; (2) clean transportation; (3) offshore wind; and (4) net-zero grid. • Massachusetts is also home to multiple clean energy incubator organizations that provide resources to support clean energy start-ups.
Minnesota	• Minnesota's major energy innovations efforts started with the "E21" initiative, short for "an electric system for the 21st century." E21 was convened by Minnesota nonprofit groups, inviting participation by "stakeholders who are actively involved in advancing Minnesota's electric system, including utilities, regulators and other state government agencies, consumer advocates, environmental advocates, local governments, academic organizations, energy technology companies, and other businesses." • E21 is presently working to "shape and accelerate progress on a wide variety of specific proceedings, filings, and topics relevant to modernizing Minnesota's electric system." Many of the current e21 activities focus on Minnesota Public Utility Commission proceedings, including a proceeding working to implement performance-based regulation; multiple proceedings to consider new utility rates, products, and services; and updates to utility system planning procedures. • Minnesota is also home to a ratepayer-funded Conservation Applied Research and Development (CARD) program.

Jurisdiction	Major features of innovations platform
New Jersey	• An explicit goal of the 2019 New Jersey Energy Master Plan is to "expand the clean energy innovation economy" (pp. 215-229). Aspects include: growing supply chain clusters for clean energy subsectors; establishing clean energy workforce training; providing innovative financing, including a statewide green bank; capitalizing on off-shore wind; and establishing a clean technologies innovations center and a clean buildings hub. • 2018 legislation directs the New Jersey Commission on Science, Innovation, and Technology to appoint from its membership an "Innovation Council . . . charged with determining how to stimulate technology transfer between public and private research institutions of higher education and industry, including the transfer of information available from federal agencies." • New Jersey also created and maintains a "Research with NJ" web portal, dedicated to showcasing and encouraging collaborations with New Jersey science, technology, engineering, and mathematics (STEM) university researchers.
New York	• CleanTech Accelerators were announced in April 2020. • The New York State Energy Research and Development Authority (NYSERDA) "innovation ecosystem" includes 66 program areas. • "REVConnect [b]rings companies and New York's electric utilities together to accelerate innovation, adopt new business models and technologies, and advance New York State's Reforming the Energy Vision (REV) goals."
Oregon	• Oregon has been home to a state Innovation Council since 2005. • Oregon Energy Office includes a Planning & Innovation Division. • Oregon is home to GridForward, a regional grid modernization collaborative. • Oregon PUC supports a Smart Grid Test Bed for Portland General Electric.
Vermont	• A multi-year regulation plan for Green Mountain Power Corp., adopted by the Vermont PSC in 2019, includes "new initiatives and innovative pilots" along with "innovation and performance metrics."
Washington	• Washington's Clean Energy Transformation Act (CETA) calls for electricity supply that is "carbon-neutral by 2030, and . . . carbon-free by 2045." The Washington Utilities and Transportation Commission has key roles in implementing CETA and has adopted new rules to do so. • Washington has a comprehensive 2021 State Energy Strategy that calls for innovations in: energy efficiency; electrification of transportation; grid modernization and storage; renewable energy; synthetic fuels; and research and deployment. • Washington's innovation ecosystem also includes a Governor's Office for Regulatory Innovation & Assistance (ORIA) that was initiated by the state legislature in 2002. ORIA provides services to help businesses navigate local, state, and federal approvals, permits, and rules and regulations, and invites suggestions for state regulatory improvements. • Since 2013, the Washington Department of Commerce has helped fund the development, demonstration, and deployment of clean energy technologies through the Clean Energy Fund.
Wisconsin	• The Office of Energy Innovation (OEI) is housed within the Wisconsin PSC. The OEI mission is "promot[ing] innovative and effective energy policies and programs." OEI offers an Energy Innovation Grant Program for "energy related projects that reduce energy consumption and support renewable energy and energy storage, energy efficiency and demand response, electric and renewable natural gas (RNG) vehicles and infrastructure, or comprehensive energy planning."

A. California

California is home to what it calls an "energy innovation ecosystem," under the auspices of the California Energy Commission (CEC), Energy Research and Development Division.[138] Funding comes in large part from California's Electric Program Investment Charge (EPIC), which is a system benefits charge initiated in 2012 and collected from ratepayers of California's three large investor-owned electric utilities.[139] The California Public Utilities Commission maintains its role for oversight and monitoring the state's EPIC funding, which totals about $130 million per year.[140] The California Energy Commission administers for 80 percent of the funding, and the three California investor-owned utilities together administer the other 20 percent.[141] Similar programs that were started in 2004 are continuing to work toward innovations for the natural gas industry.[142]

The CEC Energy Innovation Showcase web site reports on progress with California's energy innovations efforts.[143] To foster the clean energy innovation ecosystem, the CEC supports the California Clean Energy Fund, operating as New Energy Nexus (NEX) to administer two statewide initiatives and four Regional Energy Innovation Cluster (REIC) partners. The partners include the Southern California Energy Innovation Network (SCEIN), Los Angeles Cleantech Incubator (LACI), Bluetech Valley, and Activate.[144] The CEC also supports Empower Innovation, providing a clearinghouse of funding opportunities, events, news, and partnership opportunities for clean energy start-ups, accelerators, and investors.[145]

The California Energy Commission dedicates some of the EPIC funds to support the California Sustainable Energy Entrepreneur Development (CalSEED) Initiative, which applies public sector investing to accelerate clean energy goals and advance economic development.[146] New Energy Nexus is the contractor hired by the energy commission to manage the CalSEED initiative.[147] The California Energy Commission Energy Innovation Showcase web site reports on progress with California's energy innovations efforts.[148]

California is also implementing the CalTestBed initiative. There are reportedly more than 60 facilities already available for third-party testing, at nine University of California campuses and Lawrence Berkeley National Laboratory.[149] The team is continuing to expand test beds throughout the state and to connect with others around

---

138 California Energy Commission, *Energy Innovation Ecosystem*, web page, accessed June 2022, https://www.energy.ca.gov/programs-and-topics/topics/research-and-development/energy-innovation-ecosystem.

139 California Energy Commission, *Electric Program Investment Charge Program* (EPIC), web page, accessed June 2022, https://www.energy.ca.gov/programs-and-topics/programs/electric-program-investment-charge-epic-program.

140 California Public Utilities Commission, *Energy Research Development and Deployment*, web page, accessed June 2022, https://www.cpuc.ca.gov/energyrdd/.

141 Ibid.

142 Ibid.

143 California Energy Commission, *Energy Innovation Showcase*, Highlighting Energy Innovation, web page, accessed June 2022, http://innovation.energy.ca.gov/.

144 See: BlueTech Valley, *About the BlueTech Valley Initiative*, web page, https://www.bluetechvalley.org/; CleanTech San Diego, Southern California Energy Innovation Network, web page, https://cleantechsandiego.org/scein/; Cyclotron Road, *Empowering Tomorrow's Technology Leaders*, web page, https://cyclotronroad.lbl.gov/; Los Angeles Cleantech Incubator, *Unlock Your Innovations to Fight Climate Change*, web page, https://laincubator.org/; and Erik Stokes, Sherri Pittman, et al., *California Energy Innovations Ecosystem,* (2017), presentation slides, https://www.etcc-ca.com/sites/default/files/cecinnovation_final.pdf. All web pages accessed May 2022.

145 Empower Innovation, *Catalyzing the Clean Tech Community*, web page, accessed May 2022, https://www.empowerinnovation.net/en/.

146 CalSEED, *Our Network*, web page, accessed June 2022, https://calseed.fund/about/.

147 New Energy Nexus, *Our Portfolio*, web page, accessed June 2022, https://www.newenergynexus.com/portfolio. New Energy Nexus also has a partnership with New York State Energy Research and Development Administration (NYSERDA), called The Clean Fight. See The Clean Fight, *Helping Climate Tech Startups Win in New York*, web page, accessed June 2022, https://www.thecleanfight.com/.

148 California Energy Commission, Energy Innovation Showcase, *Highlighting Energy Innovation*, web page, accessed June 2022, http://innovation.energy.ca.gov/.

149 CalTestBed, *The 2021 National CalTestBed Symposium +Cohort 2*, (December 2021), press release, https://www.caltestbed.com/news/.

the country.[150] The CalTestBed initiative states, "We support diverse entrepreneurs to drive innovation and build equity into the global clean energy economy." The initiative has announced the availability of "up to $8.8 million in testing vouchers to clean energy innovators."[151] The focus is on prototype innovations that are advanced enough toward commercialization to be ready for experimental trials.[152] In the first round of CalTestBed projects, 25 start-ups were awarded approximately $5.5 million in vouchers to be used in the testing facilities. Supported projects included innovations in building and energy-efficiency technologies, energy storage, grid modernization, renewable generation, and transportation.[153]

CalTestBed is working to develop uniform contracting mechanism (UCM) documents in order to streamline the process of contracting and invoice management by and between the CalTestBed managers, entrepreneurs, and the multiple campuses and testbeds.[154] CalTestBed is working to sustain these capabilities after the initial funding is exhausted. The objective is to:

> . . . standardize entrepreneur-facing services, develop best practices, and collaborate on developing a robust pipeline of long-term, sustainable public and private funding for California's clean energy testbeds beyond the term of this program.[155]

B. Connecticut

The Connecticut Public Utilities Regulatory Authority (PURA) is pursuing regulatory innovations in the context of its Equitable Modern Grid Framework investigations.[156] The framework includes six proceedings on various issues including advanced metering infrastructure; electric storage; zero-emissions vehicles; and Docket No. 17-12-03RE05, on Innovation Pilots.[157] PURA explains that the purpose of Docket RE05 is "to identify a prospective structure that can support the ongoing development of innovative technology applications and programs that have the potential to provide net positive benefits to all electric customers."[158] In the notice initiating the process and seeking public input, PURA specifically notes, "This proceeding will examine potential mechanisms for establishing a regulatory sandbox – a safe, but monitored place to test new ideas and validate their benefits in the real world."[159]

In its initial request for comments, PURA specifically invited "lessons learned from regulatory sandbox initiatives instituted in other jurisdictions and ideas on, and best practices of, metrics to evaluate innovative technology applications and programs."[160] A hearing to receive public input, as part of an Information

---

150 https://www.CalTestBed.com and https://caltestbed.com/content/media/CalTestBed-Facilities-Directory-2020.pdf

151 Ibid.

152 The scale for determining progress from basic proof of concept research toward full commercialization is called "technology readiness level" (TRL). See: https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04-admchg1/@@images/file.

153 CalTestBed, Cohort 1 Impact Report, web page, accessed June 2022, https://www.caltestbed.com/news/.

154 CalTestBed, *About the CalTestBed Program* , web page, accessed June 2022, https://www.caltestbed.com/about/.

155 Ibid.

156 *Connecticut Public Utilities Regulatory Authority Announces Landmark Equitable Modern Grid Framework* (October 3, 2019), press release, https://portal.ct.gov/PURA/Press-Releases/2019/Connecticut-Public-Utilities-Regulatory-Authority-Announces-Landmark-Equitable-Modern-Grid-Framework.

157 Connecticut Public Utilities Regulatory Authority Docket No. 17-12-03RE05 – *PURA investigation into distribution system planning of the electric distribution companies – Innovation Pilots,* (December 4, 2019), http://www.dpuc.state.ct.us/2nddockcurr.nsf/(Web+Main+View/All+Dockets)?OpenView&StartKey=17-12-03RE05.

158 Connecticut Public Utilities Regulatory Authority Docket No. 17-12-03RE05 – *PURA investigation into distribution system planning of the electric distribution companies – Innovation Pilots*, (December 4, 2019), notice of request for presentations and comments and notice of public forum, http://www.dpuc.state.ct.us/2nddockcurr.nsf/8e6fc37a54110e3e852576190052b64d/ac99eb3f1f7a74f58525875200798c73?OpenDocument.

159 Ibid., p. 1.

160 Ibid., p. 2. In this request, the Authority specifically references, as an example, the New York REVConnect initiative. See Part III. G. for a summary of the New York initiative.

Gathering Phase called a Solutions Day was held on December 13, 2019.[161] PURA subsequently issued a draft request for proposals to supplement existing PURA staff expertise by retaining a consultant to provide expertise in: (1) electric utility regulatory sandboxes; (2) state-level programs for fostering energy innovation; and (3) state public utility commissions. The final request for proposals was issued in May 2020.[162]

In November 2020, PURA retained Strategen Consulting to provide support to PURA staff. Strategen will "help design and implement a regulatory framework and process that can create space for innovation and facilitate deployment of a wide array of innovative technology applications and customer programs."[163] In a March 2022 Order, PURA named this its "Innovative Energy Solutions Program," selecting a "January 2023 launch date."[164]

In addition to exploring regulatory innovations support practices, PURA is adopting what it calls "100-day Sprint Dockets" to address particular regulatory challenges. The Sprint process model comes from the realm of what is called "agile" product development, which is frequently associated with computer software design, development, testing, and deployment.[165] Sprints are called for when rapid action is warranted and PURA wishes to be informed by input from all interested stakeholders. PURA explains it is establishing "a series of '100-Day Sprints' (Sprints) where . . . stakeholders will meet to propose solutions" for issues identified by PURA. PURA staff are serving as facilitators for each Sprint track, and the designated staff will author reports, including recommendations based on discussions and information presented in the Sprint process. "The Authority finds that adopting the 100-Day Sprint model will enable a hands-on, collaborative problem-solving environment."[166]

Topics assigned for the first Sprint tracks, which "pertain to energy assistance and utility arrearage forgiveness programs" include: (1) Utility-Agency Coordination on Identifying Hardship Eligibility; (2) Benchmarking Matrix ("to evaluate the Companies' energy assistance programs, policies and procedures, and associated metrics") (3) Guidance for Medical Hardship Recipients; and (4) Targeted Marketing Campaign ("to promote energy assistance programs and other resources available to residential customers who experience difficulty paying their energy bills in full").[167]

Connecticut is also home to a "energy efficiency and renewable energy technology test bed" program, which enables "feasible" technologies "to be used on a limited trial basis in the operations of a State agency or facility."[168]

---

161 Connecticut Public Utilities Commission Dockets, Nos. 17-12-03RE-01–RE06, notice of request for written comments and release of draft request for proposals, 1-2. http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/e55b69de056c96418525853c005efb53/$FILE/Notice%20-%20Draft%20RFPs_Request%20for%20Comments%20-%20FINAL.pdf

162 Ibid., p. 4, 38-42, *Attachment F: Draft request for proposals for a consultant.*

163 Strategen Consulting, *Proposal for: Innovative Technology Applications and Programs (Innovation Pilots)*, prepared for [Connecticut] Public Utilities Regulatory Authority, (June 1, 2020), Docket No. 17-12-03RE05, http://www.dpuc.state.ct.us/2nddockcurr.nsf/8e6fc37a54110e3e852576190052b64d/f83e1138002f4f908525875200798e95?OpenDocument. See also *Innovation Pilots Framework – Final Proposal* at http://www.dpuc.state.ct.us/2nddockcurr.nsf/8e6fc37a54110e3e852576190052b64d/146129694f2388608525875200794e2?OpenDocument.

164 Connecticut Public Utilities Regulatory Authority, *PURA Establishes the Innovative Energy Solutions Program,* (March 30, 2022), pressrelease, https://portal.ct.gov/PURA/Press-Releases/2022/PURA-Establishes-the-Innovative-Energy-Solutions-Program.

165 See, for example: Agile Alliance, *Agile Essentials*, web page, accessed June 2022, https://www.agilealliance.org/agile-essentials/; and Project Management Institute, Agile, web page, accessed June 2022, https://www.pmi.org/search#q=Agile&sort=relevancy.

166 Connecticut Public Utilities Regulatory Authority, Procedural Order in Docket No. 17-12-03RE01, (January 2, 2020), https://portal.ct.gov/-/media/PURA/electric/Procedural-Order---Final.pdf; and *Connecticut Public Utilities Regulatory Authority Orders Eversource and United Illuminating to Overhaul Education and Outreach Efforts Related to Energy Assistance Programs*, (January 22, 2020), press release, https://portal.ct.gov/PURA/Press-Releases/2020/PURA-Press-Release.

167 Ibid.

168 Connecticut Department of Energy and Environmental Protection, *Test Bed Program*, web page, accessed June 2022, https://portal.ct.gov/DEEP/Energy/Test-Bed-Program/Test-Bed-Program.

C. District of Columbia

The District of Columbia regulatory innovations platform is an outgrowth of the Public Service Commission's broad grid-modernization proceedings, "In the Matter of the Investigation into Modernizing the Energy Delivery System for Increased Sustainability" (MEDSIS, in Docket No. FC-1130), and later renamed Power Path DC.[169]

The District presented a Draft Clean Energy DC Plan in 2016, and then invited public feedback. The D.C. Department of Energy & Environment held over two dozen meetings in all eight wards of the District, to engage with the public and receive feedback on the plan. A revised and updated plan was completed in August 2018.[170] Then, in early 2019, D.C. passed the Clean Energy DC Act, which codifies initiatives for building energy use, renewable energy, and transportation.[171] An April 2020 report provides an update of the District's actions toward implementing the Clean Energy DC Act. D.C. is presently tracking progress toward accomplishing 57 tasks, in the realms of: equity; building energy efficiency for both new and existing buildings; clean and renewable energy supply; energy system modernization; and electric vehicles.[172]

At the District of Columbia Public Service Commission (DCPSC), a stakeholder working group made proposals in the MEDSIS Docket to update utility pilot project procedures. During 2018 and 2019, the working group studied pilot program models from California and New York, grid-modernization actions in five other states, pilot projects from a few individual utilities, and the US DOE Technology Readiness Level (TRL) Model.[173] Based on those studies, the working group made recommendations to the DCPSC for a pilot projects governance model, including a governance board. The recommendations included proposals for identifying stakeholders to participate in pilot project governance, establishing selection criteria for pilot projects, and establishing screening methods, monitoring, and evaluations protocols.[174] A 2020 DCPSC Order adopted guidelines based on those recommendations.[175] As a result of a provision in the 2016 merger between Pepco Holdings and Exelon companies, DC has $21.55 million available to support pilot projects.[176] The Power Path DC Governance Board was formed in 2020. In September 2020, the governance board issued a "call for papers proposing grid modernization pilot projects."[177]

D. Hawaii

Hawaii's energy regulatory innovations work began in the early 2000's. A first energy stakeholder alliance was initiated in 2002, when the Hawaii Energy Policy Forum (HEPF) was established, with initial funding provided by Hawaiian Electric Company. HEPF is "a collaborative energy planning and policy group."[178] HEPF commissioned a 2003 report about Hawaii's energy regulatory framework, which included an extensive set

---

169 District of Columbia Public Service Commission, Power Path DC, web page, accessed June 2022, https://dcpsc.org/Newsroom/Hot-Topics/Grid-Modernization/PowerPath-DC.aspx.

170 District of Columbia Department of Energy & Environment, *Clean Energy DC*, web page, accessed June 2022, https://doee.dc.gov/cleanenergydc.

171 Ibid.

172 D.C. Department of Energy & Environment, *Clean Energy DC* Progress Report 2020, 9, https://doee.dc.gov/cleanenergydc.

173 Op Cit., note 152. See: https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04-admchg1/@@images/file.

174 Final Report of the DCPSC MEDSIS Stakeholder Working Groups Version 1.0, (May 31, 2019), https://dcpsc.org/PSCDC/media/PDFFiles/HotTopics/GridModernizationFinalReport.pdf.

175 DCPSC January 24, 2020 Order in Docket No. FC-1130, item no. 515, Order No. 20286, https://edocket.dcpsc.org/public/search/casenumber/fc1130

176 p Cit., note 152 and 173. See: https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04-admchg1/@@images/file.

177 https://dcpsc.org/CMSPages/GetFile.aspx?guid=333c8214-494a-4ad9-bb94-6074bb57bf58.

178 Hawaii Energy Policy Forum, *About the Hawaii Energy Policy Forum*, web page, accessed June 2022, http://manoa.hawaii.edu/hepf/index.php/about/.

of recommendations for both legislative and regulatory options and possible actions.[179] A 2007 HEPF report summarized existing laws to catalog obstacles and barriers to increasing implementation of energy efficiency and renewable energy.[180] That report represented a first effort to survey Hawaii laws "to identify barriers that [were], at least in some way unintended or unwarranted . . . [and] could be constructively mitigated."[181]

The Hawaii Clean Energy Initiative launched in 2008, with the signing of a memorandum of understanding between the state and the US Department of Energy, to partner on reducing Hawaii's reliance on imported fossil fuels. The Hawaii Clean Energy Initiative (HCEI) was established as a stakeholder alliance with a set of policy objectives that has since grown to encompass a comprehensive "framework of statutes and regulations." The HCEI partnership was renewed in 2014, and a year later Hawaii became the first state in the nation committing to a 100 percent renewable portfolio standard by 2045.[182] HCEI includes a set of support services for project developers and investors, and multiple testbed facilities that are intended to serve as proving grounds for technological innovation. HCEI purports to foster and demonstrate innovation, including innovations in "public policy," and includes in its goals and objectives "[e]stablish[ing] an 'open source' learning model."[183]

In 2014, the Hawaii PUC published a pivotal document entitled *Commission's Inclinations on the Future of Hawaii's Electric Utilities – Aligning the Utility Business Model with Customer Interests and Public Policy Goals*. That document cited the rapid growth in technological innovation, including advanced distribution systems and integrated energy districts, and the related need for innovations in utility business models, financial incentives, planning, and rate structures. It included discussion about need for innovation in utility programs and infrastructure to optimize the state's electricity systems for distributed energy resources.[184]

In 2018, Hawaii PUC initiated a regulatory proceeding to investigate performance-based regulation (PBR), including "innovative solutions to support grid transformation." The commission viewed PBR as a means to "enable innovations."[185] In its December 2020 order in this docket, the commission established a process for "expedited implementation" for testing "new technologies, programs, business models, and other arrangements."[186] The Hawaii PUC invited interested parties to "develop proposals for an expedited pilot process" and took notice of the regulatory innovation platform being implemented in Vermont for Green Mountain Power.[187] In its order, the commission authorized the utility companies to "exercise flexibility in . . . traditional contract bidding and selection processes."[188] The commission authorized spending of up to $10 million, annually, and allows the utility to request approval for expenditures above that cap.[189] The Hawaii PUC specifies criteria for project eligibility and provides for an open, collaborative process for determining the

---

179 Carl Freedman and Jim Lazar, *Hawaii Energy Utility Regulation and Taxation – Practice, Policy and Incentives for Energy Efficiency, Renewable and Distributed Energy Resources*, (2003), report for Hawaii Energy Policy Project, http://manoa.hawaii.edu/hepf/index.php/projects-initiatives/.

180 Freedman, Carl. 2007. *Obstacles in Hawaii's Laws to Implementation of Energy Efficiency and Renewable Resources*, Report for Hawaii Energy Policy Forum, http://manoa.hawaii.edu/hepf/index.php/projects-initiatives/.

181 Ibid., p. 1-2.

182 Hawaii State Energy Office, *Hawaii Clean Energy Initiative,* web page, accessed June 2022, https://energy.hawaii.gov/testbeds-initiatives/hcei.

183 Ibid.

184 Hawaii Public Utilities Commission, *Commission's Inclinations on the Future of Hawaii's Electric Utilities*, (2014), https://puc.hawaii.gov/wp-content/uploads/2014/04/Commissions-Inclinations.pdf.

185 Hawaii Public Utilities Commission, *Order No. 35411 Instituting a Proceeding to Investigate Performance-Based Regulation*; (April 18, 2019), Docket No. 2018-0088, 3, https://dms.puc.hawaii.gov/dms/dockets?action=search&docketNumber=2018-0088.

186 Hawaii Public Utilities Commission, *Decision and Order No. 37507*, (December 23, 2020), Docket No. 2018-0088, 166 et seq., https://dms.puc.hawaii.gov/dms/dockets?action=search&docketNumber=2018-0088.

187 Hawaii Public Utilities Commission, *Decision and Order No. 37507*, (December 23, 2020), Docket No. 2018-0088, 167-68, https://dms.puc.hawaii.gov/dms/dockets?action=search&docketNumber=2018-0088. See the description of the similar Vermont platform for Green Mountain Power (Notes 273 and 274).

188 Hawaii Public Utilities Commission, *Decision and Order No. 37507*, (December 23, 2020), Docket No. 2018-0088, 169, https://dms.puc.hawaii.gov/dms/dockets?action=search&docketNumber=2018-0088.

189 Ibid., p. 170.

subject areas or concepts for innovation pilots. The resulting work plan will be submitted to the commission for review and comment prior to implementation. Then once each pilot project is fully developed, the utility shall submit written notice to the commission, which will include ample description to enable the commission to review the proposal and "issue an order, approving, denying, or modifying the proposed Pilot, within forty-five (45) days."[190] The implementing order also includes provisions for utility reporting on the pilot projects and about the mechanisms that can be used for obtaining commission approval for converting or expanding successful pilot projects into larger-scale offerings.[191]

The Hawaii innovations platform is the subject of a research study to explore salient characteristics of the state's long-standing, comprehensive, and collaborative approach to "transformational socio-technical change in energy systems."[192] This project uses a multi-level perspective to explore how innovations have been supported at: (1) the "landscape" level, which implicates global and federal trends; (2) the "regime" level among the central policy actors in the state legislature, regulatory agencies, and other major players in the realm of state energy policy, including the public utilities commission (PUC) and regulated utility companies; and (3) the "niche" or "localized" level "where energy innovations policies catalyze numerous tactics and small-scale projects by local organizations and actors . . . [and] where experimentation in cutting edge technologies, user-experience, and co-evolution of structure can take place and ultimately reach the market."[193] Hawaii's case study researchers explain, "the HCEI is structured for collaborative engagement and partnership among all stakeholders with core functions to link regime-level actors with niche-level actors."[194] Furthermore, the researchers note, the HCEI is integrated with the state's university researchers, so that "rapid responses at the niche level [can] support regime level decision-making at the utilities and PUC."[195] They credit as "a critical factor in HCEI's success . . . the combined regime and niche-level actions to bring citizens, government agencies, utilities, and community agencies in alignment with the policy goals of the state."[196] And they highlight "the critical role of law and policy in creating directives, mandates, economic incentives and social motivation for progress."[197]

E. Illinois

A 2011 Illinois law directed utility companies to identify one or more network locations to be Smart Grid Test Beds.[198] The stated purpose was "to maximize the opportunity for real-time and real-world testing of Smart Grid technologies and services . . . open to all qualified entities wishing to test programs, technologies, business models, and other Smart Grid-related activities. . . ."[199] The legislation included provisions for a Smart Grid Advisory Council, "for the purposes of advising and working with participating utilities on the development and implementation of a Smart Grid Advanced Metering Infrastructure Deployment Plan."[200]

---

190 Hawaii Public Utilities Commission,, *Decision and Order No. 37507*, (December 23, 2020), Docket No. 2018-0088, 170-174, https://dms.puc.hawaii.gov/dms/dockets?action=search&docketNumber=2018-0088.

191 Hawaii Public Utilities Commission, *Decision and Order No. 37507*, (December 23, 2020), Docket No. 2018-0088, 175-76, 179-80, https://dms.puc.hawaii.gov/dms/dockets?action=search&docketNumber=2018-0088.

192 Lee, Glick, and Lee, "Island energy transition": 1

193 Ibid, p. 2.

194 Ibid, p. 4.

195 Ibid, p. 5.

196 Ibid, p. 8.

197 Ibid, p. 9.

198 Illinois Compiled Statutes, Section 220 ILCS 5/16-108.8 - Illinois Smart Grid Test Bed, https://casetext.com/statute/illinois-compiled-statutes/regulation/chapter-220-utilities/act-5-public-utilities-act/article-xvi-electric-service-customer-choice-and-rate-relief-law-of-1997/section-220-ilcs-516-1088-illinois-smart-grid-test-bed

199 Ibid.

200 Illinois Compiled Statutes, Section 220 ILCS 5/16-108.6 - Provisions relating to Smart Grid Advanced Metering Infrastructure Deployment Plan, https://casetext.com/statute/illinois-compiled-statutes/regulation/chapter-220-utilities/act-5-public-utilities-act/article-xvi-electric-service-customer-choice-and-rate-relief-law-of-1997/section-220-ilcs-516-1086-provisions-relating-to-smart-grid-advanced-metering-infrastructure-deployment-plan

Opportunities afforded to the utilities included: (a) retaining control of their grids and operations, including the ability to "reject any . . . activities that threaten the reliability, safety, security, or operations of its network . . .;" and (b) recovering all prudently incurred and reasonable costs associated with the test beds and permissive authority to charge user fees to recover the costs of administering the test beds. The program called for independent evaluations of the test beds after four years.[201]

In 2016, the University of Illinois Urbana-Champaign announced receipt of an $18.7 million grant from the US Defense Advanced Research Projects Agency (DARPA) to develop a test bed for grid security, with the ability to develop and validate cyber-security tools.[202] One report says the test bed is "like having a flight simulator, but for the power grid." This Cyber Resilient Energy Delivery Consortium (CREDC) is a "collaboration between universities, national labs, and private industry aimed at bolstering the security and reliability of a power grid."[203]

In Illinois, a NextGrid Utility of the Future Study initiative was launched in 2017. The process was funded by Commonwealth Edison and Ameren utilities, and a final report was compiled under the direction of the utilities. The purpose was to consider "the major challenges and opportunities the state of Illinois faces in grid modernization."[204] Seven working groups were organized to study major grid-modernization issues:

1. New Technology Deployment and Grid Integration
2. Metering, Communications and Data
3. Reliability, Resiliency and Security
4. Customer and Community Participation
5. Electricity Markets
6. Regulatory, Environmental and Policy Issues
7. Ratemaking[205]

The study process was called into question, though. Plaintiffs filed suit in Cook County Court, claiming that the NextGrid meetings did not meet provisions of the Illinois Open Meetings Act. The plaintiffs noted the NextGrid meetings were "closed and some stakeholders . . . excluded from the process."[206] The NextGrid report was blocked from publication by the court, until the lawsuit was eventually dropped, following a transition in the makeup and leadership of the Illinois Commerce Commission (ICC), and after the newly formed commission reached a settlement agreement, which functionally disavowed the NextGrid report.[207] In an open letter to the public, the commission stated:

> Simply put, this Report is not suited for any regulatory, legislative, or policy pursuit within Illinois or any other jurisdiction. . . . The current administration neither endorses nor accepts responsibility for

---

201 See *Smart Grid Test Bed Plans for 2012 through 2022*, plus quarterly test bed reports for Ameren Illinois Company and Commonwealth Energy Company, among other related reports, available at: Illinois Commerce Commission, *Infrastructure Investment Plans*, web page, accessed May 2022, https://www.icc.illinois.gov/industry-reports/infrastructure-investment-plans.

202 University of Illinois Urbana-Champaign, *Illinois receives $18.7M to develop testbed for electric grid security* (August 16, 2016), news release, https://iti.illinois.edu/news/illinois-receives-187m-develop-testbed-electric-grid-security.

203 David Unger, "Illinois partnership looks to build trust in grid through cybersecurity research," *Energy News Network*, (June 12, 2017), electronic article, https://energynews.us/2017/06/12/illinois-partnership-looks-to-build-trust-in-grid-through-cybersecurity-research/.

204 University of Illinois Urbana-Champaign (UIUC), *NextGrid Illinois: Utility of the Future Study Final Report*, web page, accessed May 2022, https://nextgridreport.web.illinois.edu/.

205 NRRI was selected to lead the stakeholder process for working group #7, about ratemaking.

206 Nicholas Nhede, "Illinois Commerce Commission sued for closing meetings to the public," (June 27, 2018), electronic article, *Smart Energy International*, https://www.smart-energy.com/news/illinois-commerce-commission-sued/.

207 "Illinois Commerce Commission Settles Open Meetings Lawsuit, Agrees to Disclaimer Stating NextGrid Study Was Funded by ComEd and Ameren and Should Not Influence Policy" (April 24, 2020), electronic article, *Business Wire*, https://www.businesswire.com/news/home/20200424005448/en/Illinois-Commerce-Commission-Settles-Open-Meetings-Lawsuit-Agrees-to-Disclaimer-Stating-NextGrid-Study-Was-Funded-by-ComEd-and-Ameren-and-Should-Not-Influence-Policy.

> the contents of the Report. . . . [F]or the purposes of determining regulatory or legislative activities, we find it wholly improper and further disavow the Report's use for any purpose. For these reasons, this Commission did not release the Next Grid Report.[208]

The report was then published by the University of Illinois, containing disclaimers, including:

> The NextGrid Study is not a docketed proceeding of the Commission and there is no Commission Order pursuant to this initiative. The NextGrid collaborative effort has not involved hearings, testimony or cross-examination. Opinions of NextGrid participants and drafters of the report do not necessarily represent the views of all stakeholders or the ICC or any of its members.[209]

More recently, Illinois regulators approved two important microgrid pilot programs. One is a joint project of Commonwealth Edison Company and Illinois Institute of Technology, in the Bronzeville area in Chicago.[210] The other is at the Ameren utility company Technology Applications Center, near the campus of the University of Illinois at Champaign-Urbana.[211] These are both among the first microgrid projects in the US that allow the participating utilities to include distribution system costs in revenue requirements, to be recovered from all ratepayers.

In September 2021, Illinois passed Public Act 102-0662, known as the "Climate and Equitable Jobs Act" and including the "Energy Transition Act."[212] This broad legislation includes provisions for

> accommodating and incentivizing more renewable generation, increasing deployment of customer-owned distributed energy resources (DER), and hastening uptake of electric vehicles (EVs), all while ensuring grid reliability and a just and reasonable distribution of the costs and benefits of these transformational efforts.[213]

The Illinois Commerce Commission anticipates that implementation will entail "revisions to various Commission rules as well as other processes and procedures."[214]

Illinois is also home to two nongovernmental organizations that specialize in energy and water industry innovations. Evergreen Climate Innovations is a nonprofit dedicated to identifying, funding, and growing high-impact clean-tech startups from the Midwest.[215] The trust "makes seed investments and provide[s] mentorship, coaching, access to a national network, and patient, hands-on support to help entrepreneurs scale and succeed." In addition, "Current" is a Chicago-based nonprofit water innovation hub, focused on water technologies and developing a "blue economy" and facilitating innovations for the energy-water nexus.[216]

---

208 Illinois Commerce Commission, *A Message to the Public from the Illinois Commerce Commission Regarding the University of Illinois Next Grid Report*, (June 26, 2020), https://icc.illinois.gov/about/news.

209 University of Illinois Urbana-Champaign, *NextGrid Illinois*, 11 and 209.

210 See: Lisa Cohn, "Here comes the future: Bronzeville 'microgrid cluster' set to begin operating this year" (January 24, 2022), electronic article, *Microgrid Knowledge*, https://microgridknowledge.com/bronzeville-microgrid-cluster-lessons-comed/; and Commonwealth Energy Company, *Community of the Future*, (2021), web page, accessed May 2022, https://communityofthefuture.comed.com/.

211 Ameren Illinois, Technology Application Center, web page, accessed May 2022, https://www.ameren.com/illinois/company/reliability/grid-of-the-future/technology-application-center.

212 Illinois General Assembly, Public Act 102-0662, https://ilga.gov/legislation/publicacts/fulltext.asp?Name=102-0662.

213 Carrie Zalewski, Jordan Graham, and Tanya Rabczak, 2021, "Illinois' new clean energy law could be a regulatory playbook for other states," electronic article, November 23, 2021, *Utility Dive*, https://www.utilitydive.com/news/illinois-new-clean-energy-law-could-be-a-regulatory-playbook-for-other-sta/610450/.

214 Illinois Commerce Commission, *Climate and Equitable Jobs Act Implementation*, web page, accessed May 2022, https://www.icc.illinois.gov/programs/climate-and-equitable-jobs-act-implementation.

215 Evergreen Climate Innovations, *About Us*, web page, accessed May 2022, https://evergreeninno.org/about-us.

216 Current, *Current's Story*, web page, accessed June 2022, https://www.currentwater.org/our-story.

F. Massachusetts

Massachusetts is home to an ongoing state energy and water innovation support platform named InnovateMASS. The program, operated by the Massachusetts Clean Energy Center, is described as

> a state economic development agency dedicated to accelerating the growth of the clean energy sector . . . to spur job creation, deliver statewide environmental benefits and to secure long-term economic growth. . . .[217]

The InnovateMASS program can provide up to $250,000 per project

> in grant funding and technical support to applicant teams deploying new clean energy technologies or innovative combinations of existing technologies with a strong potential for commercialization.[218]

Projects are awarded in four focus areas: (1) high-performance buildings; (2) clean transportation; (3) offshore wind; and (4) net-zero grid.[219] The funding source is the Massachusetts Renewable Energy Trust Fund, which was established by the legislature in 1997 as a utility system benefits charge collected from customers of the state's investor-owned electric utilities plus five municipal electric departments that have also joined.[220]

Massachusetts is home to multiple clean energy incubator organizations that provide resources to support clean energy start-ups.[221]

G. Minnesota

Minnesota's major energy innovations efforts started with the "e21" initiative, short for "an electric system for the 21st century."[222] The initiative was convened, starting in 2014, by the Great Plains Institute and Center for Energy and Environment, both Minneapolis-based nonprofit groups working on energy, environmental, and economic "innovations that contribute to the common good."[223] E21 invited participation by "stakeholders who are actively involved in advancing Minnesota's electric system, including utilities, regulators and other state government agencies, consumer advocates, environmental advocates, local governments, academic organizations, energy technology companies, and other businesses."[224]

E21 describes its efforts in three phases: (1) Consensus for Change; (2) Implementation Plans; and (3) Ideas to Action. The Minnesota experience is different from other states, because the initiative was started by self-organizing stakeholder groups, rather than by the legislature or any executive branch agency. The present phase, Ideas to Action, is working to "shape and accelerate progress on a wide variety of specific proceedings, filings, and topics relevant to modernizing Minnesota's electric system." Many of the current e21 activities focus on Minnesota Public Utility Commission proceedings, including a proceeding working to implement performance-based regulation; multiple proceedings to consider new utility rates, products, and services, and updates to utility system planning procedures.[225] A Smart Electric Power Alliance case study states,

---

217 Massachusetts Clean Energy Center, *About MassCEC,* web page, accessed June 2022, https://www.masscec.com/about-masscec.

218 Massachusetts Clean Energy Center, *InnovateMASS,* web page, accessed June 2022, https://www.masscec.com/innovatemass.

219 Ibid.

220 Ibid.

221 Massachusetts Clean Energy Center, *Massachusetts Clean Energy Incubators,* web page, accessed June 2022, https://www.masscec.com/massachusetts-clean-energy-incubators.

222 E21 Initiative, *About the e21 Initiative,* web page, accessed June 2022, https://e21initiative.org/about-e21/.

223 Ibid.

224 Ibid.

225 Ibid.

"Minnesota's deliberate, measured and comprehensive approach to regulatory reform offers guidance and best practices for other states considering how to evolve their regulatory processes and practices."[226]

Minnesota's A 2019 e21 Forum focused on four major areas for Minnesota energy innovation: (1) comprehensive utility planning; (2) a "Mod Squad" for developing a utility grid-modernization toolkit; (3) decarbonizing natural gas end uses; and (4) a battery storage game plan.[227]

Minnesota is home to a ratepayer-funded Conservation Applied Research and Development (CARD) program. A 2019 project funded by CARD investigates "emerging technologies being developed and studied by publicly funded research in California through the Electric Purpose investment Charge (EPIC) program" to determine which ones have "the greatest potential relevance to Minnesota."[228] The published consultant report suggests:

> Given the comparatively light investment required to screen and summarize technologies funded by other states or public entities, there may be value in examining other large research and development programs.

In 2021, the Minnesota legislature passed the Natural Gas Innovations Act (NGIA).[229] The second portion of the law directs the Minnesota PUC to develop, by June 2022,

> a general framework to compare the lifecycle greenhouse gas emissions intensities of power-to-hydrogen, strategic electrification, renewable natural gas, district energy, energy efficiency, biogas, carbon capture, and power-to-ammonia; and a cost-benefit analytic framework to be applied to innovative resources and [natural gas utility company] innovation plans.[230]

Another 2021 law added provisions for a Minnesota Efficient Technology Accelerator, with the goals of "accelerating deployment and reducing the cost of emerging and innovative efficient technologies."[231]

The Minnesota Department of Commerce supports commercialization assistance activities for innovators in clean energy, including energy efficiency and renewable energy.[232]

---

226 Smart Electric Power Alliance, Renovate Initiative, *Renovate Best Regulatory Practice 'Toolkit' Series: Performance Based Regulation, Part I*, 2020, https://sepapower.org/resource/renovate-best-regulatory-practice-toolkit-series-performance-based-regulation-part-i/. See also: Drake, Trevor, e21 Initiative, *Performance Based Regulation in Minnesota: A Decade of Progress*, electronic article, 2020, https://e21initiative.org/performance-based-regulation-in-minnesota-a-decade-of-progress/.

227 Trevor Drake, *e21 Forum Highlights Four Areas of Energy Innovation Across Minnesota*, E21 Initiative, 2019, web page, accessed June 2022, https://e21initiative.org/e21-forum-highlights-four-areas-of-energy-innovation-across-minnesota/.

228 Ingo Bench, Martha Wudka, et al., *Emerging Energy Efficiency Technologies – Leveraging Public Research for Application in Minnesota*, report prepared for Minnesota Department of Commerce, Division of Energy Resources by Evergreen Economics, (2019), https://eeaps.evergreenecon.com/card-emerging-technology/ and https://www.cards.commerce.state.mn.us/CARDS/security/search.do?documentId=%7BCEB6F97C-702B-41DA-9643-BBA24B9147A5%7D.

229 The NGIA is reflected in two sections of Minnesota Law: Chapter 216B, Section 216B.2427, about *Natural Gas Utility Innovation Plans*, https://www.revisor.mn.gov/statutes/cite/216B.2427; and Chapter 216B, Section 216B.2428, about *Lifecycle Greenhouse Gas Emissions Accounting Framework; Cost-Benefit Test for Innovative Resources*, https://www.revisor.mn.gov/statutes/cite/216B.2428. A Minnesota Commerce Department presentation summarizes 2021 legislative actions regarding clean energy, https://mn.gov/commerce/industries/energy/policy/.

230 Ibid., p. Section 216B.2428. The Minnesota Public Utilities Commission initiated NGIA implementation in 2021, opening Dockets No. 21-565, *In the Matter of a Commission Evaluation of Changes to Natural Gas Utility Regulatory and Policy Structures to Meet State Greenhouse Gas Reduction Goals*, and No. 21-566, *In the Matter of Establishing Frameworks to Compare Lifecycle Greenhouse Gas Emissions Intensities of Various Resources, and to Measure Cost-Effectiveness of Individual Resources and of Overall Innovative Plans,* https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=eDocketsResult&userType=public.

231 2021 Minnesota Statutes, Chapter 216, Section 216B.241, Public Utilities; *Energy Conservation and Optimization, Subdivision 14. Minnesota efficient technology accelerator,* https://www.revisor.mn.gov/statutes/cite/216B.241#.

232 Minnesota Commerce Department, Commercialization Assistance, web page, accessed June 2022, https://mn.gov/commerce/industries/energy/commercialization-assistance/.

H. New Jersey

New Jersey is operating under multiple executive directives by Governor Phil Murphy. Executive Order No. 28 of 2018 "directed the New Jersey Board of Public Utilities, in partnership with other state agencies, to develop [a] statewide clean energy plan and shift away from energy production that contributes to climate change."[233]

In 2018, the New Jersey Legislature also reestablished the New Jersey Commission on Science, Innovation, and Technology.[234] Governor Murphy explained, the commission "was originally created in 1985 and became non-operational in 2010."[235] The 2018 legislation also directs the Commission on Science, Innovation, and Technology to appoint from its membership an "Innovation Council . . . charged with determining how to stimulate technology transfer between public and private research institutions of higher education and industry, including the transfer of information available from federal agencies."[236] New Jersey also created and maintains a "Research with NJ" web portal, dedicated to showcasing and encouraging collaborations with New Jersey science, technology, engineering, and mathematics (STEM) university researchers.[237] That database includes profiles of nearly 4,500 researchers at five of the state's major universities.

New Jersey is also home to a state Office of Innovation, created by Governor Murphy in 2018.[238] Among many activities under the purview of that office are increasing public engagement in policymaking and providing innovation advisory services to the governor's office and other state partners. The public engagement project includes "creating tools to enable the public to participate in open policy making [and] . . . meaningfully contribute to the policymaking process."[239]

In early 2020, Governor Murphy announced the 2019 New Jersey Energy Master Plan, Pathway to 2050, which prominently features a strategy for "expand[ing] the clean energy innovation economy."[240] Plans include: growing supply chain clusters for clean energy subsectors; establishing clean energy workforce training; providing innovative financing, including a statewide green bank; capitalizing on off-shore wind; establishing a clean-tech innovations center and a clean buildings hub.[241] Governor Murphy proclaims,

> New Jersey will drive a world-leading innovation economy that invests in people and communities, ensures environmental justice for all residents, creates good-paying jobs, protects diverse vulnerable ecosystems, improves public health, and leads the way in the global clean-energy transition."[242]

The New Jersey Economic Development Administration (NJEDA) touts a series of Strategic Industry Support activities and Innovation Economy Programs, including special emphases on clean tech and offshore wind.[243]

---

233 State of New Jersey, *Governor Murphy Unveils Energy Master Plan and Signs Executive Order Directing Sweeping Regulatory Reform to Reduce Emissions and Adapt to Climate Change*, (January 27, 2020), news release, https://www.nj.gov/governor/news/news/562020/approved/20200127a.shtml.

234 New Jersey Economic Development Administration, *Governor Phil Murphy Signs Legislation Re-Establishing Commission on Science, Innovation and Technology*, (August 15, 2018), news release, https://www.njeda.com/governor-phil-murphy-signs-legislation-re-establishing-commission-on-science-innovation-and-technology/. See also https://www.njeda.com/csit/.

235 Ibid.

236 Ibid.

237 *Research with New Jersey*, web portal, accessed May 2022, https://www.researchwithnj.com/.

238 State of New Jersey, *Office of Innovation and Office of Innovation – About Us*, web portal, accessed June 2022, https://innovation.nj.gov/ and https://innovation.nj.gov/about/.

239 State of New Jersey, *Office of Innovation – Our Work*, web portal, accessed June 2022, https://innovation.nj.gov/projects/.

240 State of New Jersey, *2019 Energy Master Plan – Pathway to 2050*, (2019), http://d31hzlhk6di2h5.cloudfront.net/20200127/84/84/03/b2/2293766d081ff4a3cd8e60aa/NJBPU_EMP.pdf.

241 Ibid., p. 215-231.

242 State of New Jersey, Governor Phil Murphy. *Governor Murphy Unveils Energy Master Plan and Signs Executive Order Directing Sweeping Regulatory Reform to Reduce Emissions and Adapt to Climate Change*, (January 27, 2020), news release, https://nj.gov/governor/news/news/562020/approved/20200127a.shtml.

243 New Jersey Economic Development Administration, *Strategic Industry Support*, web portal, accessed June 2022, https://www.njeda.com/strategic-industry-support/.

New Jersey has established what it calls an "accelerator program" to encourage and nurture "the next generation of entrepreneurs." So far, three different program operators have been declared "approved accelerators" by NJEDA. The accelerators operate what are called "'boot camps' offering educational programs for start-up founders [and] exposing them to a wide variety of mentors, including former entrepreneurs, venture capitalists (VCs), angel investors, and corporate executives."[244]

I. New York

New York is home to a long-standing innovations ecosystem. New York State Energy Research and Development Authority (NYSERDA), formed in 1975, presently has 79 active program areas, inviting innovations for 19 different sectors and nine different technology types. NYSERDA touts what it calls its

> comprehensive suite of services . . . offer[ing] entrepreneurs and innovators a complete roadmap starting from the idea-stage and leading to full scale market adoption that makes New York State one of the best places in the world to start and scale a clean energy company.[245]

Innovations program areas include: carbon-neutral buildings; carbon-neutral economic development; entrepreneurs-in-residence; innovative market strategies; New York Green Bank; New York Prize competition for community microgrids; regional clean energy hubs; renewable heat wood heating technology; and REV Connect, which "[b]rings companies and New York's electric utilities together to accelerate innovation, adopt new business models and technologies, and advance New York State's Reforming the Energy Vision (REV) goals."[246] The New York REV proceedings began in 2014.[247]

REV Connect, which started in 2017, invites innovators to make proposals related to specific topic areas, working in what it calls "innovation sprints," with topics of interest announced on the REV Connect web site.[248] NYSERDA also hosts Research and Innovation Centers[249] and CleanTech Accelerators.[250]

J. Oregon

Oregon legislation, Senate Bill 978 of 2017, directed the Oregon PUC to "explore and examine the . . . changing dynamics of the regulated electric system."[251] In response to that legislation, the Oregon PUC convened stakeholders and held a series of meetings to identify coming changes and set priorities for action. The PUC reports, "By a wide margin, participants' top priorities were for the PUC to directly address climate change

---

244 New Jersey Economic Development Administration, *NJ Accelerate*, web pages, accessed July 2021, https://www.njeda.com/njaccelerate/.

245 Op Cit., note 147, NYSERDA.

246 New York State Energy Research and Development Authority, *About NYSERDA and Find a Program*, web pages, accessed July 2021, https://www.nyserda.ny.gov/About and https://www.nyserda.ny.gov/All-Programs. See also: Bradley, Dan, and H. Christine Richards, "Four Learnings from REV Connect," *Public Utilities Fortnightly*, (2018), https://nyrevconnect.com/wp-content/uploads/2018/12/Public-Utilties-Fortnightly-REV-Connect-4-Learnings-FINAL.pdf; and Dan Bradley, and H. Christine Richards, "How REV Connect's Innovation Sprints Redefine Utility Procurement," *Public Utilities Fortnightly*, (February, 2019), https://guidehouse.com/-/media/www/site/insights/energy/2019/rev-connect-innovation-under-deadline.pdf.

247 New York Department of Public Service, *REV-related proceedings*, web pages, accessed June 2022, https://www3.dps.ny.gov/W/PSCWeb.nsf/All/8C1741CD17739013852582F30056EEE8?OpenDocument#ReformingTheEnergyVision.

248 REV Connect, *Innovation Sprints – Accelerating innovative partnerships to address near-term priorities*, web pages, accessed July 2021, https://nyrevconnect.com/innovation-sprints/. See also REV Connect, *Innovation Opportunities*, web pages, accessed June 2022, https://nyrevconnect.com/innovation-opportunities/.

249 New York State Energy Research and Development Authority, *Research & Innovation Centers*, web pages, accessed June 2022, https://www.nyserda.ny.gov/Researchers-and-Policymakers/Research-and-Innovation-Centers.

250 New York State Energy Research and Development Authority, *NYSERDA Launches Two Cleantech Accelerators for Entrepreneurs to Bring Clean Energy Solutions to the Marketplace*, (April 9, 2020), news release, https://www.nyserda.ny.gov/About/Newsroom/2020-Announcements/2020-04-09-NYSERDA-Launches-Two-Cleantech-Accelerators-for-Entrepreneurs-to-Bring-Clean-Energy-Solutions-to-the-Marketplace.

251 Oregon Public Utility Commission, *SB 978 – Actively Adapting to the Changing Electricity Sector*, (September 2018): 4, legislative report, https://www.oregon.gov/puc/utilities/Documents/SB978LegislativeReport-2018.pdf.

and equity."[252] The outcome of the stakeholder process was a 2018 report from the PUC, identifying ideas for "a dynamic strategy" by the PUC and legislature to: (a) update and clarify PUC objectives, and (b) develop modern regulatory tools, market structures, and processes. . ."[253] Stakeholders identified both actions the PUC could take within its current regulatory authorities and legislative actions that might be required in order to address other changes.[254]

Oregon governor Kate Brown issued Executive Order 20-04, adding new goals and considerations to Oregon PUC reviews of utility plans, including "progress on GHG reductions; transportation electrification; wildfire mitigation; and minimizing energy burden of customers."[255] The executive order calls on a dozen state agencies and departments to develop climate action implementation plans.[256]

Oregon legislation in 2021 builds on Executive Order 20-04.[257] House Bill 2021 of 2021 requires GHG emissions from electricity sold to Oregon consumers to be reduced by 80 percent by 2030, 90 percent by 2035, and 100 percent by 2040, subject to a cumulative rate impact cap of 6 percent of annual revenue requirements.[258] The law prohibits the Oregon Energy Facility Siting Council from issuing site certificates for new fossil fuel-generating facilities, unless they are "non-emitting."[259] Electric companies are required to convene Community Benefits and Impacts Advisory Groups with input from stakeholders, and file biennial reports with the Oregon PUC.[260] The State Department of Energy is directed to convene a working group to report to an interim legislative committee, by not later than September 2022, about opportunities to develop small-scale and community-based renewable-energy projects.[261] The law also sets a portfolio standard of 10 percent by 2030 for electric capacity "from small-scale renewable energy projects or facilities using biomass."[262]

Another 2021 law, HB 2475, directs the Oregon PUC to consider environmental justice and equity, including affordability, in determining customer classes and in rate setting.[263] The law also provides for funding, up to $500,000 per year, from public utilities entering into agreements with organizations representing low-income customers and environmental justice communities, to participate in PUC proceedings.[264]

Oregon has a long-standing environmental justice policy and a law that directs more than a dozen state agencies, including the PUC to consider environmental justice in decision making and "to follow prescribed steps to provide greater public participation and ensure involvement of people who may be affected by

252 Ibid., p. 2.

253 Ibid., p. 2.

254 Ibid., p. 8.

255 Oregon governor Kate Brown, *Climate Change & Sustainability*, web page, accessed June 2022, https://www.oregon.gov/gov/priorities/Pages/climate-change-and-sustainability.aspx.

256 Ibid. See also: Oregon Public Utility Commission Chair Megan Decker, *PUC Work Plans Executive Order 20-04*, presentation to House Interim Committee on Energy and Environment, December 16, 2020, https://olis.oregonlegislature.gov/liz/2019I1/Downloads/CommitteeMeetingDocument/227418; and Oregon Public Utility Commission, Utility Regulation – Executive Order 20-04, web page, accessed June 2022, https://www.oregon.gov/puc/utilities/Pages/EO20-04.aspx.

257 Oregon House Bill 2021 of 2021, can be found at https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2021, and Executive Order on Climate Action at https://www.oregon.gov/gov/Documents/executive_orders/eo_20-04.pdf.

258 Cameron D. Miles, *Open Government Impact Statement*, Measure: HB 2021-C, 81st Oregon Legislative Assembly, (June 24, 2021), https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureAnalysisDocument/63112.

259 Ibid.

260 Ibid.

261 Ibid.

262 Ibid.

263 Oregon House Bill 2475, https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2475.

264 Cameron D. Miles, *Open Government Impact Statement, Measure HB2475*, 81st Oregon Legislative Assembly, May 12, 2021, https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureAnalysisDocument/60956.

agency actions."[265] The PUC reports that it is focusing "on reducing barriers to public participation to ensure that all voices are heard in the decision-making process. . . ."[266]

The Oregon Energy Office is home to a Planning & Innovation Division, which works on program areas authorized by the state legislature. A report published in 2020 highlights the Energy Planning and Innovation strategic framework activities and accomplishments from 2015 through 2019.[267] The Strategic Framework is intended to:

> [p]rovide[] policy leadership to keep Oregon on the cutting edge of energy sector innovation, collaborating with stakeholders to leverage our technical expertise as reflected in the development of white papers, pilot projects, program improvements, rule revisions and legislative proposals.[268]

Oregon started a state Innovation Council in 2005.[269] It is a public-private partnership designed to bring new jobs and new companies to the state. The council does not specifically target regulated utility industries, but it has funded projects supporting electric vehicles, wave energy, clean tech research and development, energy efficiency, wind energy, and more.[270]

Oregon is also home to a regional consortium called GridForward, which is "a member-based non-profit organization that brings together utilities, solution providers, government agencies, regulators, advocates and others to work together on making grid modernization a reality."[271]

K. Vermont

The Vermont Public Service Commission adopted in 2019 a multi-year regulation plan for that state's major investor-owned utility, Green Mountain Power Corporation (GMP). The Commission Order provides for "new initiatives and innovative pilots" along with "innovation and performance metrics."[272]

Under the terms of this order,

- GMP can offer "new initiatives," which are "transformative, customer-facing energy projects that require an initial upfront capital investment by GMP and are forecasted to contribute a net positive benefit to non-participating customers through new sources of revenue or cost savings over the life of the program." [273]
- "GMP may not spend more than $5 million on new initiatives during the term of the Plan without seeking approval from the Commission. . . ."[274]
- "The Plan includes 26 new "innovation and performance metrics . . . . There will be no penalties or incentives associated with GMP's performance on these metrics during the term of the Plan. It is

---

265 Oregon Department of Environmental Quality, *Environmental Justice – State Laws and Policy* [Web page, retrieved June 2022], https://www.oregon.gov/deq/about-us/Pages/Environmental-Justice-laws.aspx.

266 Op Cit., note 251.

267 Oregon Department of Energy, *Energy Planning & Innovation Strategic Framework – 2015-19 Activities and Accomplishments*, electronic article, accessed April 2023, https://www.oregon.gov/energy/energy-oregon/Documents/2020-SF-Activities-Accomplishments.pdf.

268 Ibid., p. 1.

269 Business Oregon, *Oregon InC*, web page, accessed June 2022, https://www.oregon.gov/biz/aboutus/boards/oregoninc/Pages/default.aspx.

270 Oregon InC, *Revenue & Expense*, web page, accessed June 2022, https://data.oregon.gov/Revenue-Expense/Oregon-InC/5rri-u7xe.

271 GridForward, *About Grid Forward*, web page, accessed June 2022, https://gridforward.org/about/.

272 Vermont Public Utility Commission, *Order in Case No. 18-1633-PET*, (May 24, 2019), https://epuc.vermont.gov/?q=node/64/132296/FV-BDIssued-PTL. The provisions in this order for innovation pilot projects are very similar to the subsequent decisions reached in Connecticut (See notes 156 through 164) and Hawaii (See notes 185 through 187).

273 Ibid., p. 30, ¶66

274 Ibid., p. 30, ¶68

appropriate to gain experience with these new innovation and performance metrics before linking them to financial incentives or penalties."[275]

A commission-approved settlement between GMP and Renewable Energy Vermont sets criteria for the new initiatives and pilots, including third-party participation and extending or expanding bring-your-own-device (BYOD) pilots.[276] The settlement states:

- "GMP will provide competitive market participants with transparent and nondiscriminatory access to GMP's DER [distributed energy resources] platform, marketing, and billing services to allow customer and third-party ownership arrangements of DER products, and to facilitate efficient integration into the grid."[277]
- "[F]or any new GMP tariff or pilot program . . . GMP will provide a comparable, parallel third-party offering(s) . . . for any GMP pilot . . . program offering where feasible. This provision is . . . intended to ensure that customers have choice and that energy service providers have competitive opportunity to provide products and services deployed on the customer side of the electric energy services market."[278] s
- Third-party offerings may require interconnection and interoperability with the utility grid, and may include an option for customers to elect to pay . . . through appropriate charges on their GMP bill.[279]

L. Washington

Washington's Clean Energy Transformation Act (CETA) of 2019 commits the state to achieving an electricity supply that will be "one hundred percent carbon-neutral by 2030, and one hundred percent carbon-free by 2045."[280] Coal-fired electric generation serving Washington State customers must be eliminated by 2025. The utilities are eligible for transformation relief if electric grid reliability or safety is compromised, and subject to cost caps. The law states:

> [U]tilities in the state have an important role to play in this transition, and must be fully empowered, through regulatory tools and incentives, to achieve the goals of this policy. In combination with new technology and emerging opportunities for customers, this policy will spur transformational change in the utility industry.[281]

Washington Utilities and Transportation Commission laid out its plans for CETA implementation in an August 2019 Order in Docket No. U-190485. The UTC has several key roles in implementing CETA. In late 2020, the Washington Utilities and Transportation Commission (UTC) adopted new rules implementing CETA. The law also directs the state Department of Commerce, Department of Ecology, Department of Health, Department of Labor and Industries, Energy Facility Site Evaluation Council, and "all other state agencies" to participate in CETA planning and implementation. The law also provides for establishing a Washington State Energy Strategy Advisory Committee. The Department of Commerce delivered to Governor Jay Inslee and the state legislature a comprehensive 2021 State Energy Strategy.

---

275 Ibid., p. 32, ¶s 74, 77, 78

276 *Stipulation and Memorandum of Understanding Settlement Agreement filed by Renewable Energy Vermont,* (March 27, 2019), https://epuc.vermont.gov/?q=node/64/132296/FV-ALLOTDOX-PTL.

277 Ibid., p. 5, ¶9

278 Ibid., p. 5-6, ¶10

279 Ibid., p. 6, ¶10

280 Washington State Department of Commerce, *Clean Energy Transformation Act*, web page, accessed June 2022, https://www.commerce.wa.gov/growing-the-economy/energy/ceta/.
See also: State of Washington, *Certification of Enrollment, Engrossed Second Substitute Senate Bill 5116*, §1(2), http://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/Session%20Laws/Senate/5116-S2.SL.pdf?q=20210822161309.

281 Ibid., §1, p. 5.

Key features of the Energy Strategy include innovations in energy efficiency, electrification of transportation, grid modernization and storage, renewable energy, synthetic fuels, and research and deployment.[282] Electric utility CETA implementation plans are slated for adoption by year-end 2021.

Washington's innovations ecosystem also includes a special Governor's Office for Regulatory Innovation & Assistance that was initiated by the state legislature in 2002. That office provides a suite of services designed to help businesses navigate all kinds of local, state, and federal approvals, licenses, permits, and state rules and regulations, and invites any and all suggestions for state regulatory improvements.

Washington's Clean Tech Alliance, founded in 2007, includes over 1,100 member organizations from 10 US states and three Canadian provinces. The Cascadia Clean Tech Accelerator provides mentorship for business start-ups. And Maritime Blue is an alliance dedicated to innovation and sustainable progress in the maritime industry and services, including its own maritime innovations business accelerator programming.

Since 2013, the Washington Department of Commerce has helped fund the development, demonstration, and deployment of clean energy technologies through the Clean Energy Fund.[283]

M. Wisconsin

The Wisconsin Office of Energy Innovation (OEI), part of the Wisconsin Public Service Commission, is responsible for "promot[ing] innovative and effective energy policies and programs that benefit Wisconsin's citizens and businesses."[284] OEI coordinates with multiple state energy office programs, the University of Wisconsin, and Wisconsin's Focus on Energy program, which plans and delivers utility energy efficiency programming. OEI offers an Energy Innovation Grant Program for "energy related projects that reduce energy consumption and support renewable energy and energy storage, energy efficiency and demand response, electric and renewable natural gas (RNG) vehicles and infrastructure, or comprehensive energy planning."[285] The commission "chooses eligible activities based on its energy priorities, emerging trends, and public input."[286] An initial round of grants in 2018 was supported by federal American Recovery and Reinvestment Act (ARRA) stimulus funds. In April 2022, the PSC of Wisconsin announced $10 million in grant funding for 46 projects, in three categories: (1) renewable energy and energy storage; (2) energy efficiency and demand response; and (3) comprehensive energy planning.[287]

Table 5 summarizes and compares key characteristics of these state innovations platforms.

282 Ibid., p. 18, 67, 79, 97-98.

283 Washington Department of Commerce, *Clean Energy Fund*, web page, accessed June 2022, https://www.commerce.wa.gov/growing-the-economy/energy/clean-energy-fund/.

284 PSC of Wisconsin, *Wisconsin Office of Energy Innovation*, web page, accessed May 2022, https://psc.wi.gov/Pages/Programs/OEI.aspx.

285 PSC of Wisconsin, Office of Energy Innovation, Energy Innovation Grant Program, web page, accessed May 2022, https://psc.wi.gov/Pages/Programs/OEI/EnergyInnovationGrantProgram.aspx.

286 Ibid.

287 PSC of Wisconsin, *PSC Awards $10 Million in Energy Innovation Grants for 46 projects*, (April 15, 2022), news release, https://apps.psc.wi.gov/APPS/NewsReleases/.

Table 5: Key Features and Characteristics of State Energy Regulatory Innovations Platforms

Jurisdiction and agencies in charge	Year initiated and ending, (utility types included)	Primary participants	Primary sources for project concepts	Available funding	Regulatory flexibility
California California Energy Commission, Energy Research and Development Division	2016–present (all utilities and transportation systems, with a primary focus on electric utilities)	Open to utilities, entrepreneurs, innovators, inviting diverse participation.	CEC issues thematic calls for proposals.	Yes, from electric program investment charge (EPIC)	Determined in specific CAPUC dockets
Connecticut Public Utility Regulatory Authority (PURA)	2017–present (electric distribution companies)	Connecticut will "create opportunities for and encourage participation from the full ecosystem of potential solutions providers and innovators." An Innovation Advisory Council, composed of diverse stakeholders, will offer input and recommendations.	Electric distribution companies, innovators	Yes, from ratepayer funds, with $10 million preauthorized	Yes, derogations or limited waivers may be permitted
District of Columbia Department of Energy and Environment and DCPSC	2020–2025 PowerPath DC innovations pilots	Multi-stakeholder governing board	Commission, other D.C. government agencies, stakeholders	$21.55 million from utility merger settlement	Determined in specific DCPSC Dockets
Hawaii Hawaii PUC and Hawaii Clean Energy Initiative	2021–2025 (electric)	Utility led process, invites stakeholder participation with Commission oversight, universities, Hawaii Clean Energy Initiative stakeholder alliance	Collaborative decisions based on participant input, with PUC oversight	$10 million annually, for utility pilot projects	Not explicitly discussed in the HIPUC Order authorizing the program
Illinois Illinois Commerce Commission,	2017–present	Commission, utilities, universities, stakeholders	Utilities, grant funders	Grant funding	Determined in specific ICC dockets
Massachusetts Massachusetts Clean Energy Center	2000–present (energy and water)	Innovators, entrepreneurs	Legislature	System benefits fund	Not explicitly discussed
Minnesota E21 Initiative	2014–present (electric and natural gas)	Multi-stakeholder process, organized by NGOs	Broad stakeholder coalition plus legislative action	Ratepayer funding	Not explicitly discussed

Jurisdiction and agencies in charge	Year initiated and ending, (utility types included)	Primary participants	Primary sources for project concepts	Available funding	Regulatory flexibility
New Jersey New Jersey Board of Public Utilities	2018–present (energy)	Entrepreneurs, innovators, NJ Board of Public Utilities, NJ Economic Development Administration, other state agencies, universities	Executive orders	Green Bank, Regional Greenhouse Gas Initiative	Not explicitly discussed
New York New York State Energy Research and Development Authority	2014–present (energy)	Entrepreneurs, innovators, NYSERDA, utilities, regulators, communities	NYSERDA, regulators	Green Bank	Decisions in individual Reforming the Energy Vision proceedings
Oregon Oregon Public Utilities Commission	2017–present (electric)	Open stakeholder process to update and clarify PUC objectives and develop modern regulatory tools, market structures, and processes	Legislature, governor, State Deptartment of Energy, and electric companies, with stakeholder input	Some public-private partnership funding	State energy office provides reports to the legislature, including proposals for rule revisions and new legislation
Vermont Green Mountain Power Electric Co.	2019–present (electric)	Green Mountain Power electric utility, working with stakeholders, third-parties and bring-your-own-device pilots	Utility and stakeholders	Yes, up to $5 million for "new initiatives" without seeking PUC approval	Not explicitly mentioned
Washington Washington Utilities and Transportation Commission	2019–present (electric, natural gas)	Key state departments and "all other state agencies," electric utilities	Unclear	Yes, through state Clean Energy Fund	Not explicitly mentioned
Wisconsin Office of Energy Innovation, Public Service Commission (PSC) of Wisconsin	2016–present (municipal utilities)	MUSH <sp? facilities, tribes, municipal utilities (water, wastewater electric and natural gas), University of Wisconsin and Wisconsin Technical College campuses and facilities, public or nonprofit hospitals, and 501(c)(3) nonprofits	Office of Energy Innovation, PSC of Wisconsin, chooses eligible activities	Yes, $10 million for 2022 grants	Not explicitly mentioned

Sources: Author's construct. See the prior text descriptions for additional details and links to relevant documents.

V. Getting This Right – Challenges to Regulatory Innovations Support Platforms

This part of the report reviews existing literature and evaluation reports about regulatory innovations support platforms. In particular, potential problems and pitfalls to be avoided in designing and implementing innovations platforms are reviewed. Not all observers agree that regulatory innovations platforms can or do mitigate at least some important risks. Some researchers recommend specific provisions to avoid potential negative outcomes.

As Miles points out, novel innovations support solutions are not immune from some of the same potential hazards that are long-standing concerns for utility regulators. These include asymmetry in both information and financial incentives, and the potential for the exercise of monopoly power. In addition, Miles cites "framing," by which he means describing or illustrating choices "in a way that alters the 'natural' balance of attractiveness of each choice," and "herding," by which he means justifying an action because others are also doing it. Miles urges regulators to ensure that all product and service offerings: (a) balance utility and third-party profits with customer protection; (b) protect both new and existing, participating and nonparticipating customers; and (c) validate "good conduct" on the part of service providers through ongoing review and analysis. Miles proclaims, "One of the regulator's core purposes . . . is to give customers . . . the fairest possible deal. . . ."[288]

Buckley et al. list several additional concerns. These include:

- Do decision makers, including the regulators, regulatory staff, and utility companies, possess enough knowledge about innovations to identify worthy subjects for innovations trials?
- Is the innovations support platform a level playing field, or are too many advantages given to specific parties?
- Do the innovators understand how their innovation might fit into the existing or a changed regulatory environment?
- Are the innovators and their innovations nearly ready for commercial success, so that they are ready for a trial?
- Are the regulators' hands tied, such that they are unable to offer the required relief?
- Does the innovations support platform entail a potentially wasteful duplication of efforts? Will all the pre-existing, traditional regulatory innovations activities still be necessary? These include, for example, utility pilot programs, experimental programs, and eventually both legislative and administrative procedures, especially rulemaking, needed to define the roles and responsibilities of all parties participating in the regulated industries.[289]

Kelly warns that efforts to advance innovations, might result in a "race to the bottom, setting up. . . 'light touch' [regulation]. . . to attract start-ups." Kelly lists two major concerns. First, firms might improperly describe their participation in innovations trials, to "increase credibility with both consumers and investors," by at least hinting that their participation implies official endorsement. And second, Kelly warns that the same practices that might work well in a carefully controlled experiment with a small group of customers and limitedfunds at

288 Roger Miles, *Catching the Careless Nudists: The Behavioral Regulators' Agenda. Berkeley Research Group*, emphasis in original, (2015), https://www.academia.edu/38834762/Financial_Services_CATCHING_THE_CARELESS_NUDISTS_THE_BEHAVIOURAL_REGULATORS_AGENDA.

289 Buckley et al., *Building FinTech Ecosystems*, 9-10, 23-26.

risk, could turn into a major problem when expanded to a whole utility system.[290] Similarly, Chen notes that consumers could construe that a firm's participation in an innovation trial implies the regulators' endorsement. Or, conversely, Chen explains that consumers might hesitate to try innovations, thinking they will be insufficiently protected against abuses on the part of participating innovators and utilities.[291]

Chen raises several important questions, too, about both the innovations platforms themselves and about innovations trials. Regarding innovations platforms, Chen questions whether the platform designers will know enough to establish measures of success for the platforms themselves. Chen cautions that regulators and other participants might divert important resources to a new platform, thus hindering their efforts and possibly slowing or stalling policy changes and market engagement strategies that will prove necessary to support particular innovations.

Regarding specific innovations trials, Chen asks:

- How can anyone know enough to estimate costs and benefits and establish measures of success until after completing at least preliminary trials?
- What information must the innovators reveal before their products and services can be fully vetted and understood? Will fears of public disclosures of intellectual property prevent innovators from participating?
- Could individual trials suffer from a lack of standardization and therefore replicability, such that trials might be repeated, ad infinitum, for similar innovations or business models?

For example, Brattle researcher Ahmad Faruqui reports that public utility time-of-use rate design pilot programs have been ongoing since 1975, with US utilities completing a few hundred similar pilot projects. Faruqui states, "We do not need a single new pilot. . . . No more pilots are needed. Just do it. Everyone knows what needs to be done. Pilots are just being used to buy time and delay."[292]

Chen also notes that any temporary regulatory relief offered during innovations trials might not translate into long-term solutions that the innovations might require. That risk is particularly acute if utilities can act as gatekeepers because existing regulatory barriers or obstacles prevent innovators from offering new solutions.[293]

Another set of potential problems can occur if existing regulatory innovations platforms are not producing the necessary amount of innovation and at the speed necessary to achieve any associated industry restructuring in the relevant time frame. A primary example is global climate action, with the goal of reducing very substantially and eventually zeroing out greenhouse gas emissions. Researchers at the Columbia University Center on Global Energy Policy explain that today's energy industry "presents daunting barriers that impede the swift adoption of newer, cleaner technologies." For this reason, they conclude, "government policies shoul d bolster market demand for clean energy to encourage private investors and firms to scale up and commercialize new technologies ('demand-pull' policies)."[294]

---

290 Jemima Kelly, "A 'fintech sandbox' might sound like a harmless idea. It's not", *Financial Times Alphaville*, (2018), electronic article, accessed 5 December 2018, https://ftalphaville.ft.com/2018/12/05/1543986004000/A--fintech-sandbox--might-sound-like-a-harmless-idea--It-s-not/

291 Op Cit., note 110.

292 Ahmad Faruqui, *Moving from Pilots to Full-Scale Deployments of Time-of-Use Rates: Bridging the Chasm*, presentation to MI Power Grid: Energy Programs and Technology Pilots Stakeholder Meeting, April 16,2020, https://www.michigan.gov/mpsc/0,9535,7-395-93307_93312_93593_95590_95594_95685-508663--,00.html. See also Ahmad Faruqui, Sanem Sergici, and Long Lam, "Bridging the chasm between pilots and full-scale deployment of time-of-use rates," *Electricity Journal*, 33(10), (2020), doi: 10.1016/j.tej.2020.106857.

293 Op Cit., note 110.

294 Varun Sivaram, Matt Bowen, Noah Kaufman, and Doug Rand, T*o Bring Emissions-Slashing Technologies to Market, the United States Needs Targeted Demand-Pull Innovation*, Columbia University School of International and Public Affairs, Center on Global Energy Policy, electronic article, accessed January 20, 2021, https://www.energypolicy.columbia.edu/research/commentary/bring-emissions-slashing-technologies-market-united-states-needs-targeted-demand-pull-innovation.

A lack of expressed consumer demand-pull can present a major obstacle to regulatory innovation. Many potential innovations raise important questions about the extent to which consumers might be interested in and willing to accept changes in utility services. The more change that an innovation might engender, the more challenging it can be to understand consumer interest: The potential users of the innovations, end-use consumers, can be wholly unaware of why and how they might value available innovations. When that is the case, there can appear to be little if any demand-pull for the innovations and regulators, and incumbent businesses could misunderstand that the lack of expressed interest means there is no urgency in changing the status quo.

Market evolution and consumer preferences for new technologies might never be fully understood, but in the face of pressing needs for change in regulated industries, there is real value in doing rapid, yet careful experiments, to increase the rate of learning. A 2020 workshop project of the US National Academies of Sciences, Engineering, and Medicine (NASEM) is exploring means for enhancing federal clean energy innovation. The workshop agenda explains what NASEM calls "the imperative to accelerate energy innovation":

As today's technologies are deployed to bend the carbon emissions curve, new and improved technologies will be required to unlock additional pathways to a net-zero emissions economy by 2050. To achieve this goal, we must accelerate the current pace of innovation. To do that, we need innovation in the innovations process itself.[295]

Another potential challenge is that stranded costs can result if innovations change utility service options faster than existing assets depreciate, resulting in what economists call creative destruction.[296] The International Renewable Energy Association (IRENA) expresses that concern, cautioning that several trillion dollars of near-term investment in new fossil fuel infrastructure could be stranded as governments, corporations, institutions, and individuals take actions to reduce their greenhouse gas emissions in the coming few decades.[297]

Utility system defection is another potential risk associated with innovations in technologies and business models.[298] The possibility exists at every scale from individual devices to entire campuses and communities. At least some consumers might perceive that the costs of meeting their needs using regulated utility services exceed the benefits the utility services deliver: Consumers might believe that adequate self-supply options can provide ample benefits to warrant choices other than those offered by regulated utility companies. In such cases, consumers can engage in partial or total self-supply, thereby permanently reducing their utility purchases. That is the kind of action that could conceivably grow to a scale that could trigger a utility death spiral.[299] This concern could well be exaggerated, but "the threat of disruptive forces . . . that may compete with utility-provided services" has been raised to help convince regulators that existing barriers to customer self-supply need to be maintained or even strengthened.[300]

---

295 National Academies of Sciences, Engineering, and Medicine, *Enhancing Federal Clean Energy Innovation*, web page, accessed May 2022. https://www.nationalacademies.org/event/07-27-2020/enhancing-federal-clean-energy-innovation-a-national-academies-workshop-series.

296 Massachusetts Institute of Technology, Department of Economics, *Creative Destruction*, electronic article, no date, https://economics.mit.edu/files/1785.

297 International Renewable Energy Agency (IRENA), *Global Energy Transformation: A roadmap to 2050* (2019 Edition), https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition

298 Trevor B. Peffley and Joshua M. Pearce, "The potential for grid defection of small and medium sized enterprises using solar photovoltaic, battery and generator hybrid systems," *Renewable Energy 148* (2020): 193-204, https://doi.org/10.1016/j.renene.2019.12.039.

299 See, for example: Jimenez Castaneda, et al. "Myths and facts of the utility death spiral," *Energy Policy 110* (2017): 105-116, https://doi.org/10.1016/j.enpol.2017.07.063; Felder and Athawale, "The Life and Death of the Utility Death Spiral," *The Electricity Journal 27*(6) (2014): 9-16, https://doi.org/10.1016/j.tej.2014.06.008; and Trevor B. Peffley and Joshua M. Pearce, "The potential for grid defection of small and medium sized enterprises using solar photovoltaic, battery and generator hybrid systems," *Renewable Energy 148* (2020): 193-204, https://doi.org/10.1016/j.renene.2019.12.039.

300 Peter Kind, *Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business*, report for Edison Electric Institute, (2013): 3, http://roedel.faculty.asu.edu/PVGdocs/EEI-2013-report.pdf.

Philipsen, Stamhuis, and de Jong propose that regulators should implement and publicize guidelines for their decisions about regulatory innovations. They explain that the proposed guidelines apply to "the pre-experimental stage when deliberation takes place on whether the experiment should be facilitated and in what form." Their primary focus is on the legal basis for innovations trials, and for the regulatory agency to be able to "withstand legal attacks, should they occur."[301] Such guidelines would include publicly announcing each innovation trial, clarifying:

- the regulatory agency's legal authority to initiate and conduct the trial in the desired form;
- the eligibility criteria for and responsibilities of the participating parties;
- the goals and duration of the trial;
- risks associated with the trials, including liabilities, indemnifications, and "worst-case scenarios";
- conditions under which the trial will be considered successful and extended or expanded; and
- conditions under which the trial will be considered unsuccessful, including proposed exit strategies for the participating parties.[302]

Finally, if jurisdictions are not sufficiently amenable toward innovations, the utilities and their service territories could miss opportunities to benefit from potential economic development associated with innovations. More state legislatures and governors are directing their public utility regulatory agencies to include economic development as a consideration in regulatory decision making. That responsibility suggests that the economic development prospects associated with utility innovations will be at least one consideration among many, which could guide regulatory innovations support actions.[303]

301 Stefan Philipsen, Evert F. Stamhuis, and Martin de Jong. "Legal Enclaves as a Test Environment for Innovative Products: Toward Legally Resilient Experimentation Policies," *Regulation and Governance*, (March 2021), doi 10.1111/rego.12375.

302 Ibid., p. 10-11.

303 For example, North Carolina plans actions intended to integrate the state's Clean Energy Plan with its economic development efforts. *North Carolina Clean Energy Plan: Policy & Action Recommendations*, (October 2019): 42-43, 92, https://governor.nc.gov/documents/north-carolina-clean-energy-plan. As shown in Table 2, several state public utility regulatory commissions have responsibilities for including economic development considerations in their decision making, including Alabama, Arizona, Maryland, Missouri, Pennsylvania, Rhode Island, and West Virginia.

VI. Concluding Observations and Practical Proposals for Pathways to Progress

As this review demonstrates, many jurisdictions are already initiating efforts intended to ask and answer questions about possible innovations for their regulated public utility industries. Such efforts include considering many technologies that are in the early stages of adoption, as described in the diffusion of innovations theory initially proposed by Rogers.[304]

This situation raises these questions:

1. Do policy makers, energy utility regulators, and regulated industries need regulatory innovations platforms?
2. What additional research is needed now to help guide the process of developing and implementing successful regulatory innovations platforms?
3. Are there operational guidelines that can be applied, starting now, by developers and implementers of regulatory innovations platforms?

Answering the first question requires an assessment of the regulatory commission and its environment. The answer could depend on the presence or absence of: (a) directions from the governor or state legislature; (b) regulatory agency legal authorities, if any, allowing for flexibility and experimentation; and (c) analysis of the regulatory agency and regulated utility company strengths, weaknesses, opportunities, and threats (SWOT).[305] Related actions could also be triggered by litigation, as happens when innovators ask for determinations of their rights and responsibilities related to specific business activities or when utility customers or their representatives seek relief from existing regulations.

One threshold question is whether regulators need to obtain any legislative or executive branch permissions before undertaking innovations support actions, or whether they can do so under their preexisting legal authority. In that context, the regulatory agency needs to consider whether its staff, or staff from any other state agencies that engage in innovations support activities, are competent to lead or at least fully participate in the activities. For example, does the regulatory agency already possess, or can it readily develop, a team with sufficient expertise in innovations? Will the team be capable of identifying the potential values that innovations might provide to the utility system as a whole? Will the team be capable of assessing how ready different innovations are for early testing? Will the team have sufficient, creative problem-solving skills to be ready to explore plausible business model options, and determine quickly whether limited trials need waivers or other relief from existing rules and regulations?

As Zetzsche et al. explain, regulatory innovations platforms can function properly only "where a solid foundation of financial and technical expertise meets regulatory openness and market demand."[306] Where a regulatory agency might find some of the necessary capabilities lacking in its own staff, could there be an opportunity to partner with other agencies that do have personnel who possess the necessary innovations support acumen? Existing innovations platforms in California, Georgia, Illinois, New Jersey, New York, Oregon, Vermont, and Washington all point to opportunities for nonregulatory state agencies, state universities, and other stakeholders to take active leadership roles in the state's regulatory innovations. In that way, the regulatory agency could participate in the larger innovations ecosystem. Indeed, the regulatory agency's participation

304 Everett M. Rogers, *Diffusion of Innovations*, 5th Edition, New York: Free Press, (2003), https://www.simonandschuster.com/books/Diffusion-of-Innovations-5th-Edition/Everett-M-Rogers/9780743222099.

305 Emet Gürel, "SWOT Analysis: A Theoretical Review," *Journal of International Social Research 10*, (2017): 994-1006, doi 10.17719/jisr.2017.1832.

306 Zetzsche et al., *Regulating a Revolution*, 103.

might be required only when specific regulatory relief is required or if utility ratepayer funding is used for innovations trials.

Growing numbers of state public utility regulators are finding themselves thrust into roles as innovations screeners, gatekeepers, or facilitators. Legislatures are directing regulatory commissions to take on leading- or supporting-agency roles for climate action and in many states also for at least some specific economic development responsibilities. Triedman et al. report,

> Legislative direction may be the single most impactful factor. . . . [W]ithout policy cues, commissions face significant barriers to the regulatory innovation required by the uncharted territory of implementing a clean energy transition.[307]

And Allen points out,

> Waiting for perfect information before taking a formal regulatory position will often result in the maintenance of the regulatory status quo – an outcome that is likely to favor [incumbents] – even after there is a clear case for . . . advanc[ing] a well-delineated public interest.[308]

The examples reviewed in this paper, from the dozen states and District of Columbia, plus the 15 countries reviewed in the Appendix, demonstrate that many policy makers are striving to improve the speed and quality of decisions regarding innovations in technologies, business models, and associated changes that could be needed in regulatory provisions. Regulated industries that experienced rather moderate and incremental changes over previous decades are more recently the focus of major technological changes that could also usher in major changes in business models for both regulated and competitive market segments.

Regulators and the industries they regulate are grappling with very similar challenges, but with few exceptions the means for regulatory commissions and parties in regulatory proceedings to learn from one another and speed decision making have hardly changed at all. Prominent examples of these challenges include:

- mitigating and adapting to climate change, combined with the need to rapidly reduce and phase out ghg emissions from energy production and delivery systems;
- modernizing public utility infrastructure systems to embed more and more communications, sensors, and controls;
- balancing energy supplies and demands in systems that are using more and more sources of supply that have variable output and are not necessarily amenable to operator control;
- incorporating both thermal and electrical storage technologies in systems that previously made little use of those technologies;
- using electricity to power transportation and thermal energy systems that were previously powered by liquid or gas fuels, with greater GHG emissions;
- making our public utility infrastructures more reliable and resilient in the face of multiple natural and man-made challenges; and
- increasing equity in utility structures, improving environmental justice, and providing support for disadvantaged communities and populations.

One information gap that is seldom discussed in literature about innovation is that the potential users of innovations, the end-use consumers, are not likely to be aware of why and how they might value an innovation, if it were available to them. The more change that an innovation might produce, the more challenging it can be to understand how consumers will react. In the regulatory arena, regulators and incumbent businesses could

307 Op Cit., note 52, 15.

308 Allen, "Regulatory Sandboxes," 603-04.

misunderstand that a lack of expressed consumer interest means there is no urgency in changing the status quo. Market evolution and consumer preferences for new technologies may never be fully understood, but in the face of pressing needs for major change in regulated industries, there is real value in doing rapid, yet well designed experiments to increase the rate of learning.

Evaluation and reporting on the lessons learned from existing regulatory innovations platforms will certainly help enable broader progress in more jurisdictions. For the time being, these preliminary conclusions summarize what appear to be broadly acknowledged objectives for such platforms:

- rapid response dialogue in response innovator questions and proposed business models, including teams with increasing expertise in the realms of both technological and regulatory innovations;
- some open, competitive mechanisms to identify the best opportunities, like pitch competitions or open calls for solutions to specific thematic concerns;
- multi-party negotiations under the watchful eye of the regulator to design and rapidly implement well-designed experiments that include monitoring, opportunities for mid-course corrections, and evaluations, with an eye toward broader implementation if the early experiments prove successful; and
- accessible funding sources to support multiple innovations that are ready for testing.

What appears less than ideal is for monopoly utility providers to be making many or all decisions about technological and business model innovations on their own, without regulatory oversight and ample stakeholder participation.

Cross-Call, Gold, et al. compare utility of the future models based on the likely ratios between monopoly provided products and services versus competitively provided products and services. They propose:

> [U]tilities and their regulators should proactively consider what utility structure they seek, and then begin to align new programs and revenue sources in a manner that builds operational and business experience with those.[309]

They explain that no "single . . . decision or regulatory proceeding [will] establish the end state for the electricity market . . . with the exact form and functions of the utility predetermined." Still, they suggest, "set[ting] a vision in advance, then let[ting] decisions follow from that" is preferable. They call for "establish[ing] the general terms . . . at the beginning, and then future decisions can be evaluated against those." This, they say, is "a better approach," compared to "pick[ing] off decisions one by one and see[ing] over time where they end up."[310]

Klass and Chan explain,

> Over the long run, a more just energy system aligns the interests of many public stakeholders, high- and low-income residential customers, C&I customers, and even utilities, by creating community wealth and collective prosperity. . . . [A] financially healthier customer base that thrives through clean energy that stimulates beneficial electric load growth can also be one that provides more stable returns to the utility and its shareholders.[311]

Blackhall et al. state that the scope of needed change "should not prevent us from thinking big and experimenting with different ideas." They note the need "to encourage an iterative approach to the design,

309 Cross-Call, Gold, et al., *Reimagining the Utility*, 25.

310 Ibid., p. 25-26.

311 Alexandra B. Klass and Gabriel Chan, "Regulating for Energy Justice," New York University Law Review, (2022): 56, forthcoming, available at SSRN: https://ssrn.com/abstract=4032969.

implementation, and evaluation of new markets or incentives as the operating environment continues to evolve."[312] Blackhall et al. assert:

> [I]t is imperative to find a way to be courageous about making technical, regulatory and market reforms that allow the full value of DER to be captured and shared for the benefit of all electricity and energy consumers. . . . Such a work program will require collaboration amongst all stakeholders including the market and regulatory bodies, consumers and consumer advocates, and industry. . . . [This] . . . work must grow beyond . . . trials and seek to implement these solutions at scale.[313]

The hope is that careful attention to the many opportunities for innovations that are capable of providing multiple benefits to all participating parties will help to best manage the major industry transitions that are already underway.

312 Blackhall et al., "Optimizing the value of distributed energy resources," 4.

313 Op Cit., note 45, Blackhall et al., 2020, p. 5.

References

Allen, Hilary J. "Regulatory Sandboxes," *George Washington Law Review 87*, June 25, 2019. https://ssrn.com/abstract=3056993.

Andersen, Glen, Megan Cleveland, and Daniel Shea. *Modernizing the Electric Grid: State Role and Policy Options*. Report for National Conference of State Legislatures, 2019. https://www.ncsl.org/research/energy/modernizing-the-electric-grid-state-role-and-policy-options.aspx.

Blackhall, Lachlan, Gabrielle Kuiper, Larissa Nicholls, and Paul Scott. "Optimising the value of distributed energy resources." *Electricity Journal 33*, 9 (2020): 106838. https://doi.org/10.1016/j.tej.2020.106838. Open access link: http://users.cecs.anu.edu.au/~pscott/extras/papers/blackhall2020.pdf.

Baldwin, Sara, Ric O'Connell, and Curt Volkmann. *A Playbook for Modernizing the Distribution Grid; Volume I: Grid Modernization Goals, Principles and Plan Evaluation Checklist.* IREC and GridLab. May 2020. https://irecusa.org/publications/ and https://gridlab.org/publications/.

Behringer, Marguerite. "Equity at the Public Utility Commissions: Recent Research and Lessons." *Clean Energy Action,* 2022 (February 22, 2022). https://www.cleanenergyaction.org/blog/equity-research-2021.

Bernstein, Marver H. *Regulating Business by Independent Commission.* Princeton, New Jersey: Princeton Legacy Library. ISBN 978-0691650388.

Bird, Lori, and Tyler Clevenger. *2019 Was a Watershed Year for Clean Energy Commitments from US States and Utilities*. World Resources Institute, 2019 (December 20, 2019). https://www.wri.org/blog/2019/12/2019-was-watershed-year-clean-energy-commitments-us-states-and-utilities

Bischoff, Thore Sören, Kaja von der Leyen, Simon Winkler-Portmann, and Dierk Bauknecht. 2020. *Regulatory experimentation as a tool to generate learning processes and govern innovation – An analysis of 26 international cases.* Germany: Society for Institutional Analysis, Regulatory experimentation for the reflexive and adaptive governance of innovations (REraGI). ISBN 978-3-941627-85-7. https://reragi.wordpress.com/reragi-englisch/. Open access: https://www.researchgate.net/profile/Dierk-Bauknecht-2/publication/345950608.

Brosemer, Kathleen, et al. "The energy crises revealed by COVID: Intersections of indigeneity, inequity, and health," *Energy Research & Social Science 68* (2020). 101661. doi 10.1016/j.erss.2020.101661.

Brownfield, Eliza. "The Elements of an Innovation Ecosystem," In *Proceedings of the National Conference on Undergraduate Research*, Edmund, Oklahoma, 2018. http://libjournals.unca.edu/ncur/wp-content/uploads/2021/03/2591-Brownfield-Eliza-FINAL-m.pdf.

Buckley, Ross P., et al., *Building FinTech Ecosystems: Regulatory Sandboxes, Innovation Hubs and Beyond* (November 1, 2019). https://ssrn.com/abstract=3455872

Cappers, Peter A., and C. Anna Spurlock. *A Handbook for Designing, Implementing and Evaluating Successful Pilots,* Lawrence Berkeley National Laboratory, 2020. https://emp.lbl.gov/publications/handbook-designing-implementing-and.

Caramizaru, Auro, and Andreas Uihlein. *Energy communities: an overview of energy and social innovation.* Report for Joint Research Center (European Commission). March 2020, doi: 10.2760/180576

Carlson, Richard and Aida Nciri. *Enter the Sandbox – Developing Innovation Sandboxes for the Energy Sector.* Quality Urban Energy Systems of Tomorrow (QUEST) and Pollution Probe Foundation, 2020. https://questcanada.org/wp-content/uploads/2020/07/Innovation-Sandboxes-Report-1-EN.pdf

Carlson, Richard, Mariana Eret, Michael Lee, and Aïda Nciri. *Getting to Deployment – Bridging the Gaps in Energy Innovation in Canada.* Quality Urban Energy Systems of Tomorrow (QUEST) and Pollution Probe Foundation, 2020. https://questcanada.org/project/innovation-sandboxes-project./

Castaneda, Monica, Maritza Jimenez, et al. "Myths and facts of the utility death spiral." *Energy Policy 110* (2017): 105-116. https://doi.org/10.1016/j.enpol.2017.07.063.

Catolico, Eleanor, "As agencies seek more environmental justice data, longtime residents are skeptical." *Energy News Network,* (May 19, 2022). https://energynews.us/2022/05/19/as-agencies-seek-more-environmental-justice-data-longtime-residents-are-skeptical/.

Council of European Energy Regulators, *CEER Approach to More Dynamic Regulation,* 2021. Report No. C21-RBM-28-04. https://www.ceer.eu/documents/104400/-/-/70634abd-e526-a517-0a77-4f058ef668b9.

Chen, Christopher C. "Regulatory Sandboxes in the UK and Singapore: A Preliminary Survey." (September 6, 2019). In *Regulating FinTech in Asia: Global Context, Local Perspectives, . Edited by* Mark Fenwick, Steven Van Uytsel and Bi Ying, Forthcoming August 2020. https://ssrn.com/abstract=3448901 or http://dx.doi.org/10.2139/ssrn.3448901

Chen, Christopher C. *Regulatory Sandbox and InsurTech: A Preliminary Survey in Selected Countries* (October 10, 2018). https://ssrn.com/abstract=3275929 or http://dx.doi.org/10.2139/ssrn.3275929

Chicago Advanced Energy Task Force, *Exploring Innovation in Regulatory Sandboxes,* 2019. CAE Q1 Recap. https://goadvancedenergy.com/writing/2019/3/21/aeg-cae-q1-recap-exploring-innovation-in-regulatory-sandboxes

Connecticut Public Utilities Regulatory Authority. *PURA Establishes the Innovative Energy Solutions Program.* (March 30, 2022). Press release. https://portal.ct.gov/PURA/Press-Releases/2022/PURA-Establishes-the-Innovative-Energy-Solutions-Program.

Costello, Ken. *A Primer on R&D in the Energy Utility Sector.* National Regulatory Research Institute, May 2016 Report No. 16-05. https://pubs.naruc.org/pub/FA85BA08-D94D-E40F-B7E1-98F834372877

Cross-Call, Dan, Cara Goldenberg, and Claire Wang. *Process for Purpose: Reimagining Regulatory Approaches for Power Sector Transformation.* Rocky Mountain Institute, 2019. https://rmi.org/insight/process-for-purpose/.

Cross-Call, Dan, et al. *Navigating Utility Business Model Reform: A Practical Guide to Regulatory Design, Rocky Mountain Institute,* 2018. https://www.rmi.org/insight/navigating-utility-business-model-reform.

Cross-Call, Dan, Rachel Gold, et al. *Reimagining the Utility: Evolving the Functions and Business Model of Utilities to Achieve a Low-Carbon Grid.* Rocky Mountain Institute, 2018. https://rmi.org/insight/reimagining-the-utility.

Dreholb, Ariel, Lauren Ross, and Roxana Ayala. *How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burden across the United States.* American Council for an Energy Efficient Economy. 2020, Report No. U2006. https://www.aceee.org/research-report/u2006.

E4theFuture. *Build Back Better, Faster,* 2020. https://e4thefuture.org/wp-content/uploads/2020/07/E2E4-Build-Back-Better-Faster-Stimulus-Projection-Report-July-2020.pdf.

Edwards, Chris. "Entrepreneurs and Regulations: Removing State and Local Barriers to New Businesses," *Policy Analysis no. 916,* Washington, D.C.: Cato Institute, 2021. https://www.cato.org/sites/cato.org/files/2021-05/pa-916.pdf.

William D. Eggers, Mike Turley, and Pankaj Kishnani. "The Future of Regulation." *Deloitte Insights*, 2018. https://www2.deloitte.com/us/en/insights/industry/public-sector/future-of-regulation/regulating-emerging-technology.html.

Eisen, Joel B., and Shelley Welton. "Clean Energy Justice: Charting an Emerging Agenda," *43 Harvard Environmental Law Review,* (2019): 307. https://harvardelr.com/wp-content/uploads/sites/12/2019/08/43.2-Welton-Eisen.pdf.

European Commission. *European Innovation Scoreboard*, 2021. Web page. Accessed June 2022. https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en.

Fairbrother, Courtney, Leia Guccione, Mike Henchen, and Anthony D. Teixeira. *The Role of Pilots and Demonstrations in Reinventing the Utility Business Model,* Rocky Mountain Institute, 2017. https://rmi.org/insight/pathways-for-innovation/

Farinas, Richard, Rusty Haynes, et al. *2021 Utility Transformation Profile,* Smart Electric Power Alliance, 2021. https://sepapower.org/utility-transformation-challenge/.

Farley, Chandra, John Howat, et al. *Advancing Equity in Utility Regulation,* Lawrence Berkeley Energy Laboratory, 2021. Future Electric Utility Regulation Series. Report No. 12. https://emp.lbl.gov/projects/feur.

Felder, Frank A., and Rasika Athawale. "The Life and Death of the Utility Death Spiral." *The Electricity Journal 27*(6), (2014): 9-16. https://doi.org/10.1016/j.tej.2014.06.008.

Fox-Penner, Peter. *Power after Carbon: Building a Clean, Resilient Grid.* Cambridge: Harvard University, 2020. https://www.hup.harvard.edu/catalog.php?isbn=9780674241077.

Geels, F. W. "The multi-level perspective on sustainability transitions: Responses to seven criticisms," *Environmental Innovation and Societal Transitions,* 1(1), (2011): 24-40. https://doi.org/10.1016/j.eist.2011.02.002. Open source: https://www.research.manchester.ac.uk/portal/en/publications/the-multilevel-perspective-on-sustainability-transitions-responses-to-seven-criticisms(5cc6b61b-11cd-4469-bc75-91d4cf3c9458).html.

Gleason, Patrick, "Regulatory Sandboxes Give States an Edge Attracting Innovation and Investment" *Forbes,* (December 31, 2021). https://www.forbes.com/sites/patrickgleason/2021/12/31/regulatory-sandboxes-give-states-an-edge-attracting-innovation-and-investment/?sh=557c7de07003.

Gürel, Emet. "SWOT Analysis: A Theoretical Review," *Journal of International Social Research 10,* (August 2017): 994-1006. doi: 10.17719/jisr.2017.1832

Hanson, Dana, et al. *In an accelerated energy transition, can US utilities fast-track transformation? – Magnitude of change puts utilities under pressure to reinvent themselves.* Report by Gridwise Alliance and EY Global Services Limited, 2019. https://gridwise.org/wp-content/uploads/2019/12/Perspectives-on-a-Future-Distribution-System.pdf.

Hargreaves, T., N. Longhurst, and G. Seyfang. *Understanding Sustainability Innovations: Points of Intersection between the Multi-Level Perspective and Social Practice Theory.* 3S Working Paper 2012-03. Norwich, UK: Science, Society and Sustainability Research Group, School of Environmental Sciences, University of East Anglia, 2012. https://www.researchgate.net/profile/Tom-Hargreaves/publication/266486401.

International Energy Agency (IEA). (n.d.). *Lithuania 2021 Energy Policy Review.* https://iea.blob.core.windows.net/assets/4d014034-0f94-409d-bb8f-193e17a81d77/Lithuania_2021_Energy_Policy_Review.pdf.

IEA. *Sustainable Recovery, Special Report by International Energy Agency with International Monetary Fund,* Revised July 2020. https://www.iea.org/news/iea-offers-world-governments-a-sustainable-recovery-plan-to-boost-economic-growth-create-millions-of-jobs-and-put-emissions-into-structural-decline.

IEA. *Tracking Clean Energy Innovation: A framework for using indicators to inform policy*, 2020. https://www.iea.org/reports/tracking-clean-energy-innovation.

IEA-ISGAN. *Innovative Regulatory Approaches with Focus on Experimental Sandboxes – Casebook*, International Energy Agency, International Smart Grids Action Network, 2019. https://www.iea-isgan.org/wp-content/uploads/2019/05/ISGAN_Casebook-on-Regulatory-Sandbox-A2-1.pdf.

Impram, Semich, Secil Varbak Nese, and Bülent Oral. "Challenges of renewable energy penetration on power system flexibility: A survey." *Energy Strategy Reviews 31*, (2020) 100539, ISSN 2211-467X, https://doi.org/10.1016/j.esr.2020.100539.

International Renewable Energy Agency (IRENA), *Global Energy Transformation: A roadmap to 2050*, Abu Dhabi, 2019. https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition.

Iskandarova, Marfuga, Anne-Lorène Vernay, Jörg Musiolik, Leticia Müller, Benjamin K. Sovacool. "Tangled transitions: Exploring the emergence of local electricity exchange in France, Switzerland and Great Britain." *Technological Forecasting and Social Change* 180, (2022). 121677. ISSN 0040-1625. https://doi.org/10.1016/j.techfore.2022.121677.

Jenik, Ivo, and Kate Lauer. *Regulatory Sandboxes and Financial Inclusion.* Working Paper. Washington, D.C. Consultative Group to Assist the Poor (CGAP), a World Bank Agency, 2017. www.cgap.org.

Keppler, D. "Characterization of Innovations within the Multi-Level Perspective with Diffusion Typology of Innovations: A Fruitful Combination." *Journal of Innovation Management 7*(2), (2019): 15-37. ISSN 2183-0606. https://doi.org/10.24840/2183-0606_007.002_0003.

Kern, Florian. "Using the multi-level perspective on socio-technical transitions to assess innovation policy," *Technological Forecasting and Social Change 79*, (2), (2012): 298-310, ISSN 0040-1625, https://doi.org/10.1016/j.techfore.2011.07.004. Open access: https://www.academia.edu/1239410/Using_the_multi_level_perspective_on_socio_technical_transitions_to_assess_innovation_policy.

Kind, Peter. *Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business*, 2013. Report for Edison Electric Institute. http://roedel.faculty.asu.edu/PVGdocs/EEI-2013-report.pdf.

Klee, Robert J., and Sarah Baldinger. *Review of State Public Utility Commission Statutory Mandates*, 2021. Report by Yale Center for Business and the Environment for the Institute for Market Transformation, August 2021. https://drive.google.com/file/d/1bvQTifqgxGS5i7_CU1uj0HLPBQW5kjYV/view.

Köhler, J., et al. "An agenda for sustainability transitions research: State of the art and future directions." *Environmental Innovation and Societal Transitions 31* (2019): 1-32. ISSN 2210-4224. https://doi.org/10.1016/j.eist.2019.01.004.

Lacerda, Juliana Subtil, and Jeroen C.J.M. van den Bergh. "Effectiveness of an 'open innovation' approach in renewable energy: Empirical evidence from a survey on solar and wind power," *Renewable and Sustainable Energy Reviews*, (2020): 118. https://doi.org/10.1016/j.rser.2019.109505.

Lee, Taedong, Mark B. Glick, and Jae-Hyup Lee. "Island energy transition: Assessing Hawaii's multi-level, policy-driven approach." *Renewable and Sustainable Energy Reviews*, (2020): 118. https://doi.org/10.1016/j.rser.2019.109500.

Lawrence Berkeley National Laboratory, Electricity Markets & Policy, *Electricity Reliability and Resilience*, (n.d.). Web page., Accessed June 2022]. https://emp.lbl.gov/research/electricity-reliability.

Levy, Joaquim, Carter Brandon, and Rogerio Studart. *Designing the COVID-19 Recovery for a Safer and More Resilient World,* World Resources Institute Commentary, 2020. https://wri.org/news/designingcovid-19-recovery-safer-andmore-resilient-world.

Liang, Genevieve. (2021). "Commentary: It's time to tap potential of renewable community microgrids." *Energy News Network,* (February 2, 2021). Electronic article. https://energynews.us/2021/02/02/national/commentary-its-time-to-tap-potential-of-renewable-community-microgrids/.

Logan, Jeffrey S, Owen R. Zinaman, et al. *Next-Generation Performance-Based Regulation: Emphasizing Utility Performance to Unleash Power Sector Innovation.* National Renewable Energy Laboratory, 2017. NREL/TP-6A50-68512. doi:10.2172/1392203.

Loredo, E., et al. "Utilities: Innovation and Sustainability." *Sustainability* 11(4) (2019): 1085. https://doi.org/10.3390/su11041085.

Lott, Melissa A. "Plugged In: How One Electric Utility Promotes a Culture of Innovation." *Scientific American*, (March 2016). https://blogs.scientificamerican.com/plugged-in/avista-s-rosentrater-discusses-the-utility-s-culture-of-innovation/.

Lovell, Heather. *Understanding Energy Innovation: Learning from Smart Grid Experiments.* Singapore: Palgrave Macmillan, 2022. https://doi.org/10.1007/978-981-16-6253-9.

Maloney, Peter, "Brooklyn Microgrid Launches Campaign to Create Regulatory Sandbox." *Microgrid Knowledge. (*18 October 2019). Electronic article. https://microgridknowledge.com/brooklyn-microgrid-regulatory-sandbox/.

Markard, Jochen, and Daniel Rosenbloom. "A tale of two crises: COVID-19 and climate." *Sustainability: Science, Practice and Policy*, (16:1) (2020): 53-60, DOI: 10.1080/15487733.2020.1765679.

Maxim, Robert, and Mark Muro. *Ideas for Pennsylvania Innovation – Examining efforts by competitor states and national leaders.* Brookings Institution, Metropolitan Policy Program, 2019. https://www.brookings.edu/wp-content/uploads/2019/08/2019.08.13_BrookingsMetro_Pennsylvania-Innovation-Economy_Maxim-Muro.pdf.

McKenna, Barrie, et al. *The Post-Viral Pivot: How Canada's Tech Startups Can Drive the Recovery from Covid-19.* Innovation Economy Council, 2020. https://oce-ontario.org/docs/default-source/default-document-library/iec-report-april-2020-final.pdf?sfvrsn=2.

Michigan Public Service Commission Staff. *Utility Pilot Best Practices and Future Pilot Areas,* Report for MI Power Grid: Energy Programs and Technology Pilots Workgroup, September 2020. https://www.michigan.gov/mpsc/0,9535,7-395-93307_93312_93593_95590_95594_95685-508663--,00.html.

Naden, Clare, *Inspiring Successful Innovation with New International Standard.*International Standards Organization, (February 19, 2020). ISO 56000 Family. Electronic article. https://www.iso.org/news/ref2481.html.

National Academies of Sciences, Engineering, and Medicine. *Accelerating Decarbonization of the US Energy System.* Washington, D.C.: The National Academies Press, 2021. https://doi.org/10.17226/25932.

National Academies of Sciences, Engineering, and Medicine. *Enhancing Federal Clean Energy Innovation: Proceedings of a Workshop.* Washington, D.C.: The National Academies Press, 2021. https://doi.org/10.17226/25973.

National Academies of Sciences, Engineering, and Medicin. *The Future of Electric Power in the United States.* Washington, D.C.: The National Academies Press, 2021. https://doi.org/10.17226/25968.

National Academies of Sciences, Engineering, and Medicine. *Adapting to the 21st Century Innovation Environment: Proceedings of a Workshop – in Brief.* Washington, D.C.: The National Academies Press, 2019. https://doi.org/10.17226/25384.

National Academies of Sciences, Engineering, and Medicine. *Deploying Sustainable Energy During Transitions: Implications of Recovery, Renewal, and Rebuilding: Proceedings of a Workshop – in Brief.* Washington, D.C.: The National Academies Press, 2018. https://doi.org/10.17226/25175.

National Academies of Sciences, Engineering, and Medicine. *The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies.* Washington, D.C.: The National Academies Press, 2016. https://doi.org/10.17226/21712.

Peffley, Trevor B., and Joshua M. Pearce. "The potential for grid defection of small and medium sized enterprises using solar photovoltaic, battery and generator hybrid systems." *Renewable Energy 148* (2020): 193-204. https://doi.org/10.1016/j.renene.2019.12.039.

Philipsen, Stefan, Evert F. Stamhuis, and Martin de Jong. "Legal Enclaves as a Test Environment for Innovative Products: Toward Legally Resilient Experimentation Policies." *Regulation and Governance*, (March 2021). doi 10.1111/rego.12375.

Public Utilities Commission of Ohio. *PowerForward: A Roadmap to Ohio's Electricity Future.* 2018. https://puco.ohio.gov/utilities/electricity/resources/ohio-grid-modernization.

Rohracher, Harald. "Analyzing the Socio-Technical Transformation of Energy Systems: The Concept of 'Sustainability Transitions.'" Chapter 18 in *Oxford Handbook of Energy and Society*, 2018. Edited by Davidson, Debra J., and Matthias Gross. doi: 10.1093/oxfordhb/9780190633851.013.3.

Ross, Katie, Dan McDougall, and Mario Finch. *Responding to the Economic Crisis to Build Back Better—Short-Lived Climate Pollutants and the Economic Recovery*. World Resources Institute and Climate & Clean Air Coalition, 2021. https://www.wri.org/publication/short-lived-climate-pollutants-and-economic-recovery.

Saha, Devashree. "Resilience after Recession: 4 Ways to Reboot the US Economy." *World Resources Institute*, (March 31, 2020). Electronic article. https://www.wri.org/blog/2020/03/coronavirus-rebooting-US-economy.

Sanandaji, Nima, Saeid Esmaeilzadeh, and Mouna Esmaeilzadeh. "Nordic Lesson: Peripheral Regions Play a Key Role in Innovation." *NewGeography*, (January 10, 2022). Electronic article. https://www.newgeography.com/content/007307-nordic-lesson-peripheral-regions-play-a-key-role-innovation.

Sanchez, Laura, "Collaboration sparks innovation: Three landmark projects explore the future of power provision." *Homer Microgrid News*, (December 10, 2019). Electronic article. https://microgridnews.com/alabama-power-smart-neighborhood-microgrids/.

Sappington, David E.M., and Dennis L. Weisman. "Designing performance-based regulation to enhance industry performance and consumer welfare." *Electricity Journal 34*(2), (2021). 106902. ISSN 1040-6190. https://doi.org/10.1016/j.tej.2020.106902.

Schittekatte, Tim. *Regulatory sandboxes in the energy sector – the what, the who and the how*. European University Institute, Florence School of Regulation, (April 21, 2020). Electronic article. https://fsr.eui.eu/regulatory-sandboxes-in-the-energy-sector-the-what-the-who-and-the-how/.

Schittekatte,Tim, Leonardo Meeus, et al. "Regulatory Experimentation in Energy: Three Pioneer Countries and Lessons for the Green Transition." *Energy Regulation in the Green Transition,* Volume 1, (2021): 74-84 (Chapter 6). Edited by Olsen, Brigette Egelund, Henrik Lund, et al. Danish Utility Regulator, https://backend.orbit.dtu.dk/ws/portalfiles/portal/242355268/2021_DMS_danish_utility_regulators_anthology_project_series_on_better_regulation_in_the_energy_sector_vol_1.pdf#page=75.

Shafran, Ben, Hattie Slater, and Attila Hajos. *Dynamic NRAs to Boost Innovation: Report on Dynamic Regulation from the National Regulatory Authorities' Perspective. Report for Council of European Energy Regulators (CEER)* from Cambridge Economic Research Associates (CERA), May 2022. No. C22-RBM-37-04. https://www.ceer.eu/2210.

Sheahan, Brien J. "Now is the time for regulatory sandboxes in energy and utilities" *Utility Dive*, (October 22, 2021). Electronic article. https://www.utilitydive.com/news/now-is-the-time-for-regulatory-sandboxes-in-energy-and-utilities/608728/.

Sheahan, Brien, and Jimmy Zhang. "Experiment without Penalty: Can 'regulatory sandboxes' foster utility innovation?" *Smart Cities Dive*, (21 March 2019). Electronic article. *https://www.smartcitiesdive.com/news/experiment-without-penalty-can-regulatory-sandboxes-foster-utility-innov/551012/.*

Simchak, Tom, Dan Lauf, Patricio Portillo and Sue Gander. *Governors Staying Ahead of the Energy Innovation Curve: A Policy Roadmap for States.* National Governors Association, 2018. https://www.nga.org/wp-content/uploads/2018/08/Energy-Innovation-Roadmap-August-2018.pdf.

Sivaram, Varun, Matt Bowen, Noah Kaufman, and Doug Rand. *To Bring Emissions-Slashing Technologies to Market, the United States Needs Targeted Demand-Pull Innovation Policies.* Columbia University School of International and Public Affairs, Center on Global Energy Policy, (January 20, 2021). Electronic article. https://www.energypolicy.columbia.edu/research/commentary/bring-emissions-slashing-technologies-market-united-states-needs-targeted-demand-pull-innovation.

Smith, Adrian, Jan-Peter Voß, and John Grin. "Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges." *Research Policy 39*, (4) (2010): 435-448. ISSN 0048-7333. https://doi.org/10.1016/j.respol.2010.01.023. Open access: https://www.researchgate.net/profile/John-Grin/publication/241883344.

Stone, Daniel F. "Clarifying (Opportunity) Costs." *The American Economist 60*(1) (2015): 20-25. doi: 10.1177/056943451506000103.

Soutar, Iain. "Dancing with complexity: Making sense of decarbonisation, decentralisation, digitalisation and democratisation," *Energy Research & Social Science 80*, 2021. ISSN 2214-6296. https://doi.org/10.1016/j.erss.2021.102230. Open access: https://www.researchgate.net/publication/353913111_Dancing_with_complexity_Making_sense_of_decarbonisation_decentralisation_digitalisation_and_democratisation.

Taeihagh, Araz, M. Ramesh, and Michael Howlett. "Assessing the Regulatory Challenges of Emerging Disruptive Technologies." *Regulation and Governance*, (March 2021). doi:10.1111/rego.12392.

Triedman, Cole, Eve Lukens-Day, Amanda Hinh, and Noah Ball-Burack. *Can State Utility Commissions Lead in the Clean Energy Transition? Lessons from Six States.* Brown University Climate and Development Lab, 2021. http://www.climatedevlab.brown.edu/policy-briefings.html.

Tsai, Chang-hsien, et al. "The Diffusion of the Sandbox Approach to Disruptive Innovation and Its Limitations." *Cornell International Law Journal* 53(2), (2021). https://cornellilj.org/wp-content/uploads/2021/10/Tsai-et-al.-final.pdf.

UCLA Luskin Center for Innovation. *Progress toward 100% Clean Energy in Cities & States across the U.S.*, 2019. https://innovation.luskin.ucla.edu/publications/?_sft_category=energy-publications

UK Office of Gas and Electricity Markets (OFGEM). *Innovation Link*. (n.d.). Web pages. https://www.ofgem.gov.uk/about-us/how-we-engage/innovation-link and https://www.ofgem.gov.uk/publications-and-updates/innovation-link-case-studies

US EPA, *Water Technology and Innovation*. (n.d.). Web page. Accessed June 2022. https://www.epa.gov/water-innovation-tech.

US Department of Energy, Grid Modernization Initiative. *Grid Modernization Updated GMI Strategy 2020*. 2020. https://www.energy.gov/sites/prod/files/2021/02/f82/GMI_Strategy_FINAL%20as%20of%201.20.21.pdf.

Van der Waal, Esther C., et al. "Participatory Experimentation with Energy Law: Digging in a 'Regulatory Sandbox' for Local Energy Initiatives in the Netherlands." *Energies 2020*, 13(2): 458. https://doi.org/10.3390/en13020458.

Vié, Philippe, *Partner ecosystem model transforming the utilities industry.* CapGemini, (September 11, 2019). Electronic article. https://www.capgemini.com/2019/09/partner-ecosystem-model-transforming-the-utilities-industry/#.

Walrave, Bob, et al. "A multi-level perspective on innovation ecosystems for path-breaking innovation." *Technological Forecasting and Social Change* 136 (2018): 103-113. https://doi.org/10.1016/j.techfore.2017.04.011. Open source: https://www.researchgate.net/publication/316240226.

Walters, Daniel, Cary Coglianese, and Gabriel Scheffler. "Unrules." *Stanford Law Review 73* (2021): 885. https://elibrary.law.psu.edu/fac_works/427/.

Wang, Fei. "What's it like to be a strategic innovation professional at a utility?" *GreenTechMedia*, February 19, 2020. Electronic article. https://www.greentechmedia.com/articles/read/whats-it-like-to-be-a-strategic-innovation-professional-at-a-utility.

Weber, K. Matthias, and Harald Rohracher. "Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework." *Research Policy 41*(6), (2012): 1037-1047. ISSN 0048-7333. https://doi.org/10.1016/j.respol.2011.10.015.

Weisman, Dennis. *A Report on the Theory and Practice of Performance-Based Regulation* (2018). https://ssrn.com/abstract=3765691.

Whitacre, Jay F., Morgan Bazillian, Anna J. Siefken, and Michael M. Whiston. "Current status of university-based energy institutes in the United States and a pathway to forming a national organization." *iScience 25*(4), (2022). 105151. https://doi.org/10.1016/j.isci.2022.104151.

Wood, Elisa. "Microgrid Policy: How Should the Industry Proceed in Light of Covid-19?" *Microgrid Knowledge*, (June 2, 2020). Electronic article. https://microgridknowledge.com/microgrid-policy-virtual-conference/.

Woolf, Tim, and Ben Havumaki. *The Role of Innovation in the Electric Utility Sector, for National Association of State Utility Consumer Advocates.* Lawrence Berkeley National Laboratory, Future Electric Utility Regulation Report, Chapter 1, (2022): 10-19. https://emp.lbl.gov/publications/role-innovation-electric-utility.

Zetzsche, Dirk A., et al. "Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation." *Fordham Journal of Corporate and Financial Law 31* (2018): 23. https://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?article=1450&context=jcfl.

Zitelman, Kiera, and Jasmine McAdams. *The Role of State Utility Regulators in a Just and Reasonable Energy Transition – Examining Regulatory Approaches to the Economic Impacts of Coal Retirements.* National Association of Regulatory Utility Commissioners, 2021. https://pubs.naruc.org/pub/952CF0F2-1866-DAAC-99FB-0C6352BF7CB0.

Appendix – Energy Public Utility Regulatory Innovations Platforms in Other Countries

Table A-1: Key Features and Characteristics of Countries' Existing Energy Regulatory Innovations Platforms

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
Australia – *Australian Energy Regulator (AER and* Australian Energy Market Commission (AEMC) Australian Energy Market Operator (AEMO), Australian Renewable Energy Agency (ARENA), and Energy Consumers Australia (ECA)	Recommended in 2019. Enabling legislation is drafted.[1] (electric and natural gas)	Still under development[1]	Still under development[1]	No, but funding could be available through other sources	High. Plans call for "broad power" for regulatory waivers and temporary or limited trial rules
	Innovation targets: New technological solutions, products, services, new tariff models, new business models, new regulations, about smart electricity grid, integrated approaches and sector coupling,[2] energy storage, flexibility services for grid stability, and behind the meter. Objective is to encourage innovation that has the potential to contribute to the long-term interests of consumers.				
	Projects initiated: None resulting from proposed innovation platform in time for 2019 ISGAN report.				
Austria – Energie.Frei. Raum (Energy free space) The legal basis for regulatory experimenting is approved in the 2021 Renewable Energy Expansion Act (Erneuerbaren-Ausbau-Gesetz, "EAG")	2019–2025 (electric and natural gas)	**Lead organization:** Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) **Key stakeholder:** E-Control (Austrian energy regulator). Program implementation by Austrian Research Promotion Agency (FFG)	Not yet clear	Yes, five million, up to 2025, with FFG co-funding 20 to 50 percent of project costs	Medium. Provided in EAG Act of 2021. E-Control can grant to projects temporary exemptions and deviations from grid fees.
	Innovation targets: New technological solutions, products, services, new tariff models, new business models, for smart grids, energy storage, Flexibility services for grid stability, integrated and flexible energy systems and sector coupling, and renewable energy systems integration				
	Projects initiated: 2019 preliminary research on stakeholder engagement, needs analysis, and identification of regulatory barriers				

See sources and notes at the end of the table.

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
Belgium – Regulatory experimenting programs, #1 and #2 *Brussels regulatory authority (Brugel) and Flemish independent energy market regulator (VREG)* Implementation led by a consortium of Belgium T&D system operators with support from Co.Station, an innovator and entrepreneur service company	2018 decision, 2019 launch (electric only)	The project is led by T&D system operators. Open workshops were used to determine seven use cases, for testing to be completed by selected project participants.	Consumers	Unclear	Medium. Legislation identifies innovations for connecting decentralized generation to the distribution system. Brugel states it can allow derogations for other rules.
	Innovation targets: New technological solutions, products, and services, new tariff-models, and new business models, particularly aimed at solutions to connect decentralized production to distribution networks				
	Projects initiated: 2019 "Low-Regulation Zone" approved for City of Genk and EnergyVille: Thor Science and Technology Park (by VREG); 2020 community solar project installation on a school; and, 2021 community solar project on a green business incubator facility (by Brugel)				
Canada (Ontario) – OEB Innovation Sandbox *Ontario Energy Bureau (OEB)* Independent Electricity System Operator (IESO), Grid Innovation Fund, Natural Resources Canada, Innovators	2019 to present (electric and natural gas)	OEB, innovators, regulated utilities, and unregulated businesses	Innovators	No direct funding from OEB Independent Electricity System Operator (IESO) Grid Innovation Fund	Low. No flexibility as yet in OEB regulations
	Innovation targets: any new ideas, products, services, and business models in the electricity and natural gas sectors, not widely in use in Ontario, that have the potential to provide value to energy consumers				
	Projects initiated: OEB reports there have been 50 "engagements" with innovators from 2019 to the present, including customized regulatory guidance for specific projects. A utility-sponsored behind-the-meter EV charging program trial, slated for 2021-23, will test time varying access charges and off-peak charging, with funding through the IESO Grid Innovation Fund and Natural Resources Canada's EV Infrastructure Demonstration Program. OEB opened in June 2021 a consultation about proposed program "renewal" ideas for its innovations platform.				

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
Denmark – program name *Danish utility regulator and Danish Energy Agency*	2020 to present (electric only)	Danish utility regulator and Danish Energy Agency, entrepreneurs and innovators, energy agency R&D programming	Energy agency R&D programming. Entrepreneurs and innovators.	Yes, through energy agency R&D programs.	High – time-limited exemptions can be granted from specific rules for trials of new business models, new technology, and new solutions.
	Innovation targets: New technological solutions, products, services, tariff models, business models, and regulations. "Regulatory Test Zones" projects, for smart electricity grid, energy storage, digitalization, vehicle-to-grid, DC power grids, flexibility services and behind-the-meter services for grid stability, and energy islands. Program is intended to support research that leads to 100 percent renewable energy in the national grid in market terms, and 70 percent reduction of national CO_2 emissions.				
	Projects initiated: In the first application window, from June 15 through September 15, 2020, 42 applications were submitted. Twenty of those were eligible under the jurisdiction of the regulator (two of them), the ministry (ten), or both regulator and minister (eight). Trials are testing: (1) new market rules for storage; (2) an innovative network tariff to develop local flexibility; and, (3) a legal framework for injecting synthetic gases into natural gas networks. A second application window opened from September 15 to December 31, 2021.				
France – program name *Commission de Régulation de l'Énergie (CRE, the energy regulator); "Ministère de la transition écologique, (Ministry for Ecological Transition); and higher education institutions and public- and government-funded research organizations*	2019 to present. (electric and natural gas)	CRE and Ministry for Ecological Transition. When necessary, TSO and DSO, and organizing authorities for energy distribution are included	Innovators, energy utilities, auto manufacturers, energy suppliers, start-ups, and law firms	Announced in June 2021	High – exemptions may be granted, up to 4 years, from conditions of access to and use of networks and facilities
	Innovation targets: electric storage, electric vehicles, smart metering, injection of synthetic gases, smart connection rules for renewable energy sources. For regulatory exemptions, projects must: (1) contribute to achieving French energy policy; (2) present an innovative dimension; (3) clearly face identified legislative or regulatory obstacles; (4) present potential for widescale deployment if successful in trial; and, (5) benefit the community if the solution is ultimately deployed				
	Projects initiated: OEB reports there have been 50 "engagements" with innovators from 2019 to the present, including customized regulatory guidance for specific projects. A utility sponsored behind-the-meter EV charging program trial, slated for 2021-23, will test time varying access charges and off-peak charging, with funding through the IESO Grid Innovation Fund and Natural Resources Canada's EV Infrastructure Demonstration Program. OEB opened in June 2021 a consultation about proposed program "renewal" ideas for its innovations platform.				

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
Germany – Smart Energy Showcases – Digital Agenda for the Energy Transition (SINTEG) *German Federal Ministry for Economic Affairs and Energy* German Federal Networks Agency, and partners or subcontractors of five SINTEG projects	2013–present. (electric and natural gas)	Broad stakeholder process involving 80 groups, including state ministries, grid operators, energy retailers, smart home companies, law firms, researchers working on regulatory impact assessment and the regional regulators	Regional innovation zones, selected through competitive solicitations	Ministry for Economic Affairs and Energy is providing up to €230 million to five model SINTEG regions, leveraging an additional €500 million in private sector funding.	High. Including "regulatory leeway . . . lean regulation . . . [and] regulatory discovery . . . for future legislation"
	Innovation targets: New technological solutions, products, services, new business models, for smart electricity grid, integrated approaches /sector coupling, energy storage, and flexibility services for grid stability				
	Projects initiated: Five regulatory innovation zones focusing on: smart grid and market data; new business models; building energy efficiency; optimized flexible grid resources and non-wire and non-pipe solutions; renewable energy integration including solar, wind, and green hydrogen.				
Israel *Israel Public Utility Authority for Electricity (PUA)*	2020 to present (electric only)	Innovators, Ministry of Energy, PUA, utilities	PUA request for proposals		Low. Waiver approvals are needed from the Ministry of Energy and the utility, on a case-by-case basis
	Innovation targets: New technological solutions, products, services, and pathways for new and updated regulations. Smart electricity grid, energy storage and behind-the-meter storage, flexibility services for grid stability, and integrated approaches/ sector coupling				
	Projects initiated: No projects or waivers have yet been granted. Deadline for first-round applications was December 26, 2021.				

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
Italy *Regulatory Authority for Energy Networks and the Environment (ARERA)* Ricerca sul Sistema Energetico (RSE, a general-interest energy sector research institute); and Gestore dei Servizi Energetici (GSE, the state agency for renewables incentives)	2010 to present	ARERA, RSE, GSE, TERNA (the Italian TSO), balancing services parties (BSPs), and balancing responsible parties (BRPs), innovators, energy communities, and an open "focus group on EV charging"		Via existing or experimentally adjusted utility tariffs	High. Regulatory exemptions can be expanded quickly for pre-identified innovations, to enable competition among service providers.
	Innovation targets: New tariff models, new business models, new regulations, extending the ancillary services market, group self-consumption using the existing public distribution grid, facilitating smart EV charging at home, and exploiting smart-meter capabilities.				
	Projects initiated: Five regulatory innovation zones focusing on: smart grid and market data; new business models; building energy efficiency; optimized flexible grid resources and non-wire and non-pipe solutions; renewable energy integration, including solar, wind, and green hydrogen.				
Lithuania National Energy Regulatory Council (Valstybinė energetikos reguliavimo taryba, VERT)	2010–2019 (electric and natural gas)	T&D operators and ARERA. For system-level innovations, ARERA makes temporary regulatory changes and then invites competitive bids for projects, which ARERA evaluates.	Both regulators and innovators, plus a national research institute funded via system benefits charge	Partial project reimbursement; €172 million to date.	High.
	Innovation targets:				
	Projects initiated:				

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
Netherlands – EDSEP (Experiments Electricity Act) *Authority for Consumers and Markets (ACM, energy regulator)* Ministry of Energy; and, Ministry of Economy and Innovation (Ministry EZK and RVO.nl)	2015-2018 (energy utilities) Program proposed for discontinuation after 2020	Educational institutions, energy businesses, energy innovators, energy innovation testing is "available for all companies, public entities and privately owned players" (IEA, p. 94), project developers and housing corporations, Ministry of Economic Affairs and Climate change, RVO, regulatory body ACM, DSO's, (energy tax authorities), supporting service providers (administration/access to energy markets/ consultants and business developers	Limited to initial legislation, which set the scope for experiments for community-based distributed energy solutions National target for testing 300 innovative energy products and business solutions by 2030	Modernization and Innovation Fund (2020-40, €900 million); European Innovation Fund (2020-30, €1 billion); plus 20 percent project funding via Public Procurement Funds	Medium. Regulatory exemptions were decided by legislation, to apply to certain project types for 2015–2018.
	Innovation targets: Neighborhood and community scale distributed energy solutions, and a national target to test 300 energy products and business solutions by 2030, including battery, chemical, and thermal energy storage; biomass energy conversion; combined heat and power; electric vehicles and smart-charging capabilities; energy management systems, combined with consumer education, demand control, and time varying rates; grid-interactive appliances; microgrids; net-zero buildings; peer-to-peer energy exchange; neighborhood and community scale solar PV and wind energy; solar thermal energy for space and water heating; thermal energy distribution networks for space and water heating				
	Projects initiated: Distributed energy projects in housing cooperatives and associations				
Norway – program name *Norwegian Energy Regulatory Authority (NVE-RME)*	2019 to present (electric only)	Local initiatives (homeowner associations or cooperatives)	Predetermined by regulators	Public funds for R&D from NVE-RME	Medium. Waivers for specific rules Δ85 pre-determined
	Innovation targets: New technological solutions, products, services, new tariff-models, new business models, and new regulations, for smart electricity grid, Integrated approaches/sector coupling, energy storage, flexibility services for grid stability, and behind the meter.				
	Projects initiated: Ten exemptions granted as of September 2021				

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
Singapore – Regulatory Sandbox for Energy Sector Innovations *Energy Market (Regulatory) Authority (EMA)*	2017 to present. Version 2.0 introduced in 2019 (electric and natural gas)		Both open requests and thematic topics assigned by EMA	Funding may be available through EMA R&D grants	Medium – EMA may "relax" legal and regulatory requirements from Codes of Practice under the Electricity and Gas Acts, Electricity Market Rules, and Conditions for Electricity and Gas Licensee.
	Innovation targets: Thematic topics listed by EMA include: (1) distributed backup measures for localized reliability; for customers with self-generation, (2) billing and settlement issues, and (3) reducing required grid capacity; (4) facilitating vehicle-to-grid (V2G) uptake; and (5) consumer load management to enable fast-start conditions. R&D projects listed include: (1) Jurong Island renewable and low-carbon energy development; (2) net-zero start-up challenge for local energy companies; and (3) energy efficiency for electric-generating companies, improving heat rates, energy efficiency, and reducing carbon emissions. Any of those areas are open for innovators to apply for relaxing legal and regulatory requirements.				
	Projects initiated: Residential energy storage for peak load reduction				
Sweden – Regulatory Experimenting and Greenhouses Program *Swedish Energy Markets Inspectorate (SEMI)*	A SEMI project slated for completion in 2023 is exploring implementing a regulatory greenhouse approach in Sweden.[3]	Innovators and regulators, with regulators posing thematic questions for applicants to address	Both innovators and regulators	No, but separate R&D grants are available to companies and research institutes	To be determined
	Innovation targets: New technological solutions, products, services or methodologies; new tariff models; and new business models. Market-led innovations where existing regulation might prevent a proposition that is beneficial to consumers.				
	Projects initiated: None yet.				

Jurisdiction – program *Agencies in charge, if known* Other key participants	Year initiated and ending year, if known (utility types included)	Primary participants	Main sources of project concepts	Innovations project funding?	Regulatory flexibility (high, medium, or low)
United Kingdom – Innovation Link *Office of Gas and Electricity Markets (OFGEM), energy regulator.* UK industry code bodies – Elexon (Balancing and Settlement Code), Electralink (Distribution Connection and Use of System Agreement)	2016 launch, revised service launch in 2020 (electric and natural gas)	Innovators, either already licensed or working for a license holder, and intending to operate in the regulated energy market	Market-led innovations, from both innovators and regulators	No, but outside funding can be applied	High. Waivers can be considered for several pre-identified energy system rules.
	Innovation targets: Thematic topics listed by EMA include: (1) distributed backup measures for localized reliability; for customers with self-generation, (2) billing and settlement issues, and (3) reducing required grid capacity; (4) facilitating vehicle-to-grid (V2G) uptake; and, (5) consumer load management to enable fast-start conditions. R&D projects listed include: (1) Jurong Island renewable and low-carbon energy development; (2) net-zero start-up challenge for local energy companies; and (3) energy efficiency for electric-generating companies, improving heat rates, energy efficiency, and reducing carbon emissions. Any of those areas are open for innovators to apply for relaxing legal and regulatory requirements.				
	Projects initiated: Behind the meter services, innovative tariffs, peer-to-peer and local electricity trading trials				

Sources: Author's construct based on: Richard Carlson and Aida Nciri, *Enter the Sandbox – Developing Innovation Sandboxes for the Energy Sector,* Quality Urban Energy Systems of Tomorrow (QUEST) and Pollution Probe Foundation, (2020), https://questcanada.org/project/innovation-sandboxes-project/; Council of European Energy Regulators, *CEER Approach to More Dynamic Regulation*, (2021), Report No. C21-RBM-28-04, https://www.ceer.eu/documents/104400/-/-/70634abd-e526-a517-0a77-4f058ef668b9; IEA-ISGAN, *Smart Grid Case Studies – Innovative Regulatory Approaches with Focus on Experimental Sandboxes 2.0: Casebook*, International Energy Agency, International Smart Grids Action Network, (2021), https://www.iea-isgan.org/publications/; IEA-ISGAN, *Casebook on Innovative Regulatory Approaches with Focus on Experimental Sandboxes*, International Energy Agency, International Smart Grids Action Network, (2019), https://www.iea-isgan.org/publications/; IEA, *Lithuania 2021 Energy Policy Review*, https://iea.blob.core.windows.net/assets/4d014034-0f94-409d-bb8f-193e17a81d77/Lithuania_2021_Energy_Policy_Review.pdf.

Notes:

1 Australian Government, Department of Industry, Science, Energy and Resources, *Regulatory Sandboxing Legislation Consultation*, (September 2020), web page, accessed June 2022, https://www.energy.gov.au/government-priorities/energy-ministers/energy-ministers-publications/regulatory-sandboxing-legislation-consultation.

2 The term "sector coupling" is used in ISGAN reports to describe innovations that affect both natural gas and electric utilities. Examples might include using electricity to generate hydrogen as a partial replacement for natural gas (personal communications with Klaus Kubeczko, Austrian Institute of Energy, January 2022).

3 Sweden calls its approach "regulatory greenhouse," which connotes an experimental environment that is both transparent and nurturing. See Swedish Committee for Technological Innovation and Ethics (KOMET), 2021, *Testing—A working method for quicker learning*, Komet information 2020:33E, https://www.kometinfo.se/wp-content/uploads/2021/02/Testing_a_working_method_for_quicker_learning_2020_33_E-1.pdf.

NARUC
National Association of Regulatory Utility Commissioners

1101 Vermont Ave, NW • Suite 200 • Washington, DC 20005
www.naruc.org • (202) 898-2200