



BERKELEY LAB

**Regulatory Sandboxes and Other Processes to Expedite
Utility Adoption of Advanced Grid Technologies: Literature Review**

For U.S. Department of Energy's Office of Electricity

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Introduction

This document presents findings from Berkeley Lab's review of literature related to regulatory sandboxes and other approaches to expedite utility adoption of advanced grid technologies in the United States and abroad. The document first presents an analysis of key findings and best practices gleaned from the literature, including both benefits and risks of regulatory sandboxes and related approaches as well as programmatic and design elements of innovation vehicles. Next, the document presents challenges, research gaps and questions raised.

The document then includes a summary of resources we reviewed and high level-takeaways, grouped into three high-level themes:

1. **Utility Innovation and Technology:** This section covers literature related to utility pilot programs, scaling technology deployment, supporting a culture of innovation at utilities, and alternative mechanisms (other than sandboxes) for promoting innovation and includes case studies on particular innovative technologies.
2. **Utility Regulatory Sandboxes:** This section captures findings from research specifically on regulatory sandboxes in the utility industry.
3. **Lessons from Regulatory Sandboxes in Other Sectors:** This section covers literature on regulatory sandboxes deployed in non-energy sectors, largely from the Financial Technology (FinTech) sector, where regulatory sandboxes appear to be used more prominently.

The literature review does not include utility regulatory proceedings, which Berkeley Lab reviewed separately.



Table of Contents

Regulatory Sandboxes and Other Processes to Expedite Utility Adoption of Advanced Grid Technologies: Literature Review	1
Introduction.....	1
Benefits and Risks of Regulatory Sandboxes	1
Key Takeaways, Best Practices, and Lessons Learned	4
Gaps and Areas for More Research	10
Source-Specific Summaries	11
Utility Innovation and Technology.....	11
Pathways to Commercial Liftoff: Innovative Grid Deployment	11
A Blueprint to Pilot Design: Best Practices and Lessons Learned	11
Pathways for Innovation: The Role of Pilots and Demonstrations in Reinventing the Utility Business Model..	11
A Handbook for Designing, Implementing, and Evaluating Successful Electric Utility Pilots	12
Utility Pilot Best Practices and Future Pilot Areas	12
Research and Development by Public Utilities: Should More be Done?	12
A Roadmap for Advanced Transmission Technology Adoption	12
Case Studies on Agile Regulatory Governance to Harness Innovation: Civilian Drones and Bio-Solutions	13
Regulatory Experimentation: Moving Ahead on the Agile Regulatory Governance Agenda.....	13
The Electricity Governance Toolkit	13
Utility Regulatory Sandboxes	14
Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid	14
Regulatory sandboxes: Do they speed up innovation in energy?	14
Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition	14
Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland	14
Energy Regulatory Sandbox: Guidance for Innovators	15
Regulatory Sandboxes in the Energy Sector	15
Innovative Regulatory Approaches with Focus on Experimental Sandboxes: Casebook.....	15
Lessons from Regulatory Sandboxes in Other (non-energy) Sectors.....	16
How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers.....	16
Global Experiences from Regulatory Sandboxes	16
Key Data from Regulatory Sandboxes Across the Globe.....	16
Making Space for Innovation: The Handbook for Regulatory Sandboxes.....	16
Additional Resources	17

Benefits and Risks of Regulatory Sandboxes

The literature indicates that regulatory sandboxes are a good tool to advance regulatory objectives such as **advancing innovation, improving information collection and knowledge sharing, improving economic outcomes, improving grid reliability and resilience, better meeting customer needs, and increasing access to technologies**. However, regulatory sandboxes are just one tool that regulators can deploy to meet these objectives and, in some cases, other innovation approaches (e.g. traditional pilots, innovation hubs, regulatory change, wait-and-see, etc.) may be more appropriate. In addition, regulatory sandboxes pose some risks, including **possible market distortions, negative impacts to customers, the grid, or society, and undue investment of time and resources in sandbox implementation**. Regulators can assess whether the risks are acceptable based on their scale and potential impacts and likelihood of customer benefits and design sandboxes to minimize risks.

Table 1 Benefits of Regulatory Sandboxes

Benefit Category	Details	References
Advancing innovation	Advance innovation within businesses (both industry and utilities)	Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)
	Advance innovation in regulation and regulatory learning by highlighting potential areas for revising regulations and identifying gaps where new regulatory guidance or public policies may be needed	Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)
	Reduce the cost of innovation; remove barriers to entry for innovative technologies and solutions before deciding if the solution should be scaled	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen) Global Experiences from Regulatory Sandboxes
	Create evidence that there is a market for innovative technologies and encourage further technological advancements	Global Experiences from Regulatory Sandboxes
Improving information	Collect insights and data and provide opportunities to create a more collaborative approach to achieve energy-related state goals	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen)

collection and knowledge-sharing	Improve coordination and collaboration between regulators, governing bodies, utilities, industry, and other stakeholders, with clear and well-implemented knowledge-sharing practices	Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)
	Build evidence to support a regulatory decision on a utility's plan for adopting advanced technologies	How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers Global Experiences from Regulatory Sandboxes
Improving economic outcomes	Improve ability to identify and capitalize on new economic opportunities, moving more quickly from idea to demonstration	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen)
	Create new pathways for emerging energy products and services to reach commercialization, stimulating investment and new jobs	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen) Global Experiences from Regulatory Sandboxes
	Test emerging technologies that are more cost-effective than like-for-like replacements	Pathways to Commercial Liftoff: Innovative Grid Deployment
Improving grid reliability and resilience	Test emerging technologies that contribute support grid reliability and resilience in response to changing grid conditions such as increased penetration of variable renewable energy and extreme weather events	Pathways to Commercial Liftoff: Innovative Grid Deployment
Better meeting customer needs	More nimbly address customer needs and adapt to changing customer desires such as for better access to electric vehicle charging, improved building resilience, and adoption of distributed storage technologies	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen)
Increasing access to technologies	Support access to advanced technologies for varied populations by encouraging third-party and utility collaboration and encouraging successful outcomes for all parties	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen)

Table 2 Risks of Regulatory Sandboxes

Risk Category	Details and Mitigation Strategies	References
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<p>Market distortions</p>	<ul style="list-style-type: none"> • Create market distortions that can disrupt competition as firms participating in the regulatory sandbox gain an advantage, creating barriers to other firms entering the market, even after the sandbox ends • Potentially erode utility's monopoly status <p>Mitigation strategies: Transparent eligibility criteria, objectives, selection criteria, exit options, and clear (and well-implemented) knowledge-sharing obligations</p>	<p>Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)</p> <p>Global Experiences from Regulatory Sandboxes</p> <p>Research and Development by Public Utilities: Should More be Done?</p>
<p>Negative impacts to customers (e.g. increased costs, unintended consequences of technologies, etc.)</p>	<ul style="list-style-type: none"> • Negatively impact consumers as a result of the experimental nature of sandboxes and modifications to regulations intended for consumer protection (e.g. some customers may not have access to sandbox programs, sandboxes may create undue advantages for certain customer segments, rates may increase, etc.) • Negatively impact consumers when programs do not result in intended outcomes (e.g. technology costs may be higher than expected, technologies may not improve reliability or reduce load, etc.) <p>Mitigation strategies: Include consumer safeguards among the eligibility criteria for submitted projects, maintain technology neutrality, create flexibility to adjust to program learnings in real time or end projects early</p>	<p>Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)</p> <p>Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition (Engineering Science and Technology Journal)</p>
<p>Negative impacts to the grid or society</p>	<ul style="list-style-type: none"> • Fail to achieve the intended benefits of sandbox projects, resulting in negative impacts to grid reliability, safety, the economy, or other factors <p>Mitigation strategy: Embrace learning/failure as a successful outcome, create flexibility to adjust to program learnings in real time or end projects early</p>	<p>Regulatory sandboxes: Do they speed up innovation in energy? (Energy Policy Journal)</p> <p>How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers</p>
<p>Undue investment of time and resources in sandbox implementation</p>	<ul style="list-style-type: none"> • Invest significant time and resources into sandbox development and implementation, distracting from other regulatory or utility needs • Fail to achieve innovation objectives of the sandbox • Act as an imperfect substitute for other regulatory change or enablers (e.g. invest time and resources into a sandbox when a simple change to a rule or policy would accomplish the same outcome) <p>Mitigation strategy: Employ existing models and create clear project management tools, build in opportunities to adjust the sandbox framework over time</p>	<p>Making Space for Innovation: The Handbook for Regulatory Sandboxes</p>

Key Takeaways, Best Practices, and Lessons Learned

A number of articles and reports have conducted case studies on regulatory sandboxes to provide insights into design and implementation. Major considerations for designing sandboxes include developing objectives; effectively scoping and identifying the bounds of the framework; identifying the derogations (i.e. exceptions or modifications to rules or regulations), defining eligibility and the application process; establishing oversight, governance, and reporting requirements; and establishing funding and cost recovery expectations. Careful advance planning is critical to clearly communicate expectations for all participants and to help facilitate success towards the desired outcomes. Supporting actions include conducting a feasibility assessment upfront, establishing reporting and monitoring requirements, building in flexibility to change direction as needed, aligning the design of the sandbox with desired outcomes and acceptable risks, and creating clear exit options.

Table 3 Best Practices for Sandbox Design

Dimension	Details	Sources	Takeaways
Program objectives	<ul style="list-style-type: none"> Align objectives with wider regulatory constructs and policy objectives such as clean air, improved grid reliability, and improved grid resilience 	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen)	Clearly defined objectives are essential and guide the design and implementation of the sandbox.
	<ul style="list-style-type: none"> Clearly state objectives and provide information on what the sandbox is expected to achieve <ul style="list-style-type: none"> Acknowledge that an outcome indicating that a product or service isn't suitable for the energy markets is still an informative outcome Explicitly focus on facilitating scaling new products and services, not just running trials Anchor objectives in showing that technologies can operate in real energy markets/systems with real consumers 	Energy Regulatory Sandbox: Guide for Innovators (Ofgem) How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers Global Experiences from Regulatory Sandboxes	
Program scope	<ul style="list-style-type: none"> State what the sandbox is and is not capable of providing Provide information on what markets and regulations are in scope and the limits of the regulator's authority with regards to derogations 	Energy Regulatory Sandbox: Guide for Innovators (Ofgem)	Jurisdictions take different approaches to the actual design of the sandboxes. The length of the sandbox needs to balance risks of market distortion with ability to test impacts. It's
	<ul style="list-style-type: none"> Collaborate with relevant authorities, depending on the scope of the sandbox Create robust risk management procedures during the creation and design of regulatory sandboxes 	Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition	

	<ul style="list-style-type: none"> ● Create opportunities for interaction between regulators, utilities, and sandbox participants ● Maintain time limits on the sandbox or derogation - most countries keep the length of derogations down to 5 years <ul style="list-style-type: none"> ○ Shorter time periods (1-2 years) are generally preferred in cases where market distortion concerns are high ○ Longer time periods are more beneficial for projects involving more significant investments, and which require more time to allow for better regulatory learning 	<p>(Engineering Science and Technology Journal)</p> <p>Regulatory sandboxes: Do they speed up innovation in energy? (Energy Policy Journal)</p>	important to clearly define the bounds of the sandbox for stakeholders (e.g. both utilities and industry participants).
	<ul style="list-style-type: none"> ● Clearly identify the regulatory barriers that the sandbox intends to address ● Clearly identify project exit options and the exit process 	<p>How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers</p>	
Derogations	<ul style="list-style-type: none"> ● Consider how specific to be with derogations or modifications to regulatory constructs – overly specific boundaries might restrict innovators, while being too broad may limit innovators’ desire to participate <ul style="list-style-type: none"> ○ Broader derogations can help to address interactions of energy projects with energy legislation and regulation and environmental permitting, spatial planning, safety, and other regulations, but may increase sandbox complexity and risks of limited consumer protection and market distortion ○ Broadening exemption possibilities (e.g. creating exceptions to laws, licensing, or permitting obligations) can increase the impact and attract new stakeholders like system operators, energy companies, local governments and partnerships 	<p>Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)</p> <p>ISGAN (International Smart Grid Action Network) (May 2019): Innovative Regulatory Approaches with Focus on Experimental Sandboxes: Casebook</p>	<p>Narrow derogations may restrict innovators - broader derogations could enable greater levels of innovation and impact, but may increase sandbox complexity and risk, such as reduced consumer protection and unfair advantages in the market.</p> <p>Other “innovation vehicles” might be more appropriate than sandboxes in some cases.</p>
	<ul style="list-style-type: none"> ● Consider whether unique parameters are appropriate depending on the innovation the sandbox is supporting <ul style="list-style-type: none"> ○ The design may not always include derogations or exemptions from rules, but it often will ○ Sandbox implementers may provide bespoke guidance to innovators looking to participate ○ Sandboxes may include shared risk parameters 	<p>Energy Regulatory Sandbox: Guide for Innovators (Ofgem)</p>	

	<ul style="list-style-type: none"> Deploy other “Innovation facilitators” (i.e. t-and-learn, wait and see, innovation hubs, accelerator programs) when appropriate Identify foundational legal and regulatory frameworks for enabling responsible innovation – for example, exception clauses are another innovator facilitator or they can help to enable development of a sandbox 	How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers Making Space for Innovation: The Handbook for Regulatory Sandboxes	
Program eligibility	<ul style="list-style-type: none"> Specify who is eligible to apply, including information about licensees/partnerships Provide information about previous innovators/principal innovation types Create eligibility criteria that follow the outlined desirable innovation characteristics (e.g. reduced emissions, value creation, and competitiveness and effectiveness) 	Energy Regulatory Sandbox: Guide for Innovators (Ofgem)	There is value in attracting diverse participants but it is important to specify eligibility criteria to protect customers and ensure that projects are aligned with overall program objectives. There are a number ways that sandboxes may set/limit eligibility.
	<ul style="list-style-type: none"> Develop a comprehensive and specific list of selection criteria, including notification of assumption of risk by the applicants Calibrate eligibility requirements to recognize that developing a strong business case and demonstrating financial and technical capabilities be challenging for emerging technologies or businesses 	ISGAN (International Smart Grid Action Network) (May 2019). Innovative Regulatory Approaches with Focus on Experimental Sandboxes: Casebook	
	<ul style="list-style-type: none"> Decide which eligibility criteria to use (e.g. limit eligibility to business, base eligibility on technical criteria, or determine other eligibility factors) Develop eligibility criteria well in advance and with comprehensive participation of all stakeholder groups to ensure relevant stakeholders are informed and can participate 	Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)	
	<ul style="list-style-type: none"> Enable traditional and unconventional players to participate – there is value in allowing both utility and third parties to bring new ideas and technologies to the sandbox Carefully specify eligibility criteria to protect customers and ensure that projects are aligned with overall program objectives Clearly define the bounds for participating innovations and technologies 	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen) Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition (Engineering Science and Technology Journal)	
Application process	<ul style="list-style-type: none"> Consider whether to use open calls for applications, thematic calls, or to allow continuous applications 	Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition	There are benefits to open calls and thematic/dedicated calls -

	<ul style="list-style-type: none"> ○ Call-based applications allow regulators to highlight regulatory themes, but may rush innovators into applications and require updates to remain relevant ○ Continuous application periods allow innovators to apply as soon as the innovation is ready or in a timely manner when a new need arises ○ Open calls that are technology and practice agnostic are more inclusive and flexible, and may foster innovation/bring forth new tech, services, business models that was not previously envisioned ○ Thematic trials can be targeted for specific areas of focus and policy objectives but may limit innovation 	<p>(Engineering Science and Technology Journal)</p> <p>Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)</p> <p>Regulatory sandboxes: Do they speed up innovation in energy? (Energy Policy Journal)</p>	<p>Open calls are inclusive and flexible and address priorities and challenges identified in the system to foster innovation/bring forth new tech, services, business models. Thematic calls are more targeted and allow regulators to highlight specific areas of focus/regulatory learning (require updates to remain relevant). Thematic sandboxes with clear articulation of priorities and requirements may see enhanced support and a more comprehensive approach.</p>
	<ul style="list-style-type: none"> ● Create an application process that is sufficiently calibrated to avoid burdensome or prohibitive administrative requirements, but that still provides transparency and appropriate guidance for use of public funds 	<p>Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen)</p>	
Oversight and governance	<ul style="list-style-type: none"> ● Consider who should be involved in oversight and governance to facilitate the desired outcomes and choose suitable authorities for granting derogations <ul style="list-style-type: none"> ○ Consider whether involvement of government agencies beyond regulators is needed to effectuate certain derogations (e.g. permitting agencies, or environmental agencies) 	<p>Regulatory sandboxes: Do they speed up innovation in energy? (Energy Policy Journal)</p> <p>Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)</p>	<p>Ensure that entities involved in administering the sandbox have appropriate jurisdiction to meet desired outcomes. Ensure sufficient management and oversight resources and commitment.</p>
	<ul style="list-style-type: none"> ● Reduce possible barriers to success by ensuring sufficient resources dedicated to management and oversight of the experimentation process 	<p>Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition (Engineering Science and Technology Journal)</p>	<p>Create transparent, clear, and public (where possible) reporting, evaluation, and exit strategies that align with sandbox and program objectives.</p>
	<ul style="list-style-type: none"> ● Establish clear evaluation criteria (such as demonstrating innovation), monitoring procedures, and determine next steps for implementing results 	<p>Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition (Engineering Science and Technology Journal)</p>	

	<ul style="list-style-type: none"> • Ensure commitment from the highest levels of the regulator and authorities • Conduct an upfront feasibility assessment to determine whether a sandbox is viable in the jurisdiction • Define who owns the sandbox, line up internal support, allocate sufficient resources, outline the internal process, ensure coordination with external stakeholders, and establish formal and informal support channels (sandboxes may generate interest that the regulator can learn from & there should be practices in place to take advantage of that) • Create a stakeholder engagement plan 	How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers	
	<ul style="list-style-type: none"> • Ensure transparency in all aspects of the sandbox, particularly for activities within the regulatory sandbox that serve the public interest and use public funds 	Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid (Strategen)	
Evaluation and reporting	<ul style="list-style-type: none"> • Consider whether innovators can support utilities by contributing to monitoring and evaluation requirements, which will help them better understand their customers' response to the offering, and provide them with valuable intelligence about consumer attitudes and behaviors, market and system operations, and regulatory challenges <ul style="list-style-type: none"> ○ Consider asking innovators to share their experiences of the sandbox for future sandbox cycles ○ Create a light-touch digital survey for innovators to complete every 6 months for two years, to help stay in touch and continue learnings ○ Create expectations that support can be withdrawn if a participant does not adhere to the monitoring and reporting requirements • Determine the scope of evaluation and reporting requirements by type of activity 	Energy Regulatory Sandbox: Guide for Innovators (Ofgem)	<p>There are multiple resources that provide insights into metrics and reporting requirements. Reporting should align with desired outcomes, track more than just economic efficiency, and should be regular.</p>
	<ul style="list-style-type: none"> • Set up an appropriate monitoring and evaluation scheme, with relevant indicators for process and outcome • Set up procedures for transitioning results into permanent regulation <ul style="list-style-type: none"> ○ These should be defined in advance of sandbox implementation to minimize market distortion and uncertainty 	Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland (CIRED)	
	<ul style="list-style-type: none"> • Create public reporting obligations for finished projects <ul style="list-style-type: none"> ○ Although these obligations exist, they might not be met in practice 	Regulatory sandboxes: Do they speed up innovation in energy? (Energy Policy Journal)	
	<ul style="list-style-type: none"> • Build in indicators of success beyond market efficiency, including distributional impacts and spillover effects 	Pathways to Commercial Liftoff: Innovative Grid Deployment	



<p>Funding and cost recovery</p>	<ul style="list-style-type: none">● Look into funding sources beyond customers rates when designing a Sandbox<ul style="list-style-type: none">○ Regulators can consider allowing cost recovery even if trials aren't successful (even outside of a sandbox)○ Consider cost or risk-sharing requirements for innovators	<p>Making Space for Innovation: The Handbook for Regulatory Sandboxes</p> <p>Pathways to Commercial Liftoff: Innovative Grid Deployment</p>	<p>Sandboxes outside of the US frequently rely on funding outside of utility bills.</p> <p>Regulators can explore alternative cost recovery mechanisms or standards.</p>
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Gaps and Areas for More Research

At a high level, there are many positive indicators, but the research does not appear to be conclusive on whether regulatory sandboxes are successful at promoting innovation. They are a relatively new approach, and there is limited information, particularly in the U.S. energy sector, on success stories and sandbox outcomes, overall.

- Key question: Are regulatory sandboxes effective for fostering innovation and regulatory learning?
- Key need: There is a need to collect evidence of sandbox outcomes to support their proliferation.

Some countries are closing their sandbox programs, which may indicate that they did not meet their stated objectives.

- Key questions: Are there ways to design sandboxes to ensure continued success over time?

The research indicates that most sandboxes and reviews of sandboxes have focused on market impacts (e.g. price and competition), but have not focused on affordability impacts. There is a lack of focus in the literature on affordability.

- Key questions: What data and information exists to help illuminate the impacts of regulatory sandboxes on outcomes beyond price and competition? How can regulatory sandboxes be designed to remove barriers for small innovators in accessing sandbox opportunities? How can sandboxes better consider stakeholder input and participation in testing innovative solutions?

Tools developed for the fintech sector do not exist in the same way for the energy sector.

- Key need: There is a need for easily accessible and usable tools for U.S. regulators, utilities, and other stakeholders to draw upon to generate support for regulatory sandboxes, reduce the need to create materials from scratch, and streamline development and implementation for successful sandboxes.

Source-Specific Summaries

Utility Innovation and Technology

This section covers literature related to utility pilot programs, scaling technology deployment, supporting a culture of innovation at utilities and alternative mechanisms (other than sandboxes) for promoting innovation, and includes some case studies on particular innovative technologies.

[Pathways to Commercial Liftoff: Innovative Grid Deployment](#)

White et. al, 2024

This report includes information on how to scale “advanced grid solutions” (advanced transmission technologies, situational awareness and system automation, grid-enhancing technologies (GETs), and foundational systems in the U.S. to meet grid needs. It provides an overview of the typology of advanced grid solutions, identifies the strategies needed to de-risk adoption at scale, and provides priority actions for different stakeholders. The report finds that most of these solutions could be deployed at scale in the next 3 – 5 years at lower cost than like-for-like replacements.

[A Blueprint to Pilot Design: Best Practices and Lessons Learned](#)

Sergici, 2020

The Brattle Group has maintained a database of pricing and technology pilot programs in order to track customer responsiveness to time varying rates and improve the state of pilot programs for the future. This source is a deck created by Brattle which provides advice and guidance to those seeking to conduct a pilot program, particularly in reference to pilot programs testing customer responsiveness to time varying rates.

[Pathways for Innovation: The Role of Pilots and Demonstrations in Reinventing the Utility Business Model](#)

Fairbrother et. al, 2017

Utilities, in our current era of electricity markets, must develop innovative ways to deal with increasing DERs causing lower volumetric sales in their service territories. This report describes challenges limiting effective innovation through utility pilot and demonstration programs, and provides recommendations for utilities, regulators, and technology providers to accelerate energy system innovation.



[*A Handbook for Designing, Implementing, and Evaluating Successful Electric Utility Pilots*](#)

Cappers and Spurlock, 2020

This source provides a step-by-step process that regulators, policymakers, and utilities can follow to help ensure a pilot is successful, even if whatever is being tested fails to produce the intended or expected result(s). The more regulators and policymakers can create an environment of utility ownership over the pilot's purpose and outcome, the more likely the utility is to support it and do what is necessary to ensure its success.

One such approach is a *regulatory sandbox*. This framework can be used by utilities and other electric industry stakeholders to jointly develop, test, and evaluate new or evolving business ideas under limited regulatory supervision without fear of the outcome. Regulatory Sandboxes encourage innovation through the creation of a relatively low-risk testing environment that promotes experimentation while reducing legal uncertainty regarding the consequences of undesirable outcomes

[*Utility Pilot Best Practices and Future Pilot Areas*](#)

Michigan Public Service Commission Staff, 2020

This report highlights the efforts of the Energy Programs and Technology Pilots workgroup, its stakeholder process, and its learnings regarding past and current Michigan pilot projects, pilot best practices, and future pilot areas. It also includes MPSC (Michigan Public Utility Commission) staff (Staff) recommendations to remedy common issues with pilots in Michigan.

[*Research and Development by Public Utilities: Should More be Done?*](#)

Costello, 2015

This presentation provides foundational information on R&D and innovation in the utility sector. It provides some key facts and figures about R&D in general, as well as R&D in the energy sector. The deck lays out specific questions for regulators, effects of regulation on innovation, and illustrative regulatory principles for R&D.

[*A Roadmap for Advanced Transmission Technology Adoption*](#)

Deese et. al, 2024

U.S. electricity deployment is falling behind the pace necessary to meet projected demand growth — posing risks for the United States' ability to meet its clean energy deployment goals and raising costs for ratepayers. Currently, there is increased electricity demand due to the electrification of buildings and

transportation, renewed domestic manufacturing, cryptocurrency mining, and data centers. Increased use of advanced transmission technologies (ATTs) can play a major role in meeting this demand growth quickly and cost-effectively. However, electricity market structures—which disincentivize investment in innovation—are impeding progress towards modernizing the electric grid. This paper lays out a five-part framework for unlocking the potential of ATTs.

[Case Studies on Agile Regulatory Governance to Harness Innovation: Civilian Drones and Bio-Solutions](#)

Hernández and Amaral, 2022

This source provides two case studies focusing on civilian drones and bio-solutions. Each of the case studies focuses on the key transformative impacts of the innovations at hand as well as the associated regulatory challenges and responses. The case studies illustrate the need for fit-for-the-future and innovation-friendly regulation. They also highlight the need for a whole-of-government approach to regulation and the crucial importance of testing, piloting and experimentation.

[Regulatory Experimentation: Moving Ahead on the Agile Regulatory Governance Agenda](#)

OECD, 2024

This policy paper aims to help governments develop regulatory experimentation constructively and appropriately as part of their implementation of the 2021 OECD Recommendation for Agile Regulatory Governance to Harness Innovation. This policy paper examines key concepts, definitions and constitutive elements of regulatory experimentation (RE).

Objectives: 1) enhance RE as policy tool to improve public policy, promote adaptive learning and enhance the body of relevant evidence in the face of uncertainty and knowledge gaps and 2) foster innovation by businesses (i.e. introduction of new ideas, products and business models) and governments (e.g. trialing new approaches to regulating).

[The Electricity Governance Toolkit](#)

WRI, NIPFP, Prayas, 2007

This toolkit presents a framework to assess and promote good governance in the electricity sector, with focus on four overarching principles of good governance - transparency and access to information, participation, accountability and redress mechanisms and capacity. The principles of good governance apply to the design and implementation of energy sector regulatory sandboxes and can be used, at a high level, to guide best practices.



Utility Regulatory Sandboxes

This section captures findings from research specifically on regulatory sandboxes in the utility industry.

[*Regulatory Sandboxes: Program Design to Accelerate Innovation for an Evolving Electric Grid*](#)

McDonnell, et al., 2022

This report provides a list of best practices/regulatory framework design elements drawn from nine case studies across four countries. It also outlines a framework for customizing regulatory sandboxes, which includes the following pillars - align with public policy goals, enable iterative, practical learning, recognize the value of utility and third-party participation, create a defined structure for scaling, provide a clear and consistent source of funding, and build complexity over time.

[*Regulatory sandboxes: Do they speed up innovation in energy?*](#)

Beckstedde, et al., 2023

The article examined 72 existing sandbox projects, determined five main categories of innovation: local energy, flex participation in electricity markets, distribution network tariffs, connections to electricity networks and connections to gas networks. The article provides information and lessons learned from European sandbox design and implementation.

[*Regulatory sandboxes and pilot projects: Trials, regulations, and insights in energy transition*](#)

Aydin, Z., and O. Yardimci, 2024

This resource identifies critical elements as vital to the effectiveness of regulatory sandboxes: regulatory flexibility, resource availability, support for innovators, and alignment with national energy goals. It also identifies the need for robust risk management procedures during the creation and design of regulatory sandboxes.

[*Regulatory Sandboxes in the Energy Sector - Review and Learnings for the Case of Switzerland*](#)

Heymann, et al., 2021

This resource identifies the defining feature of regulatory sandboxes as the possibility for granting derogations to specific regulatory provisions to innovators experimenting new solutions with the aim to



provide lessons for changing the regulatory framework and with close oversight from the regulator or other authority. It also identifies barriers, risks, benefits, and best practices for regulatory experimentation approaches.

[Energy Regulatory Sandbox: Guidance for Innovators](#)

Ofgem, 2020

This document discusses the Ofgem UK Energy Regulation Sandbox. It is targeted at innovators intending to trial and bring to market new products, services, methodologies and business models. The sandbox is available to start-ups, new entrants, established sector players, businesses transferring in from other sectors, public or third sector bodies. This document outlines the intentions behind and the parameters of the sandbox, as well as all important specific information for applicants, including timeframes, derogations/types of support, limitations, oversight, evaluation and reporting requirements, and visions for success.

[Regulatory Sandboxes in the Energy Sector](#)

Publications of the Office of the European Union, 2023

This document analyzes experience with regulatory sandboxes in the European Union member states, including their legal basis, purpose and objectives, challenges, and outcomes or impacts. It notes that sandboxes are distinguished from other regulatory experimentation approaches by their more open and often case-by-case approach to granting derogations for projects. It identifies barriers to successful implementation of sandboxes, such as lack of legal basis, requested derogations not within competences of implementing entities, participation constraints, especially for smaller entities, such as start-ups, lack of resources and expertise within authorities regulating and/or supervising the sandbox, and perception of potential conflicts of regulatory derogations with other binding regulations. They find that regulatory sandboxes are a helpful policy tool for enabling new products and services.

[Innovative Regulatory Approaches with Focus on Experimental Sandboxes: Casebook](#)

ISGAN (International Smart Grid Action Network), 2019

In recognition of the need for regulatory innovation and experimentation, this resource studies sandboxes in Australia, Germany, Italy, and the Netherlands to help illuminate lessons learned. It identifies that complementary policy actions are necessary to support regulatory sandboxes, that learning is as important as the actual outcomes of experimenting, knowledge exchange is critical, and that there are mitigation options to reduce risk and overcome common challenges.

Lessons from Regulatory Sandboxes in Other (non-energy) Sectors

This section covers literature on regulatory sandboxes deployed in other sectors, largely from the Financial Technology (“FinTech”) sector, where regulatory sandboxes appear to be used more prominently.

[*How to Build a Regulatory Sandbox: A Practical Guide for Policy Makers*](#)

Jeník and Duff, 2020

This is a technical guide for financial regulators that provides information on whether a sandbox is right based on their landscape, and if so, how to design and implement it. It does not focus on evaluating the impact of sandboxes. It has appendices with checklists and tools regulators can use to assess the feasibility, design, and implement sandboxes.

[*Global Experiences from Regulatory Sandboxes*](#)

Appaya et. al, 2020

This paper provides insights and information from a review of fintech sandboxes around the globe. It provides a background on sandboxes and then walks through design elements of sandboxes, providing examples of sandboxes from around the globe to illustrate real world experiences and lessons.

[*Key Data from Regulatory Sandboxes Across the Globe*](#)

World Bank Group, 2020

This is an interactive database of the global sandboxes identified. It accompanies the report above, and is up to date through November 2020. It provides basic statistics on sandboxes, a map and timeline of sandbox development, and then provides a data breakdown by economic status of the country, whether there is a theme of economic inclusion, different themes, and a database of sandbox features.

[*Making Space for Innovation: The Handbook for Regulatory Sandboxes*](#)

German Federal Ministry for Economic Affairs and Energy, 2019

This resource is intended for German audiences to help promote the use of regulatory sandboxes established by the Ministry for Economic Affairs and Energy. It includes testimonials from officials on why sandboxes are useful and beneficial, real-world examples, and guidance for setting up and implementing sandboxes.

Additional Resources

- [Exploring How Interest Groups Affect Regulation and Innovation Based on the Two-Level Games: The Case of Regulatory Sandboxes in Korea](#) (Lee and Seo, 2022)
- [Caught in Quicksand? Compliance and Legitimacy Challenges in Using Regulatory Sandboxes to Manage Emerging Technologies](#) (Johnson, 2022)
- [Perspectives on Transforming Utility Business Models, Paper 2: Business Models for Innovation](#) (EPRI, 2024)
- [A Primer on R&D in the Energy Utility Sector](#) (Costello, 2016)
- [Webinars on AI, smart vegetation management, substation security, storage as a transmission asset, etc.](#) (National Association of Regulatory Utility Commissioners and Various Authors/Presenters)
- [Regulatory sandboxes in the energy sector: are they key to the transition to a net zero future?](#) (Schneiders, 2021)