Regulatory Sandboxes and Other Processes to Expedite Utility Adoption of Advanced Grid Technologies

Report Findings

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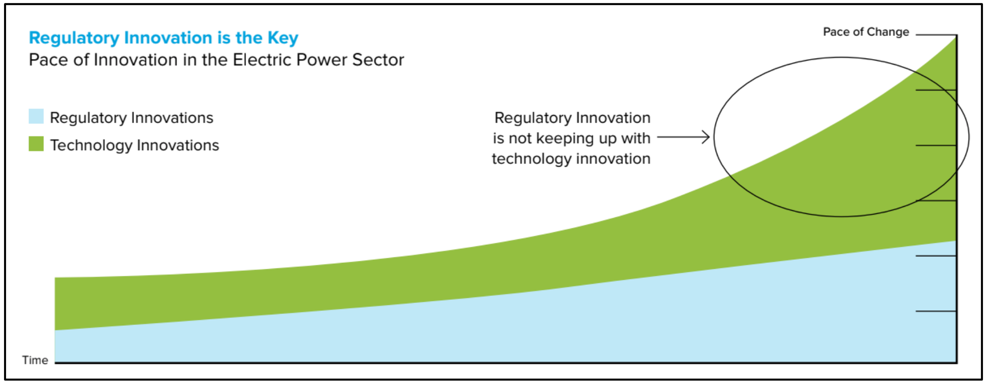
Briefing Objectives and Contents

- Objectives
  - Provide an overview of research on regulatory sandboxes in the electric utility sector
  - Discuss key findings and takeaways
  - Provide project examples
- Contents
  - Introduction and background
  - Regulatory sandboxes as innovation tools
  - Regulatory sandboxes in an ecosystem of innovation
  - Examples of specific projects resulting from sandboxes
  - Wrap up

Introduction and Background

Introduction

- Load growth, aging assets, variable energy resources, and increasingly severe and frequent weather events are challenging utilities to simultaneously:
  - Expand T&D capacity
  - Improve asset management and utilization
  - Adopt new operational practices
  - Expand resilience programs
  - Maintain energy affordability
- Traditional regulatory processes can discourage utility interest in testing and deploying advanced grid technologies to help meet these challenges.
- ***Regulatory sandboxes*** **aim to bridge the gap between need and opportunity to deliver solutions at scale.**

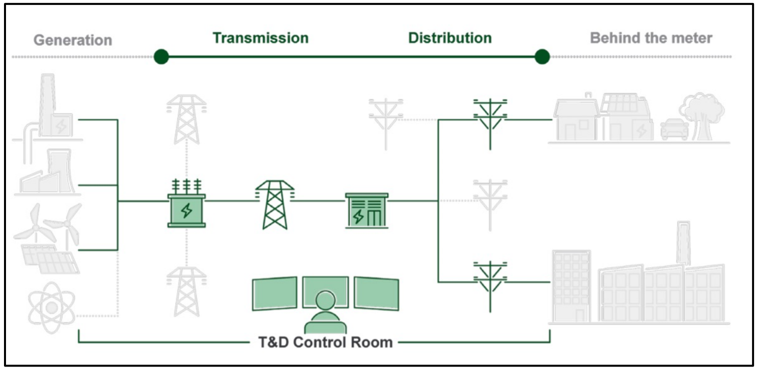


Source: McDonnell, Gorman, and Field 2022

The Potential for Advanced Grid Technologies

Advanced grid technologies that are commercially available today, but have not yet reached full market transformation, could be adopted within 3–5 years to increase peak capacity of U.S. T&D systems by 20–100 gigawatts (GW) at lower cost than like-for-like replacements.

Scope of Advanced Grid Technologies and Existing Solutions



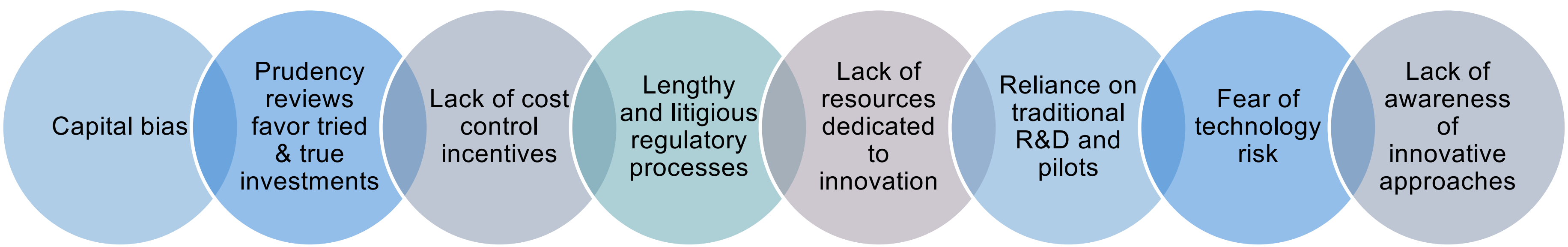
Category	Advanced Grid Solutions
Advanced Transmission Technologies	Advanced Conductors Point-to-point High Voltage Direct Current (HVDC)
Situational Awareness and System Automation Solutions	Advanced Distribution Management Systems (ADMS) and ADMS applications Distributed Energy Resource Management System (DERMS) Advanced Fault Location, Isolation, Service Restoration (FLISR) Volt/VAR Optimization (VVO) Smart Reclosers Power Factor Corrections Substation Automation & Digitization Advanced Sensors
Grid-Enhancing Technologies and Applications	Dynamic Line Rating (DLR) Advanced Power Flow Control (APFC) Topology Optimization Virtual Power Plants (VPPs)[1] Energy Storage (as a T&D asset)[2] Advanced Flexible Transformers
Foundational Systems	Communications Technologies Data Management Systems System Digitization and Visualization Alternate Timing and Synchronization

Source: White, et. al. 2024

Barriers to Utility Innovation

- The traditional utility business model and characteristics of the regulated utility sector can impede the desire for utilities to invest in R&D and scale successful pilots.
- Pilot programs, for utilities and in other sectors, frequently do not progress to full-scale programs, due to:
  - Lack of, or unclear, terminology
  - Design flaws
  - Lack of process for scaling
  - Lack of information sharing
  - Disputes

Example Barriers to Utility Innovation



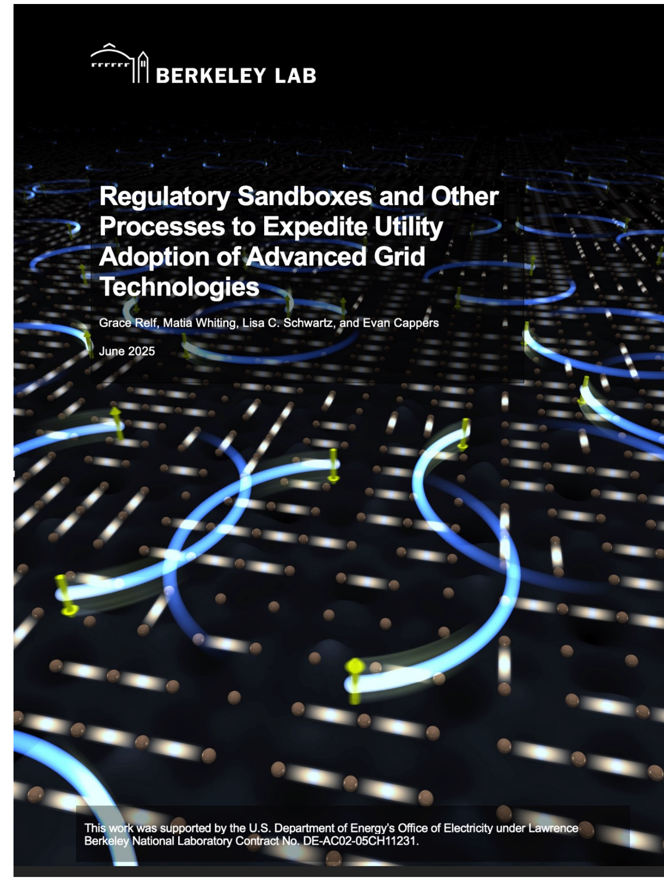
Office of Electricity and Berkeley Lab Research

Supported by the Office of Electricity, Berkeley Lab published research on regulatory sandboxes and other processes to expedite adoption of advanced grid technologies.

The research:

- Assesses the need for, and barriers to, utility innovation
- Identifies regulatory sandboxes and related processes
- Assesses emerging best practices

Berkeley Lab is creating an accompanying toolkit to support states looking to develop a sandbox (forthcoming).



Research available at: https://emp.lbl.gov/publications/regulatory-sandboxes-and-other

Report Methodology

- Literature review & synthesis of common and key findings
- With E9 Insight, comprehensive review of regulatory proceedings & deep-dive into regulatory filings, utility innovation webpages, pilot databases, and other sources
- Structured interviews with utilities, regulators, consumer advocates, industry trade groups, and consultants
- Analysis and synthesis of findings

Organizations Interviewed
American Public Power Association (APPA)
Connecticut Public Utilities Regulatory Authority (PURA)
Current Energy Group
Duke Energy Corporation (via written correspondence)
Hawaiian Electric (HECO)
Hawaii Public Utilities Commission (HPUC)
Green Mountain Power (GMP)
Public Staff – North Carolina Utilities Commission
San Diego Gas & Electric (SDG&E)
United Illuminating
Vermont Public Utilities Commission (VT PUC)
Vermont Electric Power Company (VELCO)
WATT Coalition / Grid Strategies

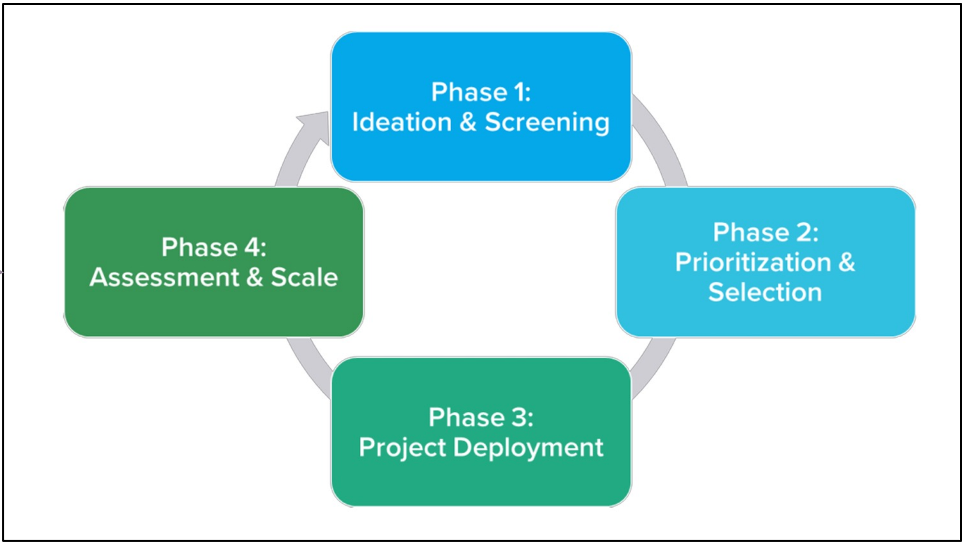
Defining Regulatory Sandboxes

Regulatory Sandboxes

Mechanisms that provide a structured environment for testing new technologies and business approaches under modified rules to increase the speed of adoption

Example

The Connecticut Innovative Energy Solutions (IES) sandbox mechanism selects cutting-edge project proposals to run for a 12- to 18-month trial period before assessing results and quickly determining scaling strategies.



Source: CT PURA

Additional Key Terminology

Term	Definition
Derogation	A modification to or exemption from typical regulations or rules deployed as part of a regulatory sandbox
Advanced grid technologies	Advanced technologies, services, and applications (both hardware and software) that enhance T&D systems by unlocking new capacity and capabilities to meet system needs
Innovation	"The search for, and the discovery, development, improvement, adoption and commercialization of new processes, new products, and new organizational structures and procedures."* Innovation requires both creating new ideas and implementing those ideas.
Innovation vehicle	A program or mechanism specifically designed to promote testing and acceleration of ideas that go beyond the status quo
Sandbox-type mechanisms	A group of programs and mechanisms that act similarly to regulatory sandboxes, but have specific or unique identifying characteristics

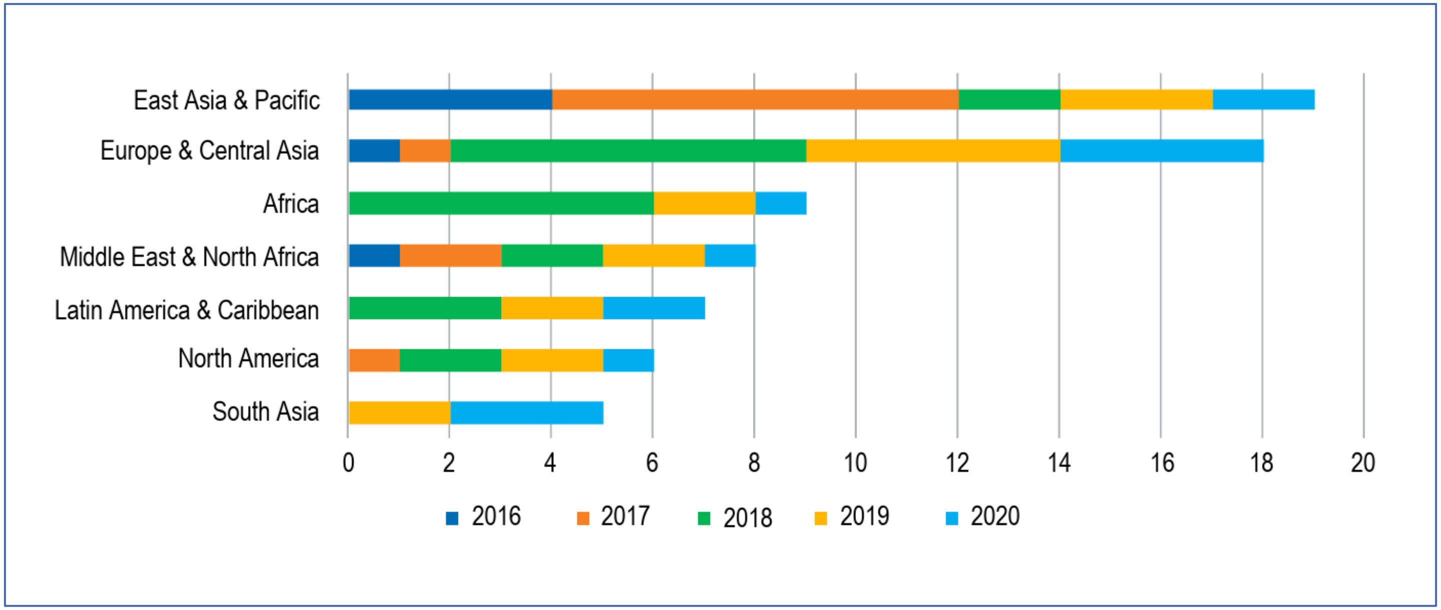
*Costello, 2016 (definition from Shy, 1995)

Regulatory Sandboxes as Innovation Tools

The History of Regulatory Sandboxes

- The term "sandbox" originated in the IT industry, where programmers created isolated environments to test new or suspicious programming, code, and software.
- In the 2010s, the Financial Technologies sector adapted sandboxes to help regulation respond to the financial crisis and rapid technology advancements and coined the term "regulatory sandboxes."
- The objectives and processes from early sandboxes are foundational for today's energy-sector sandboxes.

Financial Sector Regulatory Sandboxes by Region



Source: World Bank Group, 2020

Timeline of Sandbox-Type Mechanisms in the Electricity Sector

Regulatory Sandboxes

Mechanisms that provide a structured environment for testing new technologies and business approaches under modified rules to increase the speed of adoption

2011
- California EPIC Program

2013
- Arizona Innovations and Technological Developments exploration

2015
- New York Reforming the Energy Vision (REV) Demonstrations

2016
- PowerPath DC Pilot Project Fund

2017
- Portland General Electric's Smart Grid Testbed
- Singapore Energy Market Authority's Regulatory Sandbox
- U.K.'s Office of Gas and Electricity Market (Ofgem)'s Innovation Fund

2018
- Wisconsin Energy Innovation Grant Program

2019
- Ontario Energy Board's Innovation Sandbox
- Vermont Innovative Pilots Program

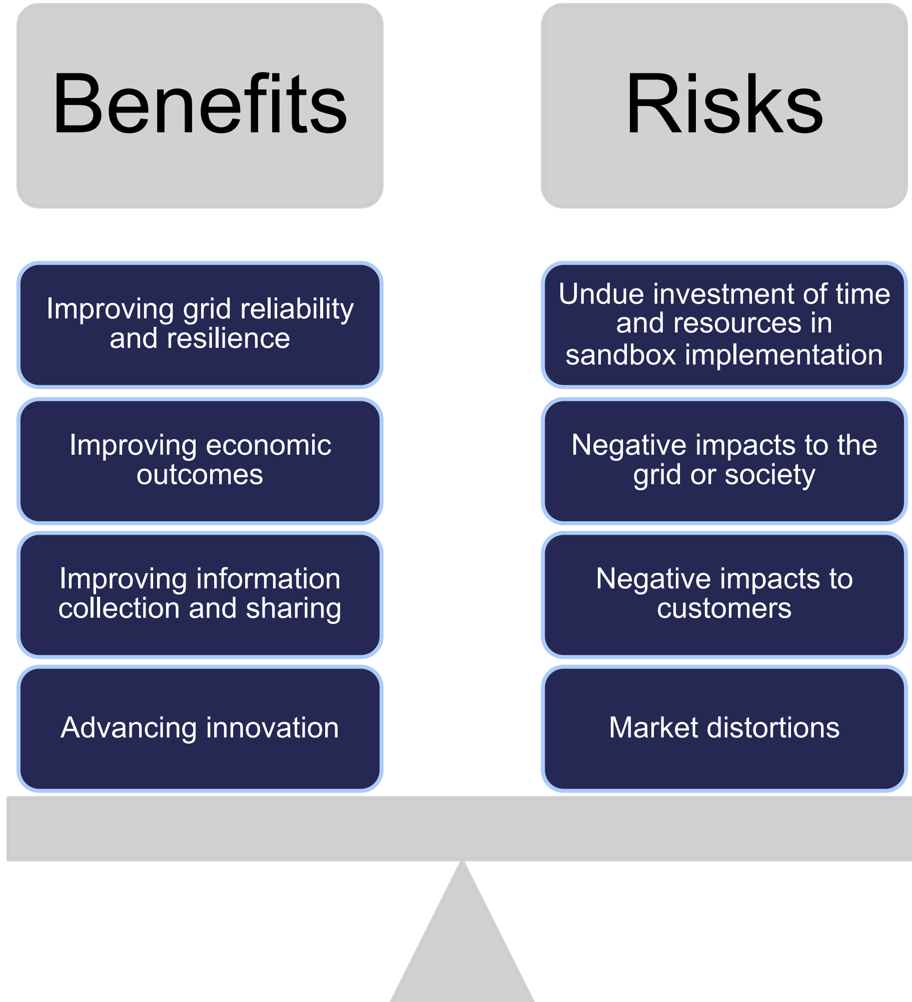
2020
- New Hampshire Grid Transformation and Enablement Program considered
- New Jersey Clean Technology Grant Programs
- Hawaii Public Utilities Commission's Innovative Pilot Framework
- Michigan New Technologies and Business Models

2021
- Minnesota Rate Case Pilot Projects considered (sandbox not adopted)

2022
- Connecticut Innovative Energy Solutions
- New Jersey Regulatory Sandbox recommended

2024
- North Carolina Innovation Prototyping Process

Potential Benefits and Risks of Sandboxes



Regulatory Sandbox Design Elements

Scoping elements
- Program objectives
- Allowable activity types
- Derogations
- Funding and cost recovery

Participation requirements
- Program and project eligibility
- Application process

Governance and oversight
- Oversight and governance systems
- Evaluation and reporting
- Scaling strategies
- Communication tactics

Taxonomy of Sandbox-Type Mechanisms

Funding Opportunity

Funding carveout for innovative grid transformation projects

Pilot Process

Activities to improve how pilot projects are approved and managed

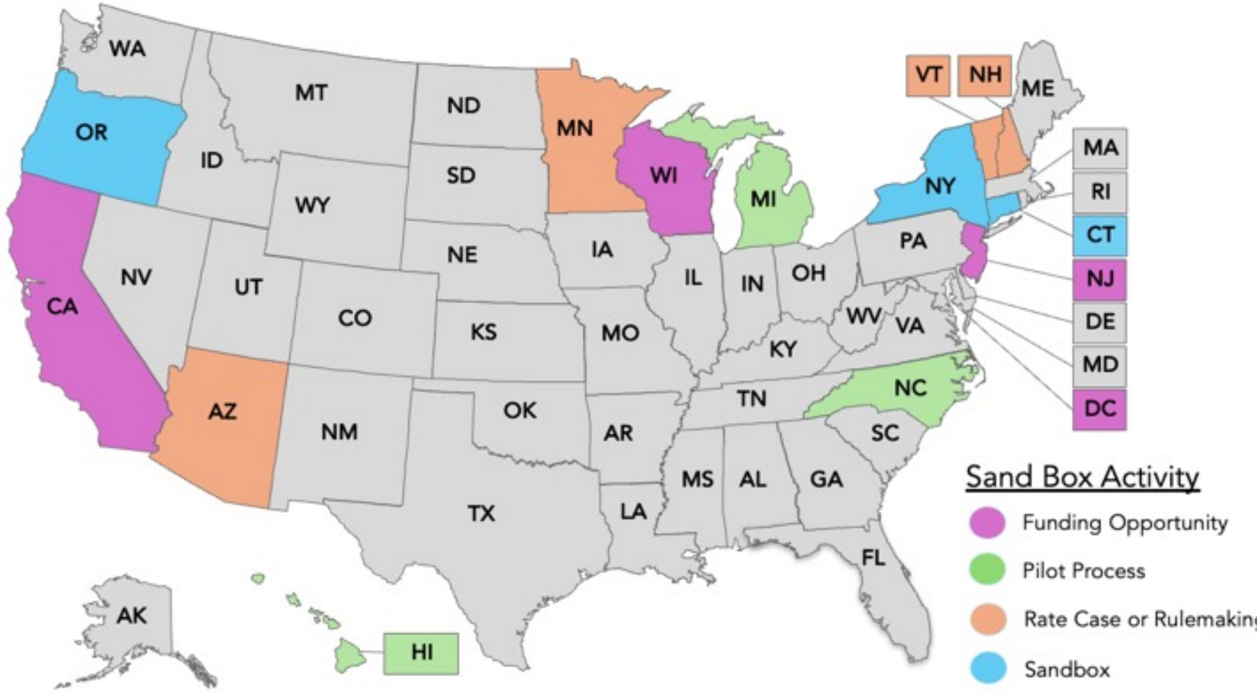
Rate Case or Rulemaking

Vehicles for broader innovation efforts that may include reforms including sandbox-like initiatives

Regulatory Sandbox

Mechanism that provides a structured environment for testing new technologies and business approaches under modified rules to increase the speed of adoption

U.S. States Exploring and Implementing Sandbox-Type Mechanisms



State	Program
National	American Public Power Association (APPA) DEED Program
Arizona (not adopted)	Innovations and Technological Developments
California	EPIC Program
Connecticut	Innovative Energy Solutions
Hawaii	Innovative Pilot Framework
Michigan	New Technologies and Business Models
Minnesota (not adopted)	Rate Case Pilot Projects
North Carolina	Innovation Prototyping Process
New Hampshire (not adopted)	Grid Transformation and Enablement Program
New Jersey	Clean Tech Grant Programs and Future Regulatory Sandbox
New York	Reforming the Energy Vision Demonstration Projects
Oregon	Smart Grid Testbed
Vermont	Innovative Pilot Program
Washington, DC	PowerPath DC Pilot Project Fund
Wisconsin	Energy Innovation Grant Program

Sandbox Examples

Connecticut Innovative Energy Solutions

- Reduces barriers for deploying new technologies and to facilitate collaboration between product innovators and utilities.
- Follows a four-phase process: ideation and screening, prioritization and selection, project deployment, and assessment and scaling.
- Uses thematic program cycles, three participation pathways and an innovation advisory council.

New York Reforming the Energy Vision Demos

- Allows utilities to develop new business models and effectively unlock new revenue streams and private investments.
- Encourages flexibility, innovation, value distribution, partnerships, customer engagement, market creation, scalability and cost recovery.

Ontario Energy Board Innovation Sandbox

- Allows proposals from utilities and businesses that support consumer value, identify relevant regulatory barriers, and have potential to scale.

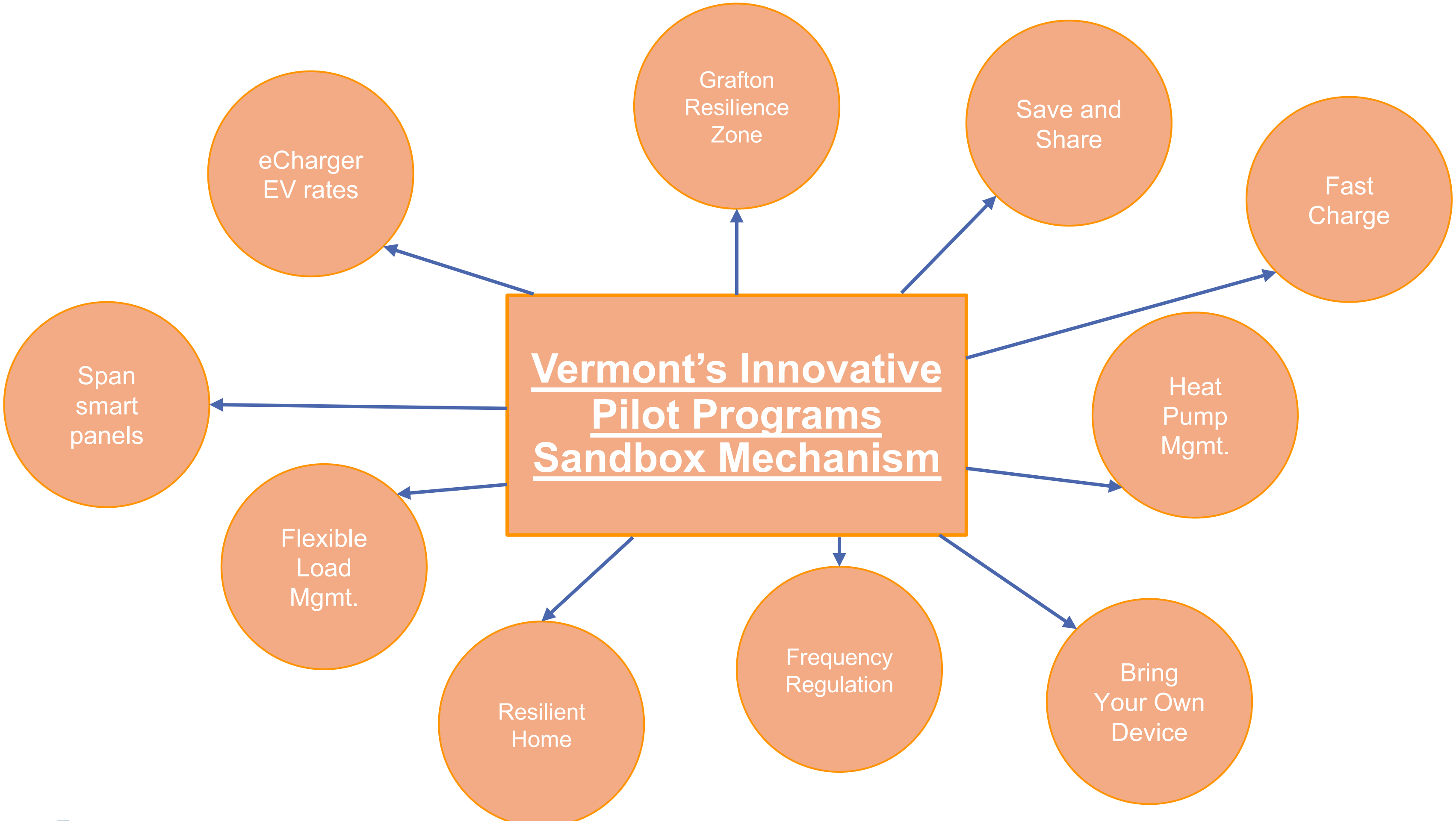
Notable Examples from Abroad

- The U.K's Office of Gas and Electricity Markets (OFGEM) developed an Energy Regulation Sandbox in 2017 as part of its performance-based regulation (PBR) framework.
  - The sandbox enables demonstrations and trials in the regulated electric and gas sectors, particularly those that may require modified or reduced regulations in order to move forward.
- The Ontario Energy Board established an Innovation Sandbox in 2016 to support achievement of the goals identified in its Strategic Blueprint document.
  - The sandbox aims to better support innovation by introducing a simpler, less adversarial, and quicker way to trial new technologies and services.
- The Singapore Energy Market Authority created a regulatory sandbox in 2017.
  - The sandbox is a means of formalizing a previous effort to identify regulatory barriers to innovation on an ad hoc basis.

Source: OEB

Sandbox Outcomes

Utilities and innovators test specific innovations through regulatory sandboxes.



Regulatory Sandboxes in an Ecosystem of Innovation

Creating an Ecosystem of Innovation

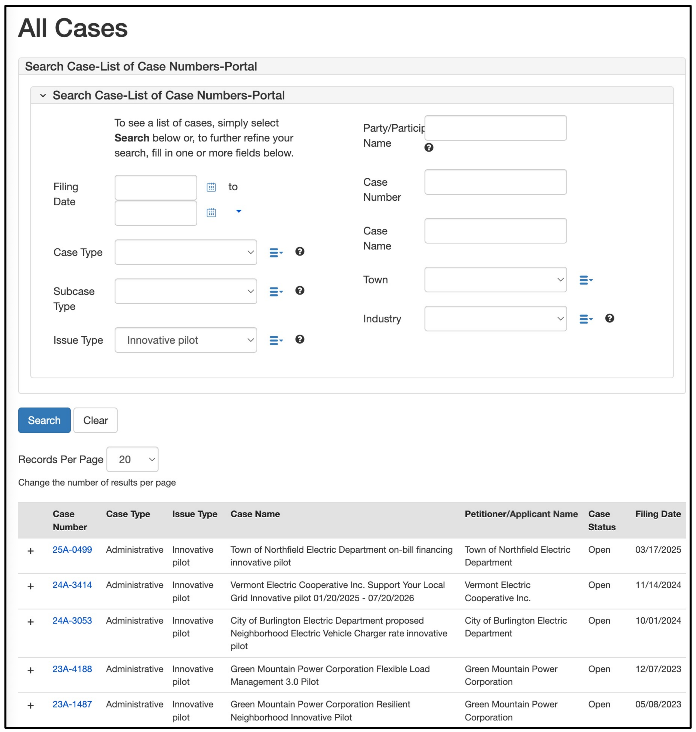
- Regulatory sandboxes do not address every regulatory barrier to innovation.
- Innovators require some level of certainty that there will be demand for their product or service to confidently invest in development.
  - Deployment of multiple innovation vehicles creates a supportive environment and an ecosystem of innovation.
  - Regulators, other government agencies, and stakeholders can deploy innovation vehicles to support innovation at different stages.

Types of Innovation Vehicles

Utility-driven approaches	• R&D • Demonstrations • Pilot programs • Organizational changes that focus on innovation
Legal- or regulatory-driven approaches	• Topical explorations and information-gathering processes • Performance-based regulation (PBR) • Changes to legislative policies and utility regulations • Track-then-act approach
Economy-wide and broader approaches	• Policy directives and vision statements • Information sharing platforms and communication tools • Innovative financing programs • Innovation hubs and incubators • Forums to bring together innovators and investors (“pitch fests”) • Technical assistance

Sandbox Repositories and Information Sharing

Vermont Pilots


All Cases

Search Case-List of Case Numbers-Portal

To see a list of cases, simply select **Search** below or, to further refine your search, fill in one or more fields below.

Filing Date | to
Case Type
Subcase Type
Issue Type: Innovative pilot
Party/Particip Name
Case Number
Case Name
Town
Industry

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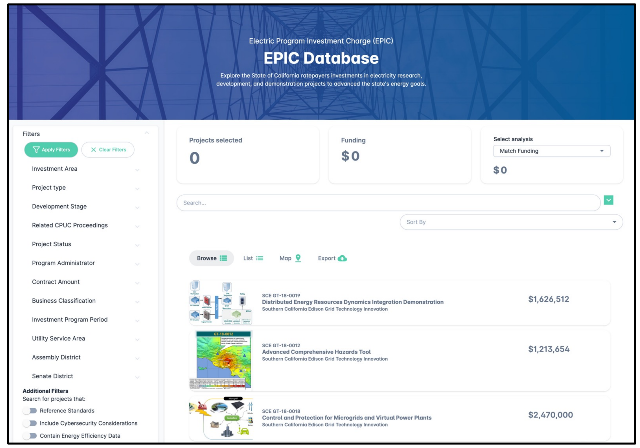
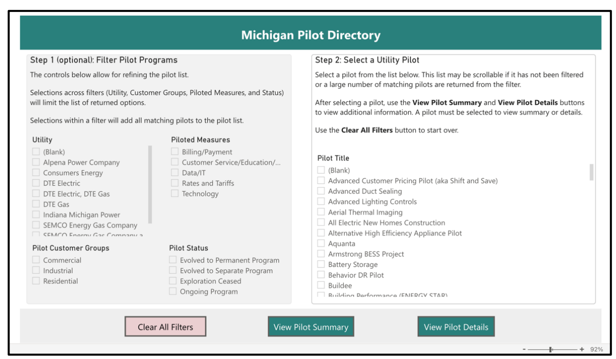
	Case Number	Case Type	Issue Type	Case Name	Petitioner/Applicant Name	Case Status	Filing Date
+	25A-0499	Administrative	Innovative pilot	Town of Northfield Electric Department on-bill financing innovative pilot	Town of Northfield Electric Department	Open	03/17/2025
+	24A-3414	Administrative	Innovative pilot	Vermont Electric Cooperative Inc. Support Your Local Grid Innovative pilot 01/20/2025 - 07/20/2026	Vermont Electric Cooperative Inc.	Open	11/14/2024
+	24A-3053	Administrative	Innovative pilot	City of Burlington Electric Department proposed Neighborhood Electric Vehicle Charger rate innovative pilot	City of Burlington Electric Department	Open	10/01/2024
+	23A-4188	Administrative	Innovative pilot	Green Mountain Power Corporation Flexible Load Management 3.0 Pilot	Green Mountain Power Corporation	Open	12/07/2023
+	23A-1487	Administrative	Innovative pilot	Green Mountain Power Corporation Resilient Neighborhood Innovative Pilot	Green Mountain Power Corporation	Open	05/08/2023

California's EPIC Database



Michigan Pilot Directory



APPA DEED Library

American Public Power Association

- DEED Home
- Utility Grants and Internships
- Student Scholarships
- DEED Project Library
- DEED News
- Awards
- Board of Directors
- Members
- Webinars
- DSTAR Collaboration
- National Community Solar Partnership

Examples of Specific Projects Resulting from Regulatory Sandboxes

Project Example: Grid Resilience Asset Investment Platform

Through the Connecticut IES program, Rhizome is implementing a project that creates a digital representation of the distribution system.

- Quantify each distribution system asset's vulnerability to weather hazards
- Estimate weather-related financial losses up to 50 years in the future
- Project holistic, rather than one-off risk analysis

- Rhizome expects the project to result in a 3–5% improvement in outage metrics and restoration time and costs.
- The IES Innovation Advisory Council supported the project because of anticipated grid resilience impacts and alignment with the Authority's related efforts on resilience standards.

Sources: CT PURA, Rhizome

Project Example: Undergrounding Low-Voltage Distribution Lines

Consumers Energy is running a pilot for Undergrounding Low-Voltage Distribution (LVD) Lines, which will underground certain sections of overhead lines.

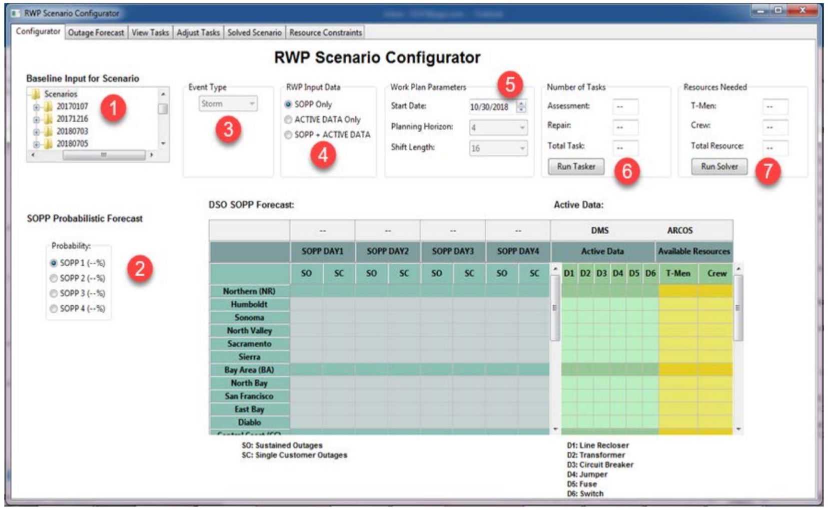
- The pilot seeks to collect data on the actual reliability and cost impacts of undergrounding LVD lines.
  - Consumers expects to spend $3.7 million and will compare costs to other reliability efforts.
  - Consumers will study actual reliability improvements.

Sources: MI PSC, Consumers Energy

Project Example: Emergency Preparedness Modeling

Pacific Gas & Electric's emergency preparedness modeling pilot uses predictive analytics and AI to recommend a restoration work plan after disruptive events.

- The model considers:
  - Damage predictions
  - Work demand
  - Resource requirements and positioning
- The pilot cost $4.7M and resulted in:
  - Successful demonstration of a tool to recommend restoration strategies
  - Reduced costs through optimized allocation of resources for restoration activities
  - Models and algorithms that other utilities could leverage
  - A safer work environment, improved reliability, and transparency in restoration efforts



Source: [CEC EPIC Database]

Project Example: Proactive Wires Down Mitigation

Pacific Gas & Electric's Proactive Wires Down Mitigation pilot is testing methods for automatically and rapidly reducing current and risk of wildfire ignition from downed wires.

- The pilot will cost $14.7M and to date has:
  - Installed Rapid Earth Fault Current Delimiter technology
  - Conducted operator training
  - Solved initial commissioning and testing issues
  - Detected and mitigated a ground fault from a tree branch contacting a distribution line
- The pilot has the potential to create cost savings by automating some work normally done by crews.

Source: CEC EPIC Database

Project Example: Resilient Neighborhood Pilot

- Green Mountain Power launched the Resilient Neighborhood Pilot in 2023 — fully electric and storm-resilient, with a microgrid that includes utility-scale storage — offering turnkey packages to 38 single- and multi-family homes.
  - Solar and storage systems
  - Smart electrical panels
  - Level 2 EV chargers
  - Air source heat pumps
  - Induction stoves
- The utility plans to pursue a 2.0 pilot to expand on initial learnings and potentially expand to statewide programs.

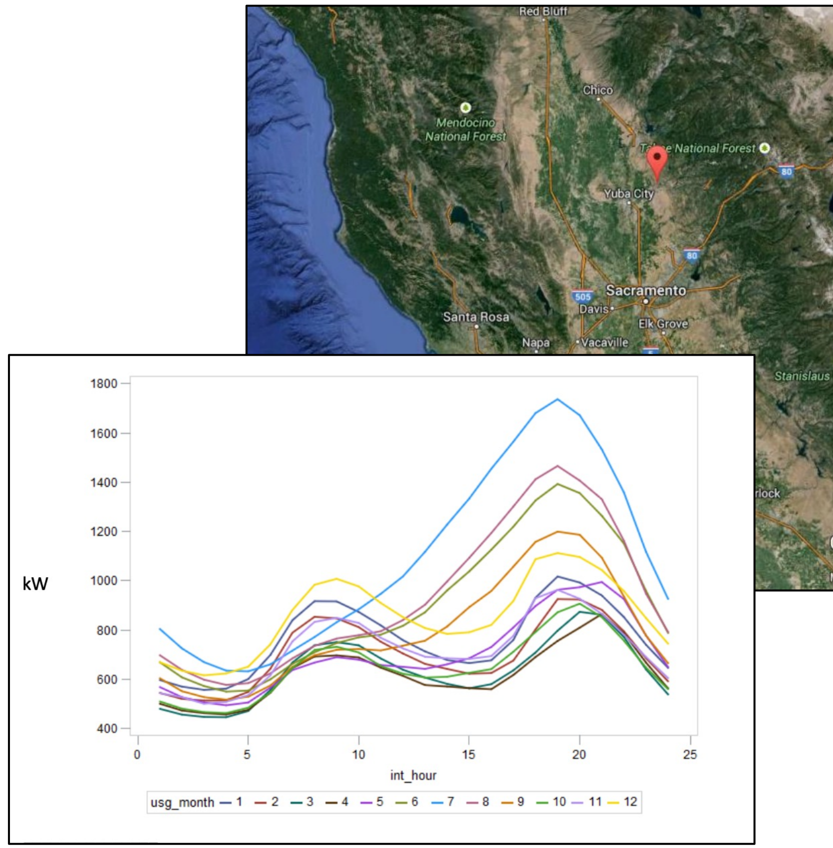
Objective	Measurement Method	Measure of Success	Status
Prove that an all-electric home can be served by a 200 amp service.	We will work with SPAN to measure load in the homes.	Home loads remain under 200 amps naturally or by smart management of loads through the SPAN panel. No adverse customer experience.	
Provide a mechanism for customers to install rooftop solar outside the scope of net metering.	GMP will be able to meter total generation and consumption as compared to expected generation and consumption as assumed in the program modeling.	Expected generation aligns with the actual output to provide the right value to non-participating GMP customers.	
Show that a fully electric neighborhood can be used as a grid asset as a whole to provide grid and market benefits.	GMP will create three or more specific load "shapes" that we use for the neighborhood and run them. For example, the neighborhood is a load during high solar times, a source during peak demand times, and neutral when no power is flowing back and forth.	Actual measurements at the recloser feeding the development will show what the net load is for the neighborhood. If we are able to match our desired load shape, we would consider that a success.	

Project Example: Distributed Storage for T&D Cost Reduction

Pacific Gas & Electric deployed energy storage at a substation to deliver autonomous distribution peak shaving.

- The project successfully demonstrated the ability to provide 500 kW of loading relief over 4 hours to delay T&D capacity expansions while maintaining or improving reliability.
- PG&E found that one ~30 MW storage solution can provide $5-15M in cost savings from avoided transmission upgrades.
- The project informed storage procurement practices, operational requirements and practices, and investments in distribution management controls.

Project Location and Average Substation Daily Load By Month



Source: CEC EPIC Database

Project Example: Noteworthy AI

Through the Connecticut IES program, Noteworthy AI is implementing a project that passively collects data on the condition of distribution system assets via smart cameras on utility vehicles.

- The project uses AI to analyze footage.
- Expected outcomes include:
  - Faster broadband deployment and easier pole attachment clearance
  - Improved vegetation management and associated better reliability and resilience
  - Reduced risk of outages by proactive identification of equipment defects
  - Analysis of 20% of the utility's poles, and 75% of poles in disadvantaged communities, within 18 months

Sources: CT PURA, Noteworthy AI

Other Project Examples

- [Hot Springs Microgrid](#)

  A Duke Energy microgrid in North Carolina, including a 2 MW solar facility and a 4.4 MW battery storage system that can independently power the entire town during outages

- Tantalus

  A Connecticut IES program that uses advanced metering infrastructure to collect granular power quality assessments and identify vulnerable distribution system assets

- Smart Pole Solutions

  An APPA DEED program in Florida to explore potential for smart poles that can improve WiFi signals, heighten security (camera monitoring), and offer level 2 EV charging

- Quail Microgrid

  A DTE Electric pilot that converted a 2 MW portable diesel generator into a blackstart stationary system and islanded microgrid

- Red Cliff Early Childhood Center Solar Energy System and Training Program

  A solar and battery microgrid system that integrates education into the school curriculum, under the Wisconsin Energy Innovation Grant Program.

- Proactive Storm Impact Analysis

  Southern California Edison's project resolved limitations in predictive models for storm-related outages (funded by California's Electric Program Investment Charge)

Duke Energy's Hot Springs Microgrid

Source: The Assembly

Wrap Up

Findings

Sandboxes have grown over time in the U.S. electricity sector

- 12 ongoing examples of sandbox mechanisms
- Sandbox types are varied

Sandboxes have demonstrated value

- Interviewees expressed enthusiasm for sandboxes
- Sandboxes are particularly good for creating a willingness to learn and an environment for experimentation

Programmatic focuses are varied

- Sandbox programs most commonly focus on demand-side resources
- Sandboxes can enable deployment of customer-sited batteries, distribution management technologies, modeling tools, and microgrids

Sandbox design can be improved to increase impact

- A stronger focus on advanced grid technologies may encourage more sandbox projects
- Scaling of programs isn't well documented and may need more focus

Sandboxes can:

- **Advance innovation**
- **Increase information collection and sharing**
- **Improve economic outcomes**
- **Enhance grid reliability and resilience**
- **Better meet customer needs**
- **Expand access to technologies**

Emerging Best Practices (1)

- Terms and objectives must be clear, ambitious, and have buy-in from utility and regulatory leadership and stakeholders.
  - Clearly define terminology such as “pilot,” “demonstration,” and “innovative” upfront and with stakeholder input.
  - Ensure that learning, speed, and eventual scaling are primary objectives.
  - Clearly identify scaling strategies and processes for projects that go through the sandbox mechanism.
- Identify barriers to innovation in the jurisdiction and determine which type of sandbox-type mechanism and other innovation vehicles are the best solutions.
  - For example, sandboxes can be structured to reduce uncertainty of utility cost recovery and burdensome regulatory processes and oversight.
- Provide clear information on project eligibility, application processes, and selection criteria that align with program objectives and employ templates or standard formats to reduce administrative burdens.
  - Create multiple pathways to participation so that innovators and stakeholders other than utilities can put ideas forward.
  - Structure projects to be simple and responsive to customer needs and desires.
  - Follow best practices for pilot design and implementation.

Emerging Best Practices (2)

- Establish clear reporting and evaluation requirements using metrics that align with desired outcomes.
  - Identify go/no-go checkpoints and criteria.
  - Require data and information-sharing as part of reporting by utilities and third-party participants.
- Dedicate sufficient staff resources, including cross-functional teams with pre-identified roles and processes for quickly reviewing applications (if relevant).
- Create channels for regular, candid, non-punitive conversations between regulators, utilities, innovators, and sandbox stakeholders.
  - Consider using advisory councils and assigning non-decisional Commission staff to help foster open dialogue.
- Create processes for continuous learning and checkpoints to adjust the sandbox mechanism over time.
- Spread the word and use multiple communication channels for sharing information on the sandbox mechanism and results and findings.

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