Beyond the Gridlock

A plan to affordably meet the needs of an AI datacenter-driven future

A Collaboration to Drive a More Affordable Grid

INNOVATION™ FORCE

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More than a century ago, America's first great energy transformation was powered by light. Edison's bulbs illuminated cities. Backed by coal and innovative grit, the infrastructure that gave birth to our modern society was born.

Today, we stand at the threshold of our second great transformation—this time powered by intelligence. Artificial intelligence is poised to become the most powerful technology humanity has ever created, next to the electric grid. And just like the grid, this new era will only be as strong as the system that powers and delivers it.

Unfortunately, that system is straining under the weight of what comes next. But what *could* come next as we scale data and computing power with the infrastructure of the grid is truly awe-inspiring.

After analyzing over 60 utility grid modernization plans revealing nearly 6,000 challenges, we understood why the industry was experiencing gridlock. Where to focus can feel daunting. That is why this report aimed to cut through the complexity and accelerate action by ranking the top 10 most urgent challenges based on what was being matched the most frequently. This report attempts to reduce complexity by focusing on 10 challenges with clearly defined problem statements that map to a technology stack of commercially available solution options. The report is interactive because the emerging technology landscape is constantly changing. This report is linked to our InnovationWorks platform that can actively map challenges to solutions in real-time. Because the industry is largely cooperative in nature, the goal is to create a centralized hub to accelerate innovation. By sharing challenges, we can remove risks, drive efficiencies and go faster together to find solutions together.

Many confuse innovation with breakthrough. We believe ingenuity drives down costs and innovation is a force multiplier toward affordability. That's what we've attempted to capture in InnovationWorks.

The job we have in front of us is massive. Like a century ago, those who innovated the most efficiently, those that collaborated and share learnings, influenced a great century of growth. The rest fell behind. It's no different today.

Let's get to work!

The Top 10 Challenges

A summary of the top 10 challenges covered in this report from an analysis of nearly 6,000 challenges.

001
Resilient Grid
Building a Weather and Wildfire Resilient Grid in the New Normal

002
Aging Grid
Upgrading Aging Assets in the New Normal

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Overcoming **Capacity** Bottlenecks.

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Meeting the future of OT/IT convergence

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Enabling the Workforce of the Future

Introduction

Capitalizing an Affordable Grid to Meet the Future

The Association for Edison Illuminating Companies

Vice President at AEIC

Get in Touch

This report highlights the work in front of us to modernize the grid. The technology to solve the key challenges exist. The hard part is not finding the solutions. It will be the ability to balance affordability with innovation and modernization to usher in the future.

The cost to operate and maintain the grid today is no longer just a function of the present—it is the compounding result of decades of deferred investment, increasing reliability demands, and the rapidly advancing dynamic energy transition. We are now burdened with paying for three overlapping challenges at once: yesterday's aged infrastructure, today’s reliability and climate resilience expectations, and tomorrow’s adoption of new technologies and capabilities.

This trifecta is placing unsustainable pressure on utility budgets, ratepayer affordability, and regulatory frameworks. Yet, regulatory and stakeholder conversations often isolate these pressures when, in truth, it is their combination that drives current costs. Fuel volatility, inflation, labor shortages, extreme weather, growing large-load interconnection requests (like data centers), and increasingly complex customer expectations all overlap in a system originally designed for a steady, linear future. But the future will be non-linear, unpredictable and require higher levels of flexibility that can only come from a digital backbone that will increasingly consist of non-wire solutions that are a combination of utility and non-utility owned generation.

So, what can we do about it?

The future grid will not be built by doing more of the same. We must modernize how we plan, how we regulate, and how we partner. It will require courage to modernize processes with shared responsibility for grid performance, and a reset of relationships between utilities, regulators, developers, large load customers like datacenters and communities.

We must stop solving within the box of outdated rules. It is time to rebuild grid by thinking out of the box.

Time to Rebuild the Grid By Thinking Out of the Box

We must modernize how we plan, how we regulate, and how we partner.
The following recommendations offer a path forward:

1

Create Safe Spaces to Innovate

Incentivize rapid piloting and experimentation that leads to production at scale

- Performance-based earnings mechanism
- Regulatory protection for well defined pilots
- Cross-utility learning

2

Utility/Developer Task Force

Utilities cannot plan in isolation. Create developer-utility alignment initiatives that will drive affordability

- Create interoperability standards that will enable data and DERs
- Vendor agnostic interoperability
- Technology matures faster, need to future proof investments

3

Capitalization of SaaS

As we move to more NWA and build out the needed data backbone, we need to consider the business model

- Capitalize NWA solutions
- Consider data, that is becoming the new backbone, as infrastructure
- Look to avoided costs that can be achieved through NWA and data

Time to Rebuild the Grid By Thinking Out of the Box

We must modernize how we plan, how we regulate, and how we partner.
The following recommendations offer a path forward:

4

Confronting the Load Crisis

Explosive, unpredictable new loads from hyperscalers is not compatible with 3–5-year IRP planning cycles.

- New disclosure rules for large load requests
- Regional planning task forces
- Real-time probabilistic forecasting tools

5

Overhaul IRP & System Planning

Current IRP planning was built for a steady grid. It now needs to account for non-linear load growth

- Rolling, adaptive planning.
- National and regional scenario planning.
- Non-Wires solutions as standard practice

6

Empowered Accountability

The regulatory model must empower future-oriented outcomes

- Support investments in planning tools, people and process
- Authorize build out of the data-driven digital backbone
- Require transparency with KPIs

Getting Started

Using this as an Interactive Report

InnovationForce

An Interactive Roadmap to Meet the Future

US utilities are projected to invest over $1 trillion to modernize an aging infrastructure originally designed for centralized generation. The stakes are high: the decisions we make today will determine whether we build a grid that is resilient, equitable, flexible, and affordable—or fall short of our climate and economic goals.

We estimate this report analyzes more than $100 billion in identified investment that were shared with regulators from publicly filed Integrated Resource Plans (IRPs), grid modernization strategies, asset management reports, and wildfire mitigation plans and more. Powered by InnovationWorks AI, we surfaced nearly 6,000 distinct challenges and identified the top 10 most frequently cited and most critical, trending challenges driving today's grid modernization priorities.

The next $1 trillion in grid investment is coming. How we spend it will define the future of the grid—and our ability to meet our climate, equity, and economic ambitions. This is a simplified way to define the capabilities we'll need to meet the future.

"We must stop solving within the box of outdated rules. It is time to rebuild the grid by thinking out of the box."

Dr. Elizabeth Cook, AEIC

These are not abstract trends. They are concrete problem statements of system constraints, and flexibility gaps. Together, they represent some of the most expensive and persistent pain points in the energy sector. By focusing on these high-leverage challenges as an industry, we hope to share with more affordable approaches that we can modernize the grid faster, more affordably, and with lower risk.

Yet despite substantial capital investment, many legacy systems remain costly to maintain and vulnerable to performance and climate risks. What's needed now is a more strategic approach—one that prioritizes modernization and leverages data over like-for-like "steel in the ground" replacements.

This report delivers the challenges and solutions.

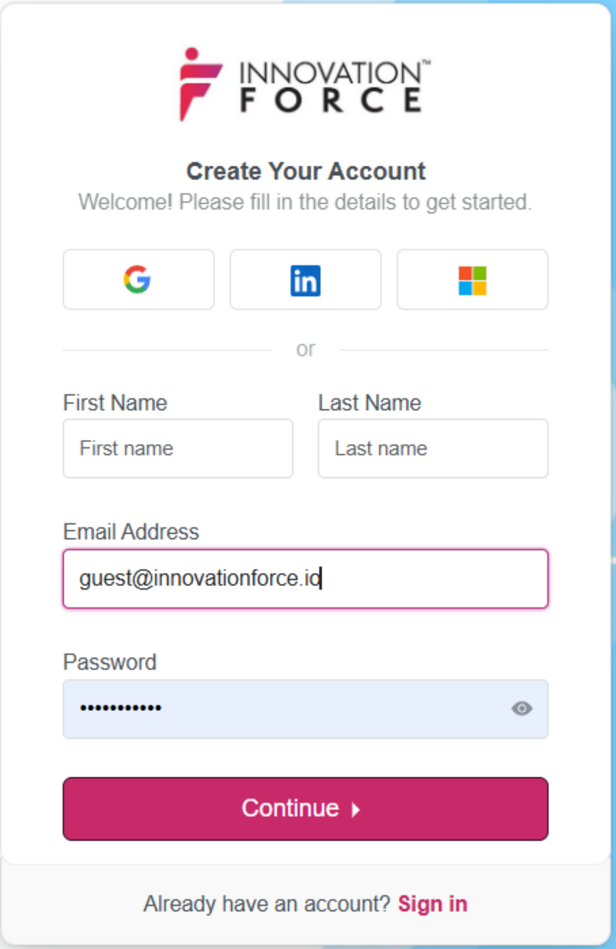
For every challenge, we share a structured tech stack framework to align investment drivers with commercially available solutions that can reduce costs, improve ROI, and leapfrog outdated infrastructure. Each stack is grounded in thousands of real-world solutions housed in our InnovationWorks platform, helping utilities reduce decision fatigue and avoid "shiny object syndrome", because chasing buzzwords like Virtual Power Plants or emerging technologies like digital twins won't solve anything unless tied to a systematic underlying challenge.

Every technology stack in this report is designed to solve a specific, validated problem and then map to real technology choices. These emerging technologies are changing. That's why we've made this an interactive report. You will get the most value by creating an account in InnovationWorks to find what your peers are working on and what commercially ready solutions are options to pilot or deploy now.

Create an Account to Get the Most from this Report

Create your complimentary InnovationWorks, account by clicking below

CLICK HERE



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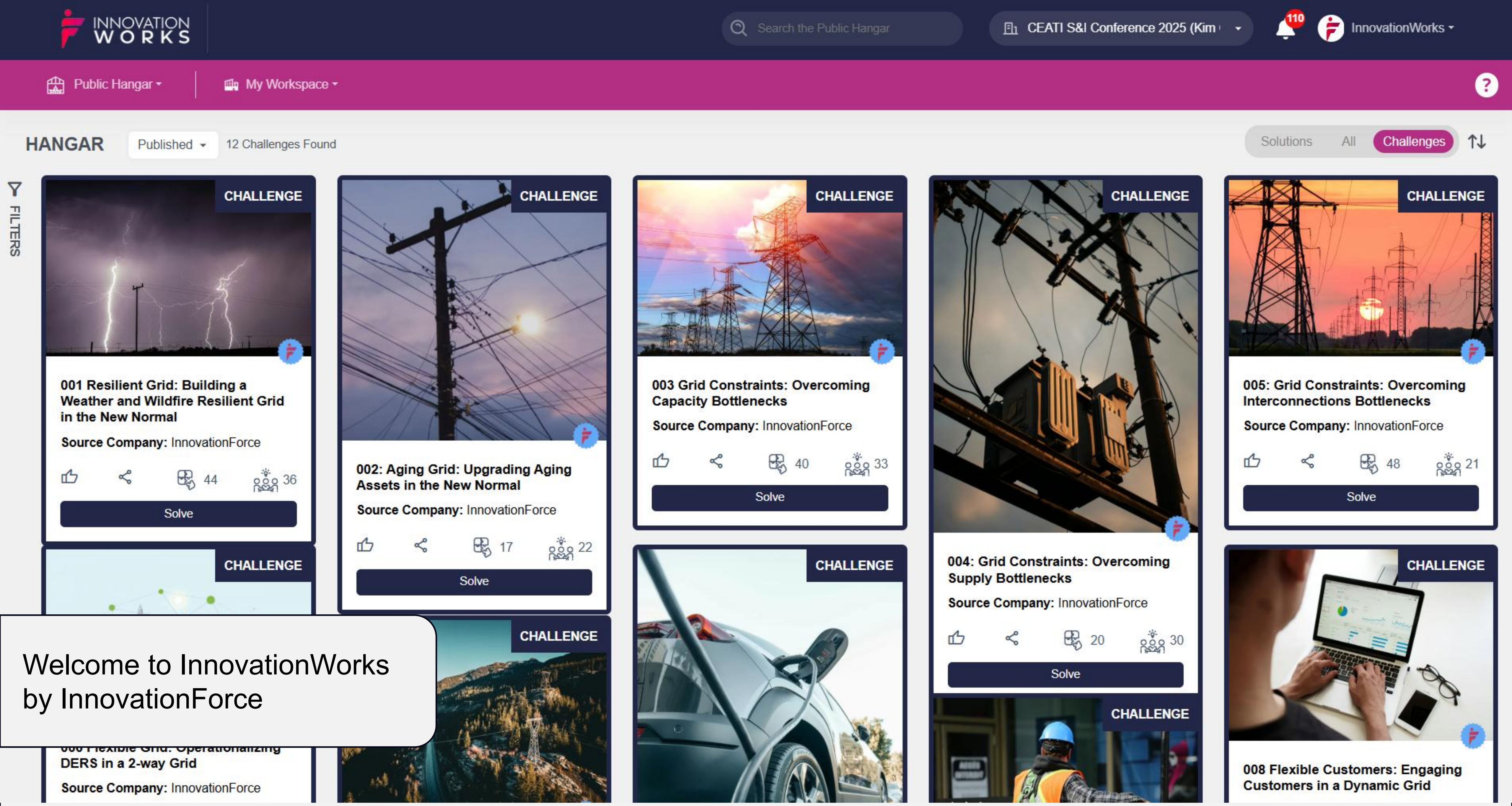


Welcome to InnovationWorks by InnovationForce

Solve Buttons in this Report are Hyperlinked

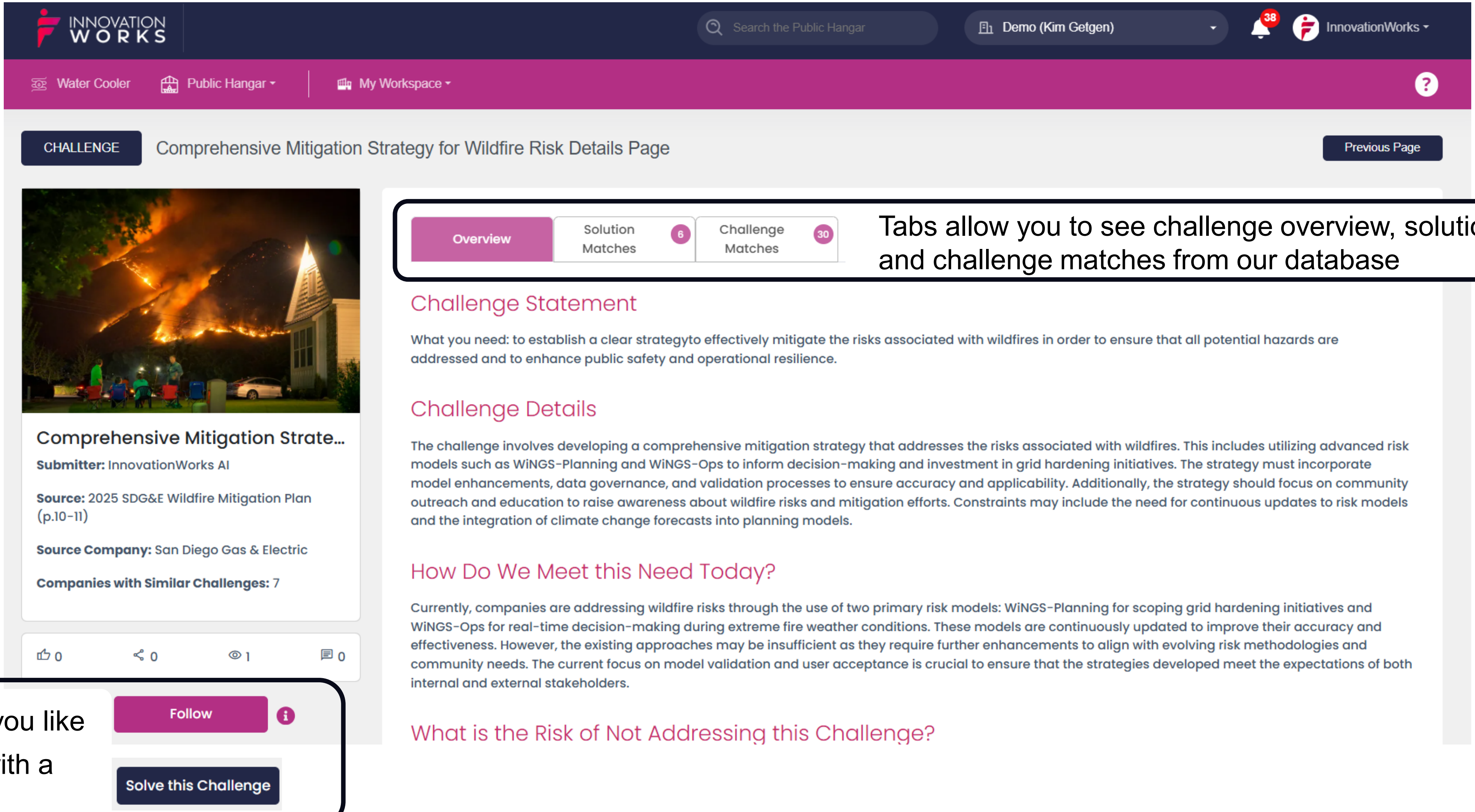
Same Challenge in InnovationWorks

Example Challenge from this Report

- All buttons are hyperlinked to a real challenge in the InnovationWorks platform.
- You can review the challenge overview to see the details by clicking the button.
- It requires you to create a FREE InnovationWorks account
- Without an account, you will hit a paywall.

With an account, you can bypass the log-in screen and go directly to challenge!

A Challenge Detail in InnovationWorks

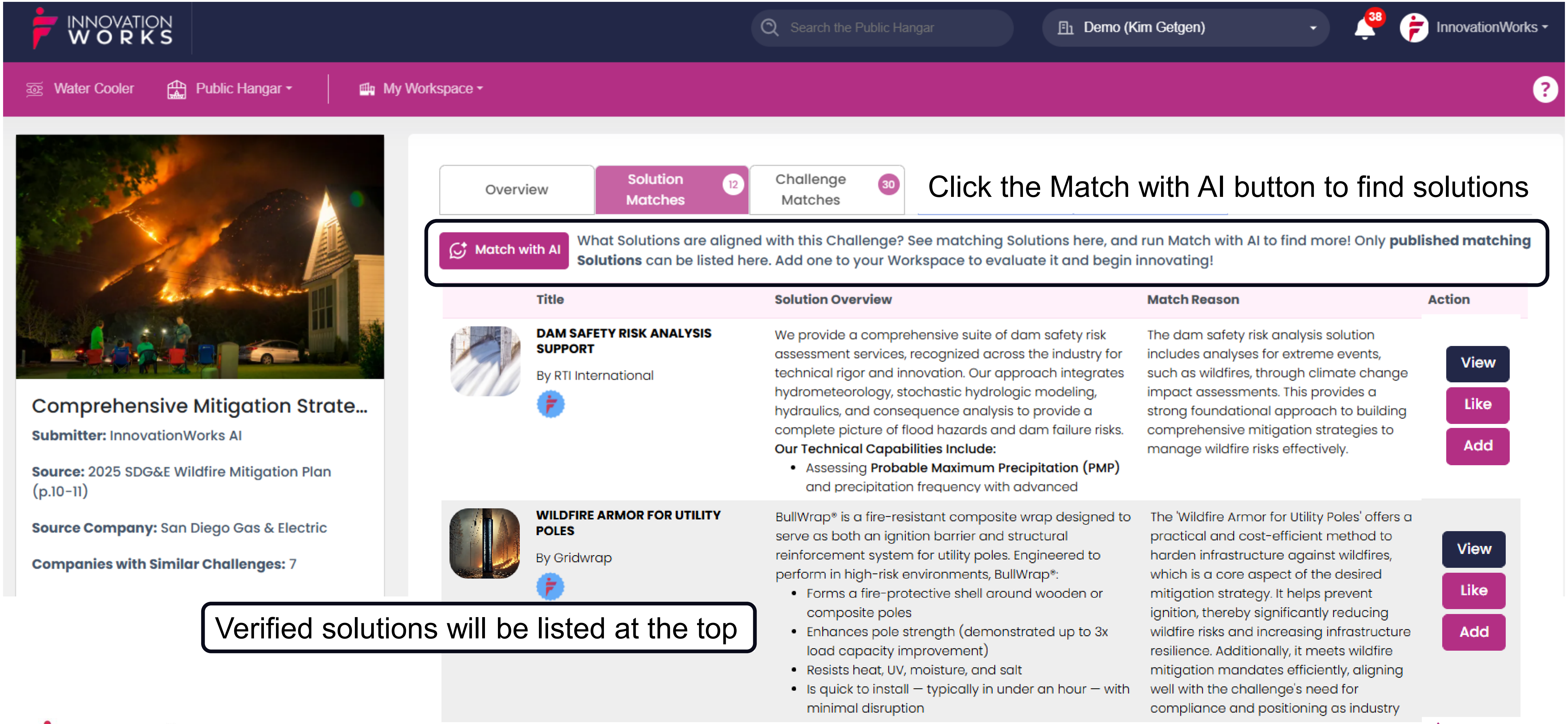


Tabs allow you to see challenge overview, solution matches and challenge matches from our database

Follow challenges you like

Are you a vendor with a solution? Solve!

Solution Matches in InnovationWorks



Click the Match with AI button to find solutions

Verified solutions will be listed at the top

The Top 10 Challenges

The Challenges

InnovationForce

The Challenges

001

Challenge Statement

Resilient Grid: Building a Weather and Wildfire Resilient Grid in the New Normal

We need targeted, cost-effective and risk-based resilience solutions to deliver reliability and resilience despite aging infrastructure and frequency in more extreme weather, flooding and wildfire events that disrupt service.

Themes

01

Wildfire risk mitigation: covered conductor, fast sectionalizing/relays, situational awareness (weather stations, AI, cameras), and non-wires options to respond to risks and reduce PSPS footprint.

02

Storm hardening & flood resilience, pole class upgrades, guying, structural replacements, selective undergrounding, substation flood barriers, tracked against reliability improvement and unit costs.

03

Outage automation such as FLISR/reclosers, ADMS and feeder automation for faster isolation and backfeed; improve SAIDI/SAIFI where feeder ties are sparse.

04

Situational awareness, comms, drones, field-area networks, satellite links in remote terrain, fiber core upgrades to keep control & telemetry during events

Challenge 001 Overview

Overview

Utilities are investing heavily in replacing and hardening aging grid infrastructure in response to electrification and extreme weather. Multi-billion grid modernization and wildfire mitigation plans have been approved.

Climate hazards are now directly tied to asset vulnerabilities, with SAIDI/SAIFI and cost-per-mile metrics guiding investment. Yet most spending flows to traditional, high-cost methods like undergrounding and pole replacement, while modern, fast-deploying technologies may be underutilized.

What's at Risk

Without fast-deploying, affordable modernization technologies and leveraging data for intelligences, utilities face longer outages, higher restoration costs, asset failures, and stranded innovation. Capital could continue to flow to outdated infrastructure while proven resilience technologies struggle to scale.

The New Normal: Building a Weather and Fire Resilient Grid Despite Aging Infrastructure

SOLVE

Current State

Capex-heavy solutions dominate; traditional pole replacements, vegetation management, and broad PSPS shutoffs.

Emerging tools like sectionalizing, wildfire AI, and predictive monitoring are stuck in pilots or fight for limited O&M budgets. Regulatory models reward asset-based investment over operational intelligence which will be the gold-standard needed to modernize the future grid.

Desired Outcome

Move toward fast and affordable resilience planning solutions that are cost-effective, modular and easy to deploy that can cut outages quickly and affordably. Data, software and communications would be capitalized alongside physical assets and, in some cases operational cloud-based software.

Utilities could shift from blanket rebuilds to targeted cost-effective hardening backed by real-time data, automation, and situational awareness.

Challenge 001

CHALLENGE

Eversource

We need to implement transmission upgrades to improve grid resilience and storm hardening to support and accelerate the siting of transmission projects essential for maintaining reliable energy delivery during adverse weather conditions..

SOLVE

CHALLENGE

PG&E

We need to improve grid visibility and flexibility to maintain a safe, reliable, and affordable energy grid to effectively respond to climate-induced challenges such as wildfires and extreme weather events.

SOLVE

CHALLENGE

FPL

We need to enhance their systems to prepare for extreme weather events, including winterizing generation units and ensuring cooperation with fuel suppliers to reliably serve customers during extreme weather conditions and minimize service disruptions...

SOLVE

CHALLENGE

SDG&E

We need to establish a clear strategy to effectively mitigate the risks associated with wildfires to ensure that all potential hazards are addressed and to enhance public safety and operational resilience.

SOLVE

Interested in learning more about these challenges? Click on the SOLVE button to learn more at the InnovationWorks platform.

Email support@innovationforce.io if you need help or have any questions!

CHALLENGE

Resilient Grid: Building a Weather and Wildfire Resilient Grid in the New Normal

We need targeted, cost-effective and risk-based resilience solutions to deliver reliability and resilience despite aging infrastructure and frequency in more extreme weather, flooding and wildfire events that disrupt service.

SOLVE

Tech Stack 001

BAU Options	Traditional Approaches and Results
Strategic Undergrounding	Eliminates storm/wildfire exposure $2M - $10M per mile
Pole/Conductor Replacement	Stronger infrastructure vs storms/wildfires ($50k-$200k per mile)
Traditional Vegetation Mgmt.	Reduce tree-related faults $1k - $2k per mile annually
Traditional GIS/Asset Mapping	Basic asset investor, outage and vegetation mgmt. ($1M - $5M/deployment
Manual Storm Response & stagging	Crews dispatched reactively
Public Safety Power Shutoff (broad)	Prevents wildfire ignitions via large de-energization zones

Modernization Levers	Descriptions
Covered Conductor Sectionalizing	Reduce wildfire/storm ignition risk; enable mile targeted PSPS
FLISR/ADMS Automation	Faster isolation & service restoration
Reinforcement Technology	Extend life of poles or physical grid assets without replacement
Structural Health Monitoring	Predictive detection of pole tilt/weakness. Target wrap & replacement
Advanced Materials Fire, Ice / Resistant Insulators	Region specific resilience to fire, ice and storms
Intelligent Substation Monitoring	Predictive failure detection, flood/fire alerts
Digital Twin technology	Model grid stress, prioritize upgrades

Tech Stack 001 Continued

Resilient Grid: Building a Weather and Wildfire Resilient Grid in the New Normal

We need targeted, risk-based and cost-effective resilience solutions to deliver reliability and resilience despite aging infrastructure and frequency in more extreme weather, flooding and wildfire events that disrupt service.

SOLVE

Modernization Levers	Descriptions
Advanced GIS (LiDAR/Drones/AI)	High resolution vegetation, wildfire and flood/storm mapping
Weather & Situational Awareness	Predictive ops, AI-driven/risk staging
Wildfire Detection Sensors	Early fire detection on grid assets
Wildfire AI Risk Modeling & Predictive PSPS	AI shrinks PSPS footprint, surgical shutoff
Integrated Vegetation + Wildfire AI	Dynamic fire/vegetation ignition risk forecasting
Flood Hardening	Protect substations, feeders from flooding surge
Cold Weather Resilience	Reduce line pole failures in extreme cold with coatings and monitoring
Flexible microgrids	Localized back-up and critical load protection hugs
Customer-Sited Backup Programs	Distributed resilience capacity
Batteries/Generators	Lowers PSPS impact
Advanced Communication	Ensure data and control (FAN, LTE, Sat)
Feeder Automatic Reconfiguration	Improves outage restoration and dynamically shifts load to reduce stress and avoid failures during storms, wildfires, and heat events
Non-Ignition Line Sensors	Advanced monitoring devices designed to avoid arcing or sparking, improving situational awareness in wildfire-prone areas
Falling Conductor Detection	High-speed monitoring that instantly trips a line if a conductor breaks

SOLUTION

Wildfire Armor for Utility Poles Details Page

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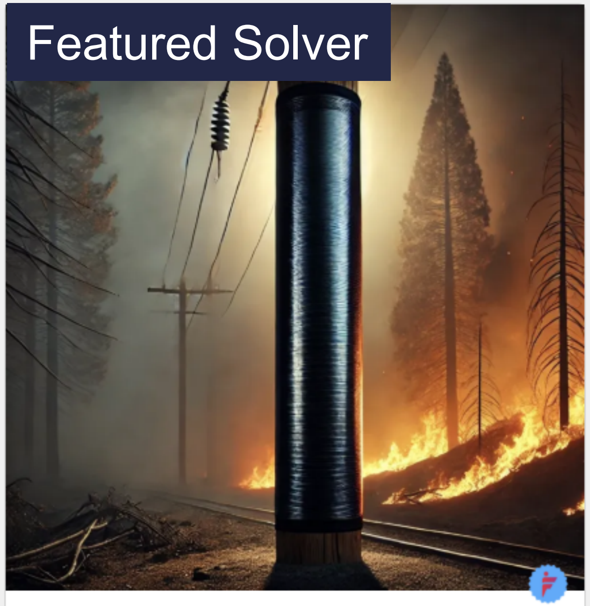

Wildfire Armor for Utility Poles

Submitter: Davoud Zamani

Company: Gridwrap

Source: -

Website: https://gridwrap.com/

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Overview | Solution Pilot Details | Challenge Matches 2 | Challenge Builder Matches

Challenge Statement

Customers need a fast, scalable, and field-ready wildfire mitigation solution for utility poles in order to reduce ignition risk, protect critical infrastructure, and avoid costly pole replacements.

Challenge Overview

As global temperatures rise and drought conditions worsen, wildfires have become more intense, frequent, and destructive. Utility infrastructure — particularly overhead distribution and transmission lines — has been a known source of ignition in many large-scale wildfires. Aging wooden poles are especially vulnerable, and existing wildfire mitigation strategies, such as vegetation management or undergrounding, are either too costly, difficult to scale, or ineffective during extreme weather. Utilities urgently need practical, cost-efficient tools to harden infrastructure and reduce ignition risk, especially in high-risk zones.

What is the Risk of Not Addressing this Challenge?

If this challenge remains unaddressed, utility providers face a growing risk of infrastructure-ignited wildfires, leading to catastrophic consequences including:

- Major grid outages and service disruptions
- Environmental devastation
- Loss of life and property
- Significant legal liabilities and regulatory penalties
- Erosion of public trust and increased insurance costs

Utilities will continue to absorb the economic burden of these disasters while struggling with outdated mitigation tools that fail under real-

GRIDWRAP

Traditional resilience planning has often treated aging infrastructure and extreme weather as separate challenges. They are tightly linked. Legacy assets, often built for the climate of the past, are increasingly failing under today's more extreme conditions. Events like the 2018 Paradise Fire, where a worn transmission hook ignited one of the deadliest wildfires in U.S. history, show how aging grid components can directly trigger catastrophic events when exposed to wind, heat, or drought.

Utilities have responded with high-capex programs such as undergrounding, pole replacement, and vegetation management. These can reduce risk, but they are expensive, slow, and often treat symptoms rather than root causes. Meanwhile, modernization tools, like wildfire detection sensors, AI-based PSPS targeting, covering poles, or predictive weather-asset overlays, offer faster, smarter, and more flexible ways to reduce risk across multiple hazard types.

These tools are often under-deployed, not because they're unproven, but because they don't fit easily into traditional capital recovery frameworks. As a recent Forbes article reported, utilities risk locking billions into hard infrastructure upgrades while leaving more agile and scalable solutions stranded in pilot purgatory. Unless regulations evolve to support the capitalization of software, situational awareness platforms, and targeted grid hardening, resilience investments will continue to overpay for underperformance, and leave the grid exposed to failure and safety risks.

Key Take-Away

Aging infrastructure and climate hazards are a compounding threat to grid reliability, customer safety, and affordability. Every storm, fire, and flood exposes legacy assets that were never built for today's conditions. Resilience requires more than hardening, undergrounding and replacement, it demands modernization.

To deliver resilient, affordable service in this new normal, utilities must move beyond traditional rebuild strategies and embrace targeted, data-rich and cloud-enabled solutions. Modern tools deliver faster resilience at lower cost, and with the right regulatory reforms, including capital treatment of cloud-based software as infrastructure and risk-based performance incentives, they can scale. Without this shift, we risk spending billions undergrounding the past, instead of preparing the grid to take advantage of the data-rich future.

002

Challenge Statement

Aging Grid: Upgrading Aging Assets in the New Normal

We need to modernize or replace aging assets to increase reliability while managing affordability and meeting the needs of our energy future.

Themes

01

Non-Wires Alternatives: Utilities could spend more repairing aging assets and face supply chain constraints. Embedding smart features and NWAs can help defer or avoid expensive upgrades.

02

Operationalizing asset data: strategic opportunity to move away from reactive replacement to predictive, condition-based upgrades that rely on data-rich and more automated inspection-based solutions.

03

Outage automation such as FLISR/reclosers, ADMS and feeder automation allow faster isolation and can improve SAIDI/SAIFI. With more data and intelligence, outage management can become more predictive.

04

AI, situational awareness & comms – field-area networks, drones, satellite links in remote terrain, fiber core upgrades to keep control & telemetry during events

Challenge 002 Overview

Overview

Much of the U.S. electric grid infrastructure like poles, transformers, breakers, and substations, was built 40–70 years ago and is now operating beyond intended lifespans. Aging assets create escalating reliability risks, safety hazards, and O&M costs, while also constraining the integration of renewable resources and electrification growth.

Modernizing these assets requires utilities to balance replacement vs. refurbishment, targeted upgrades vs. wholesale rebuilds, and explore non-wires alternatives (NWAs) to defer or avoid costly rebuilds.

What’s at Risk

If not addressed, reliability will continue to deteriorate as poles, transformers, and breakers fail more frequently, leading to longer outages, higher SAIDI and SAIFI metrics, and increasing customer dissatisfaction. Safety risks also rise exposing utilities to potential injuries, liability, and reputational harm. Utilities will spend more on emergency repairs and reactive maintenance rather than planned, efficient investment.

Aging Grid: Upgrading Aging Assets in the New Normal

SOLVE

Current State

Much of today’s electric grid infrastructure is well past its intended design life. Utilities are operating poles, transformers, substations, and breakers that in many cases were installed in the 1960s and 1970s. As these assets age, reliability has declined, with failures leading to more frequent and longer outages.

Maintenance practices are still largely reactive, with resources spent on emergency repairs instead of predictive, risk-based replacement.

Desired Outcome

Instead of blanket replacements, utilities can deploy more advanced inspection tools, predictive analytics, and risk modeling to extend the life of assets where feasible and replace them only when necessary. When upgrades are made, assets are installed with smart features such as sensors, communications, and automation capabilities that enable integration into advanced grid management platforms.

Challenge 002

Entergy

We need to replace aging poles and equipment to meet new standards to improve the reliability of the electric system.

SOLVE

Ameren

We need to address the rising costs associated with replacing aging infrastructure to maintain operational efficiency and reliability to mitigate the financial impact of unplanned outages caused by damaged and failed assets, especially in the context of increasing severe weather events.

SOLVE

Hydro One

We need to optimize the pacing of investments based on asset demographics, condition, and performance to mitigate risks associated with poor condition assets to ensure compliance with NERC and NPCC standards and enhance system reliability while minimizing operational risks

SOLVE

DTE

We need to address aging infrastructure across multiple substations to ensure reliability and capacity for new load growth to maintain operational efficiency and support the increasing demand for electricity in the region.

SOLVE

Interested in learning more about these challenges? Click on the SOLVE button to learn more at the InnovationWorks platform.

Email support@innovationforce.io if you need help or have any questions!

Tech Stack 002

Aging Grid: Upgrading Aging Assets in the New Normal

We need to modernize or replace aging assets to increase reliability while managing affordability and meeting the needs of our energy future.

SOLVE

BAU Options	Traditional Approaches and Results
Strategic Undergrounding	Eliminates storm/wildfire exposure on avg. $2M - $10M per mile
Pole/Conductor Replacement	Stronger infrastructure vs storms/wildfires (on avg. $50k-$200k per mile)
Traditional Inspections	Work crews manually inspecting assets
Traditional GIS/Asset Mapping	Basic asset investor, outage and vegetation mgmt. (on avg. $1M - $5M/deployment
Manual Storm Response & stagging	Crews dispatched reactively

Modernization Levers	Descriptions
Asset Condition Monitoring	Sensors, drones, AI-enabled inspections.
Automated Inspection	Analyze imagery from drones and other risks
Predictive Analytics	Failure modeling for poles, transformers
Structural health monitoring	Predictive detection of pole tilt/weakness. Target wrap & replacement
Non-Wires Alternatives	DERs, DERMs, Demand Response can avoid upgrades or extend asset life
Intelligent Substation Monitoring	Predictive failure detection, flood/fire alerts
Digital Twin technology	Model grid stress, prioritize upgrades

Tech Stack 002 Continued

CHALLENGE

Aging Grid: Upgrading Aging Assets in the New Normal

We need targeted, risk-based resilience solutions to deliver reliability and resilience despite aging infrastructure and frequency in more extreme weather, flooding and wildfire events that disrupt service.

SOLVE

Modernization Levers	Descriptions
Smart Transformers & Grid Edge Intelligence	Replace old transformers with smarter ones that monitor health
FLISR/ADMS automation	Faster isolation & service restoration
Digital Substations	Digital relays and automated fault isolation
Resilience oriented upgrades	Composite poles, undergrounding in high-risk areas
Predictive failure models	AI and analytics to predict critical failures before they occur
AI-driven Outage Management Analytics	Use machine learning data, asset condition and grid topology
Digital Asset Management	Asset inventory traceability & integrity
Flexible microgrids	Localized back-up and critical load protection hugs
Customer-Sited Backup Programs	Distributed resilience capacity
Batteries/Generators	Lowers PSPS impact
Advanced Communication	Ensure data and control (FAN, LTE, Sat)
Feeder Automatic Reconfiguration	Improves outage restoration and dynamically shifts load to reduce stress and avoid failures during storms, wildfires, and heat events
Fault Detection Line Sensors	Advanced monitoring devices designed to avoid or pinpoint faults and outages

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SOLUTION | Published | Touchless Asset Monitoring Details Page

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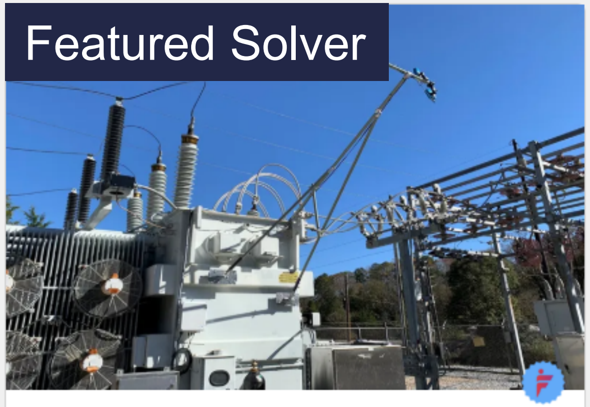
Featured Solver



Title: Touchless Asset Monitoring

Company: Systems with Intelligence

Website: https://www.systemswithintelligence.com/

Source: -

Workspace: Systems With Intelligence

Submitter: Richard Harada

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Overview | Solution Pilot Details | Challenge Matches 13 | Challenge Builder Matches

Challenge Statement

Customers need "Touchless" asset monitoring at substations in order to reduce O&M costs while having better and more meaningful data on their assets.

Challenge Overview

Substation and transformer monitoring systems are important to ensuring reliable operations and monitor transformers efficiently but expensive and time-consuming to inspect and monitor. Without visibility, it is nearly impossible to predict failure or accurately conduct preventative maintenance and end-of-life assets before failure. Name plate ratings and inspections aren't enough. Utilities need more meaningful real-time data on assets that could help predict asset health, maintenance, servicing and replacement. Additionally, with the amount of security incidents and need to physically protect substations, more rigorous monitoring and surveillance is required but crews can't be in two places at once. Trips to substations are often 20 of a utility's total O&M budget.

What is the Risk of Not Addressing this Challenge?

-

What is the Desired Outcome?

The ideal outcome is to have a solution that can monitor the substation assets automatically and inform the operations o
a condition anomaly that requires attention. The maintenance team will be able to repair the problem before a costly fai
should be easy to install and have a quick ROI.

systems with intelligence

Solution Overview

Website: https://www.systemswithintelligence.com/

Accurate asset data is not just an operational need; it is a matter of public safety and trust. The failure to properly track, inspect, and upgrade aging assets has already contributed to catastrophic events as covered in Challenge 001. Poor visibility into asset condition and gaps in inventory records meant critical risks went unidentified before it was too late can create safety concerns, destroy entire communities, and create billions in liabilities.

These risks underscore that utilities cannot afford to treat asset tagging, data integrity, and inventory accuracy as administrative housekeeping. Asset monitoring, management and prediction are critical and possible today by deploying the technology stack assigned to this challenge. They are the frontline defense against safety incidents, wildfires, and cascading outages. As climate risks intensify, regulators, customers, and insurers will expect utilities to demonstrate not only that they know where every asset is, but that they can prove those assets are maintained, modernized, and safe. New solutions that can analyze data sets are even able to predict catastrophic failures before they happen. Assets management is not just about hardware, it’s about getting comfortable with data, managing large data sets in the cloud and applying cutting edge analysis tools.

In short, a resilient and affordable grid begins with trustworthy asset data. Without it, utilities risk repeating the most costly and devastating failures in industry history.

Key Take-Away

Accurate asset data and inventory management is not a back-office task, it is the foundation of safety, reliability, and modernization. Without clear visibility into what assets exist, where they are located, and what condition they are in, utilities cannot prevent catastrophic failures like the 2018 Camp Fire in Paradise, California, which was sparked by aging equipment and poor asset oversight.

Reliable tagging and data integrity enable predictive maintenance, AI inspections, and smart grid technologies to function as intended, while also reducing O&M costs, improving outage response, and helping prioritize limited capital investments. The cost of getting asset data right is small compared to the billions in liability, regulatory penalties, and public trust lost from preventable failures.

A modern, resilient, and affordable grid begins with accurate asset data — without it, utilities risk building the future on a foundation of uncertainty.

003

Challenge Statement

Grid Constraints: Overcoming Capacity Bottlenecks

We need faster, more affordable solutions to upgrade the grid to overcome capacity constraints coming from rapidly rising AI/data center load and growing electrification needs from more customers with EVs, heat pumps, etc.

Themes

01

Non-Wires Alternatives like Virtual Power Plant (VPP) and DER Aggregation can unlock peak demand shift by 2030; avoid stranded DER value. This also stresses the importance of standardization for interoperability.

02

EV & Data Center load growth creates multi-GW additions stressing feeders; managed charging & interconnections needed. Load forecasting can help avoid overbuild and manage peaks.

03

At customer sites, electrification of heating & industrial loads can reduce winter/summer peak risk outpacing capacity; integrating demand response/VPPs & thermal storage could help shift and shape load.

04

Interoperability and standardization required to overcome interconnection delays as well as enabling new applications such as VPPs and DERMS systems to dispatch and control.

Challenge 003 Overview

Overview

Distribution load is increasing at a pace that the grid was never designed to support.

U.S. utilities face rapidly rising distribution load from AI/data center growth, building/industrial electrification, and distributed energy resources (DERs), EVs and heat pump adoption that are all stacking demand on distribution feeders and substations.

What’s at Risk

Customer could be left with stranded assets if data centers cancel interconnections or offset loads with their own generation stacks, leaving expensive infrastructure underutilized.

The reliance on capital-heavy solutions (vs non-wires alternatives) could force customers to pay more than necessary to maintain reliability.

Grid Constraints: Overcoming Capacity Bottlenecks

We need faster, more affordable solutions to upgrade the grid in order to overcome capacity constraints coming from rapidly rising distribution load stress from AI/data center growth and electrification needs of customers with EVs, heat pumps, etc.

SOLVE

Current State

Business-as-usual (BAU) approaches to upgrade traditional feeder and substation is too slow (on avg. 3–5 years) and expensive (on avg. $5M+ per 10 MW substation upgrade).

Even DR and energy efficiency programs are rigid and will not be enough to shift demand shifts in shape or location needs over the long-term.

Desired Outcome

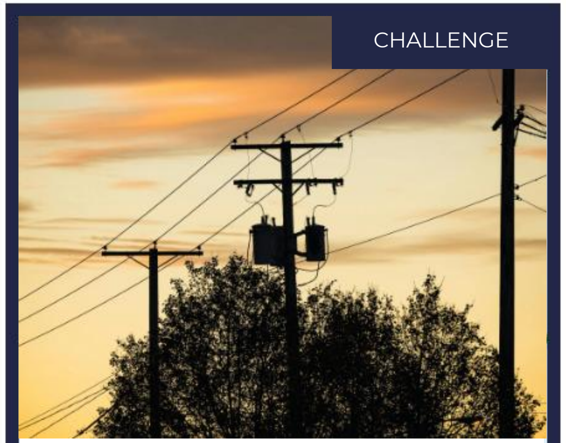
Instead of locking in higher bills through decades of capital cost recovery, customers would see faster savings and more reliable service with newer solutions like virtual power plants, managed EV charging, thermal load flexibility, and DERMS-enabled forecasting solutions that could deliver avoided costs.

Challenge 003

ComEd

We need to upgrade infrastructure capacity to accommodate new peak demands that could exceed allowable limits of substation transformers to maintain service quality and prevent asset overload and low voltage violations that negatively impact customer service.

SOLVE



Duke Energy

We need to upgrade the existing energy infrastructure to handle projected increases in energy loads, particularly during peak demand periods to ensure reliable energy delivery and meet the growing demands of consumers without compromising service quality.

SOLVE

Arizona Public Service

We need to enhance grid capacity to accommodate the projected increase in total load requirements to ensure reliable energy delivery and meet future energy demands effectively.

SOLVE

Hawaiian Electric

We need to upgrade substations and lines, and add smart switches to improve operating flexibility and capacity to enable bi-directional power flow from future DERS

SOLVE

Interested in learning more about these challenges? Click on the SOLVE button to learn more at the InnovationWorks platform.

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Tech Stack 003

CHALLENGE

Grid Constraints: Overcoming Capacity Bottlenecks

We need faster, more affordable solutions to upgrade the grid to overcome capacity constraints coming from rapidly rising AI data center distribution load stress and electrification needs of customers with EVs, heat pumps, etc. Instead of "steel in the ground", where can AI and software drive capacity and avoided costs?

SOLVE

BAU Options	Traditional Approaches and Results
Substation Feeder Upgrade	Add new capacity ~$500k/MW for a 20-40 yr payback
Energy Efficiency programs	Permanent load reduction of 1-2% per program at $200-$400 per kW saved
Demand Response	Shifts 5-10% peak load via dispatchable programs ~$50-$150 per kW enrolled

Modernization Levers*	Description of New Solutions
Virtual Power Plant	Aggregate DERs (solar, batteries, thermostats, EVs, into dispatchable capacity)
Customer Sited Storage	Provide targeted peak shaving, aggregated into portfolios
Managed EV Charging	Align EV load with off-peak system capacity
Thermal Building Heat	Shift HVAC and heating loads, integrate thermal storage
Forecasting & DERMS tools	Enable visibility, coordination and optimal dispatch, avoiding over building
Dynamic Line Rating	Unlock 10-20% hidden feeder line capacity
Volt/Var Optimization	Reduce peak by 1-2% free 2-4% feeder headroom
Intelligent Substation Monitoring	Enable predictive maintenance, avoid unnecessary expansions
Flexible Interconnections	Allow new large loads to rapidly connect to curtail/flex instead of full infrastructure
Phase Balancing	Balances load across phases, stabilize feeder voltage, unlocking hidden capacity
Dynamic Load Optimization	Communicates flexibility, orchestration of EVs, heat pumps, data centers.
AI Driven Automated DR	Next-gen DR uses AI to dispatch load reductions dynamically scaling beyond static curtailment
Tower Raising Technology	Boost clearance and enables reconductoring at 10-20% of a new build

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Featured Solver

Title: Empowering Dynamic Phase Balancing

Company: Switched Source

Website: https://www.switchedsource.com

Source: InnovationWorks AI

Workspace: Switched Source

Submitter: InnovationWorks AI

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Overview | Solution Pilot Details | Challenge Matches 11 | Challenge Builder Matches

Challenge Statement

Customers need Electric utilities need a distribution automation device that can balance power flow between phases in order to ensure reliable and efficient electricity supply while accommodating increased renewable energy resources and electric vehicles.

Challenge Overview

Electric utilities face the pressing challenge of ensuring a reliable and resilient electricity supply at the lowest possible cost, while simultaneously grappling with the growing demand for distributed solar and electric vehicle integration. This necessitates finding solutions that address operational costs, efficiency, and grid future-proofing, which are complex due to the phase imbalances in distribution circuits. Without resolving these imbalances, utilities struggle with issues such as inefficient Volt VAr Optimization, the need for costly infrastructure investments like three-phase line extensions, and reduced hosting capacity for renewable energy.

What is the Risk of Not Addressing this Challenge?

If the Phase-EQ solution is not implemented, utilities risk continued inefficiencies and high operational costs as they struggle to manually balance phase loads. This can lead to lower power quality, inadequate capacity for hosting renewable energy sources and integrating electric vehicles, and increased capital investments in infrastructure upgrades. Ultimately, failing to address the power imbalance could hinder the grid's preparedness for future energy requirements and reliability challenges.

What is the Desired Outcome?

The intended outcome of the Phase-EQ solution is to optimize power distribution by dynamically balancing power flow ac circuit. This will lead to improved power quality, enhanced distribution system energy efficiency, an increase in renewable and the overall resilience and reliability of the supply grid.

SWITCHED SOURCE

The U.S. grid is facing a capacity crunch driven by explosive demand from data centers, EVs, and electrification. Like the wildfires and frequency of 100-year storms, this new capacity demand feels like a once-in-a-lifetime or generation event. The default utility response, building substations and reconductoring feeders, is increasingly unsustainable. These assets are expensive, slow to build, and risk becoming stranded if demand projections miss. In contrast, non-wires alternatives (NWAs) like managed EV charging though software DER integration and control, or exploring thermal flexibility, and virtual power plants could offer the same capacity relief at a fraction of the cost and with far faster payback.

Yet despite technical readiness and successful pilots, most NWA solutions are software-based and do not fit the utility business model where they can earn returns on capital assets. Some states are beginning to act. Reforms in New York, Massachusetts, and Hawaii now allow certain NWAs to be capitalized or incentivized through performance mechanisms. These are promising steps, but until regulatory frameworks shift to reward flexibility and avoided costs, grid investment will continue to favor steel over software, even when the economics point the other way.

Key Take-Away

The cheapest, fastest, and most customer-friendly way to meet new demand is through NWAs, meaning we may not need a new substation every time.

But until utility incentives are aligned and these new technologies are tested, modernization will stall, and stranded assets will mount. This makes regulatory reform around NWAs one of the most important levers in avoiding billions in unnecessary costs and ensuring the grid evolves to meet the demands of an electrified economy.

004

Challenge Statement

Grid Constraints: Overcoming Supply Chain Bottlenecks

We need a resilient, diversified, and regionally aligned energy infrastructure supply chain to achieve timely and cost-effective grid modernization at the pace required by electrification and growing capacity needs.

Themes

01

Supply Chain & Manufacturing Bottlenecks: Shortages to replace the millions of pole-top and pad-mount transformer units needed for customer connections and load growth. Manufacturing delays also impacting smart meters and switches.

02

Supply Chain Concentration: Few domestic manufacturers; reliance on global suppliers could drive up costs and compliance risks. New tarifff policies could increase costs further on imports – especially steel and timber.

03

Capex pressure driving multi-billion dollar spends across utilities while much smaller OPEX budgets means fewer resources to manage software or cloud-based applications that can help manage through the bottleneck.

04

Industry needs to move away from proprietary systems and toward vendor agnostic headend solutions for investment protection from stranded assets in supply chain crisis.

Challenge 004 Overview

Overview

Core grid equipment from transformers to meters, and cables to switchgear are facing long lead times and rising costs.

As of mid-2025, transformer prices have climbed 60–80% since 2020, and lead times for power transformers now exceed 2.5 years. Experts predict a potential 30% supply shortfall for power units and 10% for distribution units by year-end.

What's at Risk

Delays stall new customer connections, EV charging, and data center interconnections. Aging fleets risk failures that utilities cannot quickly replace, raising outage and safety risks.

Emergency purchases drive up costs, while meter delays undermine affordability programs and demand flexibility.

CHALLENGE

Removing Supply Chain Bottlenecks

SOLVE

Current State

Most transformer fleets are 30–40+ years old, and many AMI systems are due for replacement just as supply chains tighten.

Procurement is often one-off and reactive, with limited vendor pools and dependence on global suppliers. Domestic manufacturing capacity remains thin.

New software-based technologies could offer leapfrog opportunities.

Desired Outcome

Utilities move from reactive replacement to a modernization strategy. Bulk purchasing and standardization shorten lead times, refurbishment extends asset life, and smarter equipment embeds sensing and control.

Paired with DER flexibility, this reduces load stress and ensures reliability, electrification progress, and affordability.

Who Has Challenge 004?

CHALLENGE

National Grid

We need to secure essential major materials, including power transformers, control enclosures, and circuit breakers, to support its construction schedules to avoid delays in project execution and ensure the successful implementation of the Future Grid Plan.

SOLVE

CHALLENGE

Duke Energy

We need to address the extended lead times for equipment and permitting that are delaying the development of new generation resources to streamline the planning process and enhance the timely implementation of infrastructure projects..

SOLVE

CHALLENGE

ConEd

We need to manage supply chain disruptions that interfere with the lead time and implementation timelines of Non-Wires Solutions (NWS) portfolios to ensure timely and effective implementation of NWS projects, which are critical for meeting load relief needs and enhancing operational efficiency.

SOLVE

CHALLENGE

ComEd

We need to address persistent supply chain disruptions that are causing delays in project timelines to ensure timely project completion and maintain operational efficiency.

SOLVE

Interested in learning more about these challenges? Click on the SOLVE button to learn more at the InnovationWorks platform.

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Removing Supply Chain Bottlenecks

We need a resilient, diversified, and regionally aligned energy infrastructure supply chain to achieve timely and cost-effective grid modernization at the pace required by electrification and growing capacity needs.

SOLVE

Tech Stack 004

BAU Options	Traditional Approaches and Results
Replace Distribution Transformers	Meets incremental load; customer connections
Replace Substation Transformers	Maintain substation reliability; load growth
Meter Replacement	Customer billing, TOU enablement
Switchgear / Breaker Replacement	Reliability at substations and feeders

Modernization Levers*	Description of New Solutions
Regional Procurement Pools	Shorter lead times and unit costs
Standardization of Specs	Fewer custom builds, faster delivery
Mobile/Modular Transformer/Switchgear	Backstop for failures; bridges supply gaps
Refurbishment & Life extension	Extend fife 5-15 years
DER Flexibility & VPPs	Defers ~10-20% of transformer feeder upgrades
Vendor Agnostic Headend Systems	Open data models for AMI and smart meter data
Power Electronics (Solid State Transformers)	Voltage/VAR support, bidirectional power flow & power quality data for DERs and data centers
Non-Wires Alternatives	Defers substation feeder capacity projects (see Challenge 001)
Smart Distribution Transformers	Grid-edge visibility; DER hosting
Dynamic rating	Reliability extension
Digital Twin Planning Tools	Simulate grid expansion options, reliability extension
Edge Controllers & Comms	Local coordination of DER clusters and EV fleets; low-latency
IEEE Interoperability	Protocol agnostic solutions to avoid proprietary vendor lock-in

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SOLUTION | Published

Preventing Transformer Failures Through Load Optimization Details Page

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Featured Solver

Title: Preventing Transformer Failures Through Load Optimization

Company: Edge Zero

Website: https://edgezero.co/

Overview | Solution Pilot Details | Challenge Matches 1 | Challenge Builder Matches 1

Challenge Statement

Customers need real-time transformer load data in order to prevent failures and extend asset life.

Challenge Overview

As load profiles shift due to electrification, rooftop solar, and EV charging, many distribution transformers are operating closer to or beyond their design limits. Traditional planning methods rely on generalized load curves or aging SCADA snapshots that miss phase-level detail. Without accurate transformer-level utilization data, utilities either under-forecast, risking failure, or overbuild infrastructure, straining capital budgets. This creates a dilemma: replace assets prematurely, or wait until failure occurs. Furthermore, unbalanced loads across phases reduce transformer efficiency and shorten operational life, especially when the imbalance is sustained or occurs at peak times. The lack of real-time insight into how transformers are performing makes strategic asset planning difficult and introduces operational risk.

What is the Risk of Not Addressing this Challenge?

Failure to detect loading trends or phase imbalances at the transformer level can lead to equipment overheating, phase failure, neutral damage, or even fires in worst-case scenarios. Asset failure often results in unplanned outages, emergency repairs and increased operating costs. Meanwhile, without accurate load data, utilities may continue to size replacements based on worst-case assumptions, overbuilding capacity and tying up CapEx that could be directed elsewhere. This leads to inefficient infrastructure spending, regulatory scrutiny and missed opportunities to modernize the

Edge Zero

What is the Desired Outcome?

Utilities need to identify stressed transformers before they fail, defer replacements where capacity is not actually exceeded and target upgrades where justified. The goal is to build a network-wide understanding of transformer performance and loading trends to shift from schedule-based replacement to

The U.S. grid is facing a supply chain bottleneck across its most critical equipment. Transformers remain the most visible bottleneck, but similar constraints are hitting smart meters, switchgear, breakers and batteries. Utilities are being forced into reactive replacement cycles, paying premiums and stretching aging fleets well beyond design life. This creates a dual threat: reliability declines from equipment failures, and stalled electrification as EV charging, housing, and data centers wait for hardware.

The crisis also presents an opportunity. By shifting from one-off procurement to standardized specifications and pooled purchasing, utilities can shorten delivery times and stabilize costs. Refurbishment and modular mobile units can bridge near-term gaps. Most importantly, the next wave of equipment replacements can serve as a modernization lever: smart transformers, adaptive meters, and power electronics provide embedded sensing, control, and flexibility that reduce the need for bolt-on devices and defer larger upgrades. In high-growth areas, these leapfrog options offer both reliability and power quality for digital industries, while lowering lifecycle costs for customers.

The supply chain bottleneck will not resolve overnight. But treated strategically, it can accelerate the shift from twentieth-century copper-and-steel assets toward intelligent, modular systems that strengthen both resilience and affordability. In some cases, “leapfrog” opportunities present itself allowing utilities to jump from an outdated technology to a more modern one skipping an investment cycle (e.g., AMR/AMI).

Key Take-Away

Supply chain constraints are a crisis, but also a chance to leapfrog and modernize.

By combining bulk procurement, refurbishment, and smart-ready equipment, utilities can keep electrification on track, reduce reliability risks, and transform replacements into long-term modernization wins.

These challenges spotlight the need toward interoperability and future-proofing investments with vendor-agnostic solutions.

005

Challenge Statement

Grid Constraints: Overcoming Interconnection Bottlenecks

We need a more scalable, cost-effective, and scenario-driven regional transmission planning and interconnection capability to achieve accelerated the dynamic energy transition, improved grid reliability, and reduced project delays under new FERC mandates.

Themes

01

Interconnection queue backlogs, especially in MISO, PJM, and CAISO face multi-year delays. Cancelling projects could cause utilities to miss capacity needs and dynamic energy transition targets.

02

Transmission congestion, limited transfer capacity raises congestion costs. Improved flow via reconductoring, DLR, and targeted expansions.

03

Cost Allocation Disputes. States and utilities often argue over who pays for regional upgrades. FERC 1920 seeks to standardize benefit-cost methods, but implementation remains uncertain.

04

Planning fragmentation, regional planning is siloed and often missing local distribution needs and state policies. New requirement for 20-year scenario-based planning.

Challenge 005 Overview

Overview

Explosive demand from renewables, data centers, and electrification has pushed interconnection queues past 2,600 GW, with 4–5 year delays. Transmission congestion drives up costs, while disputes over who pays slow expansion.

FERC Order 1920 requires 20-year scenario planning and cost sharing, but execution is uneven.

What's at Risk

Clean energy projects risk cancellation, billions in congestion costs flow to customers, and reliability suffers as load grows faster than capacity. Cost allocation fights and permitting delays compound the problem.

Clearing the Backlog: Accelerating Interconnection Through Modern Solutions

SOLVE

Current State

Utilities still default to costly, slow new 345 kV lines or redispatch, which can exceed $100M annually.

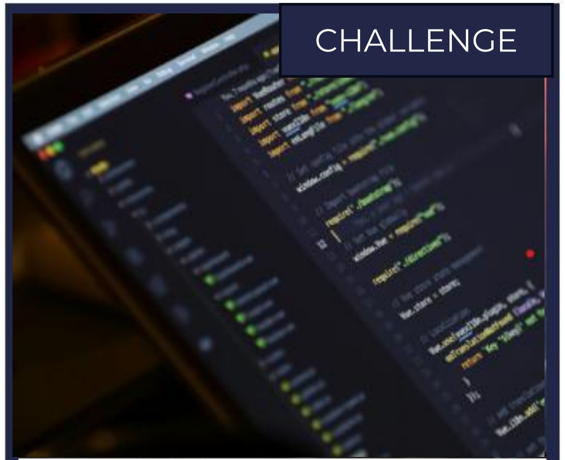
Grid-enhancing technologies like reconductoring, dynamic line ratings, and AI queue tools are proven, cheaper, and faster — but could remain sidelined by capex bias.

Desired Outcome

A balanced approach: targeted new lines plus rapid deployment of modernization tools that unlock capacity in 1–3 years at 70–80% lower cost.

Transparent, faster interconnection and scenario-based regional planning deliver affordable, reliable expansion aligned with dynamic energy transition goals.

Challenge 005



ConEd

We need to automate the application management portion of the interconnection process, including application submittal, validation, tracking, and approval to streamline the interconnection process for distributed energy resources (DERs).

SOLVE

SCE

We need to streamline the interconnection application process to eliminate reliance on paper or soft copy requests to reduce manual processing times and improve the efficiency of the interconnection process..

SOLVE

Hawaiian Electric

We need to significantly upgrade the transmission and distribution systems to accommodate the interconnection of Distributed Energy Resources (DER) selected by the RESOLVE model to ensure system stability and meet the forecasted peak demand by 2046 and beyond.

SOLVE

XCEL

We need to identify and incorporate the costs associated with interconnecting Distributed Energy Resources (DER)to ensure optimal plan selection in the Integrated Resource Plan (IRP) to effectively manage costs and streamline the interconnection process for DER projects.

SOLVE

Interested in learning more about these challenges? Click on the SOLVE button to learn more at the InnovationWorks platform.

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Tech Stack 005

Clearing the Backlog: Accelerating Interconnection Through Modern Solutions

We need a more scalable, cost-effective, and scenario-driven regional transmission planning and interconnection capability to achieve accelerated the dynamic energy transition, improved grid reliability, and reduced project delays under new FERC mandates.

SOLVE

BAU Options	Traditional Approaches and Results
Build new 345 kV transmission lines	On avg.$5M-$10M per mile, 7-10 years to permit and build
Substation expansion	On avg. $5M for 10 MW of capacity, decades to recover
Dispatch and curtailment	Pay generators to shift output or turn off to manage congestion

Modernization Levers*	Description of New Solutions
Advanced Reconductoring	Increases thermal limits of existing lines, avoiding new ROW.
Dynamic Line Rating	Unlock 10-20% hidden feeder line capacity
Phase-Shifting Transformers	Re-routes flows to balance underutilized corridors
Modular FACTS Devices	Smart Valves deployable in months reduce congestion and enhance flexibility.
Topology Optimization Software	Uses algorithms to optimize flows, often unlocking 5–10% capacity.
Storage-as-Transmission	“Grid booster batteries” acta as shock absorber at congested nodes
AI Queue Automation	Cuts interconnection study times 30-50%, reduces cancellations
Hosting Capacity & Cluster studies	Improved transparence and reduces study rework
Hybrid Interconnection	Storage + renewables raised capacity factors and reduces upgrade triggers
Flexible Interconnection Agreements	Offers limited-service interconnection to speed project entry
Digital Twin Planning Tools	Simulate grid expansion options, avoiding stranded investments
Tower Raising Technology	Boost clearance and enables reconductoring at 10-20% of a new build
FERC 1920	Integrates 20-yr scenarios, links T&D and DER
Regional Cost-Sharing Frameworks	Reduces disputes, acerates projects
Congestion Hedging/Capacity Rights	Market incentives for third-party solutions

Transmission is now the most visible chokepoint. Interconnection queues exceed 2,600 GW, and only a fraction of projects survive the 4–5 year wait. Meanwhile, U.S. transmission build-out remains far behind need, with annual line miles added falling even as demand from renewables, electrification, and data centers surges. Congestion costs are climbing into the billions, directly impacting customers.

Traditional approaches, new 345 kV lines or redispatch, remain slow, costly, and uncertain, often taking a decade or more and locking in 30–40 year recovery periods. In contrast, modernization levers like advanced reconductoring, dynamic ratings, flow control, digital planning, and storage-as-transmission can unlock significant capacity in 1–3 years at an estimated 70–80% lower cost. The technologies are proven, but regulatory and institutional inertia could keep them sidelined in pilots rather than deployed at scale.

Unless planning and incentive structures evolve, the U.S. risks creating two forms of stranded assets: oversized, delayed transmission projects that overshoot actual demand, and innovative grid-enhancing solutions that remain underutilized despite public and private investment.

Key Take-Away

The grid needs a balanced strategy: new transmission where essential, but rapid deployment of proven modernization tools everywhere else.

Without this shift, billions will be spent on slow, high-cost projects while cheaper, faster solutions remain idle delaying dynamic energy transition goals and raising costs for customers if the largest generators do not join the grid.

006

Challenge Statement

Flexible Grid: Operationalizing DERS in a 2-way Grid

We need advanced DER integration capabilities, including real-time visibility, dynamic control, and planning tools to achieve safe, scalable, and reliable operation of a two-way, distributed energy grid.

Themes

01

Strategic use of operational data increases hosting capacity and visibility gaps, lack of real-time feeder capacity data, project delays for DER developers.

02

Voltage and protection challenges; high solar penetration creates voltage and reverse power flows; protection schemes fail in bi-directional grid.

03

Interoperability and Operational Flexibility Needs: DERs not integrated into dispatchable operators, DR, storage and EV charging flexibility remain siloed.

04

Planning tool modernization: Integrated Capacity Analysis, DERMS, ADMS and lack of automation could lead to costly overbuild or DER value.

Challenge 006 Overview

Overview

Distribution grids were designed for one-way power flows, from substation to customer, but with high penetration of rooftop solar, behind-the-meter batteries, EVs, and building flexibility, the grid is increasingly operating as a two-way, dynamic system.

This problem goes beyond the capacity challenge to focus on voltage stability, protection coordination, and dispatch visibility

What's at Risk

Customer could be left with stranded assets if data centers cancel interconnections or offset loads with their own generation stacks, leaving expensive infrastructure underutilized.

The reliance on capital-heavy solutions could force customers to pay more than necessary to maintain reliability.

CHALLENGE

From One-Way to Two-Way Flow: Operationalizing DERs for a Dynamic Distribution Grid

SOLVE

Current State

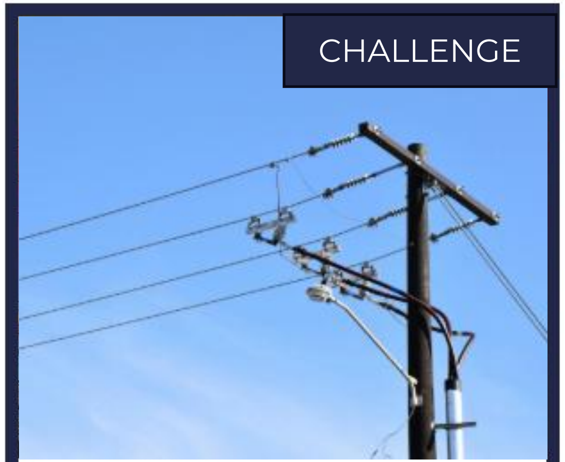
Traditional tools and planning methods cannot manage these new dynamics at scale, and without modernization, utilities face safety risks, interconnection backlogs, and missed opportunities to leverage DERs as grid assets.

Desired Outcome

Instead of locking in higher customer bills through decades of capital cost recovery, utilities would unlock faster savings and greater reliability by adopting modern grid solutions—such as virtual power plants, managed EV charging, and DERMS-enabled forecasting.

These technologies enable cost-effective alternatives to traditional infrastructure, delivering measurable avoided costs and improving service for all customers.

Challenge 006



Southern Company

We need to assess the necessary technology to stabilize the grid due to increased Distributed Generation (DG) adoption in order to ensure reliable power delivery and adapt to changing regulatory policies and Grid Resource Capacity (GRC) structures.

SOLVE

Dominion

We need to fundamentally change the electric grid to accommodate the dynamic flow of electricity from Distributed Energy Resources (DERs) in order to enhance grid reliability, improve power quality, and maximize the value of DERs while maintaining consistent electric service for customers..

SOLVE

ComEd

We need to upgrade existing distribution systems that were not designed for two-way power flows from customer premises to substations in order to ensure safe and reliable operation of the grid as renewable energy sources become more prevalent.

SOLVE

Duke Energy

We need to expand the deployment of distributed energy resources across the service area in order to improve grid resilience

SOLVE

Interested in learning more about these challenges? Click on the SOLVE button to learn more at the InnovationWorks platform.

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CHALLENGE

From One-Way to Two-Way Flow: Operationalizing DERs for a Dynamic Distribution Grid

We need advanced DER integration capabilities, including real-time visibility, dynamic control, and planning tools to achieve safe, scalable, and reliable operation of a two-way, distributed energy grid.

SOLVE

Tech Stack 006

BAU Options	Traditional Approaches and Results
Traditional Feeder Upgrades	Reconductoring, voltage regulators., adds capacity addresses voltage rise
Blanket Interconnection	Ensures safety, but adds time/cost

Modernization Levers*	Description of New Solutions
Capacity Analysis (ICA)	Transparency, faster interconnection
DERMS/ADMS	Enables real-time DER dispatch
Advanced Forecasting	Improves net load prediction; aligns DER dispatch with true conditions
Smart Inverters	Local voltage/frequence support
Volt/Var Optimization / CVR	Peak reduction, feeder headroom
Advanced Protection Schemes	Adaptive and directional relays / safe two-way operations
Digital Twins Distribution	Simulation of DER impact; proactive planning
DER Aggregation / VPP Participation	Shifts peak, relieves feeders
EV Managed Charging	Prevents overloads, enables bi-directional flows
Flexible Interconnection Agreements	Offers limited-service interconnection to speed project entry
Digital Twin Planning Tools	Simulate grid expansion options, avoiding stranded investments
Edge Controllers & Comms	Local coordination of DER clusters and EV fleets; low-latency

Featured Solver

Title: Electric Thermal Storage (ETS) systems

Company: Steffes

Website: https://steffes.com/ets/

Source: Steffes

Overview | Solution Pilot Details | Challenge Matches 12 | Challenge Builder Matches

Challenge Statement

Customers need innovative and cost-effective energy solutions for winter peak load management in order to achieve lower energy costs, enhance grid stability, integrate renewable energy efficiently, and manage increasing demand from electrification.

Challenge Overview

Utilities face mounting challenges in maintaining grid stability and efficiency amid growing datacenter infrastructure, increasing renewable energy integration, electric car adoption and the rise of distributed energy resources. With electrification expanding to space heating, winter peak demand could double that of summer. Pairing Electric Thermal Storage (ETS) technology with Air Source Heat Pumps provides a powerful solution, enhancing grid flexibility, resilience, and cost-effectiveness while ensuring customer comfort.

What is the Risk of Not Addressing this Challenge?

1. GRID INSTABILITY AND RELIABILITY ISSUES

- Increased winter peak demand could overwhelm grid infrastructure, leading to higher risks of blackouts and service interruptions.
- Strain from unmanaged electrification and intermittent renewables could reduce grid reliability and resilience.

2. HIGHER OPERATIONAL COSTS

- Utilities may need to invest in costly grid upgrades, including new generation and transmission capacity, to meet peak demand.
- Increased reliance on peaker plants or expensive energy imports during high-demand periods can drive up operational costs.

3. MISSED OPPORTUNITIES FOR DECARBONIZATION

- Failing to integrate demand-side management solutions like ETS could limit the ability to optimize renewable energy utilization, slowing progress toward climate goals.
- Without effective load shifting, utilities may rely more heavily on fossil fuel-based backup generation.

4. CUSTOMER DISSATISFACTION AND INCREASED COSTS

- Customers could face higher electricity bills due to infrastructure investments and inefficient energy usage.
- Unreliable service during peak periods could erode customer trust and satisfaction.

5. LOST COMPETITIVE EDGE

- Utilities that don't adapt may fall behind peers leveraging innovative solutions to meet demand while optimizing costs and decarbon
- Regulatory and stakeholder pressures may increase if utilities are seen as unprepared for the energy transition.

STEFFES

The grid's success in the next 100 years will depend not just on more infrastructure, but on more intelligence and control. As DERs scale across rooftops, driveways, and behind-the-meter systems, utilities can no longer treat the edge of the grid as passive. Two-way power flow, variable generation, and shapeable loads demand a shift in mindset: from static infrastructure to dynamic coordination.

Traditional tools—built for centralized, one-directional power delivery, simply cannot manage this new complexity. Voltage stability, protection coordination, and hosting capacity are becoming dynamic, real-time challenges. Without modern control platforms like DERMS, adaptive protection, and dynamic hosting analysis, utilities will fall behind the pace of DER adoption and risk treating these assets as problems rather than opportunities.

The stakes are high. Delay in modernization leads to longer interconnection queues, higher capital spending, and increased operational risk. But with the right control stack, utilities can transform the grid edge from a vulnerability into a flexible, dispatchable layer of grid support. In a world of rising electrification and customer-owned energy, control is no longer optional, it is the foundation of a safe, efficient, and equitable modern grid.

To fully realize the benefits of DERs, utilities want to shift from planning DERs on the margin to controlling them as core operational assets. This means embedding real-time DER integration into everyday operations, supported by regulatory frameworks that reward flexibility, safety, and customer engagement, not just wires or steel in the ground.

Key Take-Away

The future grid is no longer a one-way system; its success depends on control.

Advanced DER integration capabilities turn solar, batteries, and EVs from risks into flexible assets, enabling safe, reliable, and affordable two-way grid operations.

This will be the new normal for the grid in the next 100 years.

007

Challenge Statement

Flexible Load Forecasting: Planning for a Nonlinear Future

We need adaptive, data-driven planning tools with real-time DER visibility and flexible resource integration to achieve cost-effective, resilient grid investments in a rapidly evolving and uncertain demand environment.

Themes

01

Adaptive planning & forecasting: scenario-based planning tools that incorporate data, DER adoption, electrification, weather and market signals

02

Real-time DER data visibility: System-wide awareness of DER operations (solar, EVs, batteries) down to the feeder level. Hosting capacity and voltage monitoring with dynamic updates

03

Flexible Resource Integration: Controllable DERs (VPPs, DR, EV, BTM batteries), emphasis on distributed flexibility as an operational asset

04

Strategic use of operational data: Tools that accommodate unpredictable load growth from electrification or policy shifts, probabilistic models

Challenge 007 Overview

Overview

Utilities are navigating an era of rapid and unpredictable grid change. Electrification, data centers, DERs, and extreme weather are driving non-linear demand that legacy planning tools can't keep up with.

Traditional methods, like annual forecasts and static models, leave utilities exposed to costly missteps, either by overbuilding and stranding assets or underbuilding and triggering expensive emergency responses. Modern, data-driven planning must now become a core capability, not a side investment.

What's at Risk

Failure to modernize planning tools could result in billions in stranded or misallocated investments, rising customer costs, and declining regulatory trust. Utilities that can't anticipate load volatility or DER growth will fall behind, triggering emergency spending and delaying critical infrastructure.

Current State

Most utilities still rely on deterministic forecasts and manual planning cycles designed for gradual growth. DER visibility is limited, scenario analysis is slow, and NWAs are often treated as niche pilots rather than mainstream alternatives.

Planning systems lack automation and fail to reflect uncertainty or climate risks—leading to reactive investments and poor alignment with real-world system conditions.

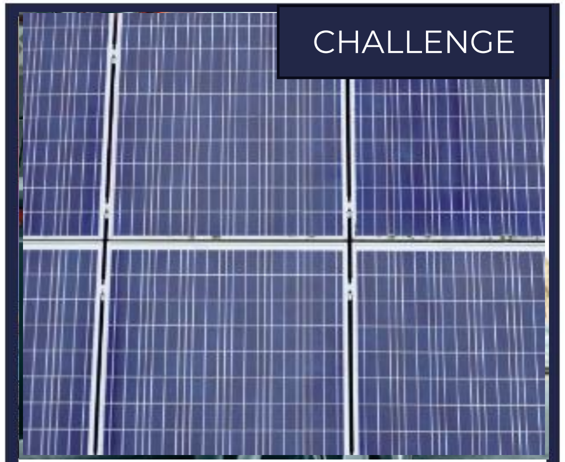
Desired Outcome

Utilities need adaptive, analytics-driven planning platforms that integrate real-time data, probabilistic forecasting, and DER visibility. Scenario-based tools should account for flexible demand, climate stress, and locational value, while NWAs and DERs must be treated as integral to capacity planning.

Automation should shrink planning timelines from years to months, enabling faster, smarter, and more affordable decisions.

Challenge 007

CHALLENGE



Ameren

We need to improve the integration of renewable generation forecasts into load growth scenarios to provide a more comprehensive view of future energy needs and enhance resource planning.

SOLVE

CHALLENGE

NYSEG

We need to transition from a top-down DER forecasting methodology to a reliable bottom-up forecasting approach to accurately reflect DERs by type, such as solar photovoltaic, energy efficiency, and storage..

SOLVE

CHALLENGE

Entergy

We need to account for uncertainties in load forecasting due to technological changes, economic activity, and increased adoption of electric vehicles to maintain reliable service and effectively plan for future energy demands.

SOLVE

CHALLENGE

Hawaiian Electric

We need to develop long-term load forecasts that accurately reflect system and network peak demand to guide infrastructure investment decisions and ensure reliable power delivery.

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CHALLENGE

Tech Stack 007

BAU Options	Traditional Approaches and Results
Static Load Forecasting	Inexpensive annual updates that miss volatility
Traditional Deterministic Models	Incremental growth assumptions, limited DER/EV visibility

Modernization Levers*	Description of New Solutions
Enhanced Load & Flexibility Forecasting	Forecasts shapeable demand and load flexibility to improve near-term accuracy to avoid overbuilds
Climate-integrated Load Forecasting	Captures long-term demand under extreme heat, wildfires & storms
End-use Appliance-level Forecasting	Bottom-up view of load growth (e.g., EVs, heat pumps), more precise
Integrated NWA Assessment Platforms	Standardizes NWA cost-benefit analysis in planning
Locational Value Analysis	Quantifies value of DERs/storage by feeder/substation
DERMS-lite Integration Planning Tools	Incorporates DER forecasts/visibility into planning
Probabilistic Scenario Modeling	Captures uncertainty ranges, not single-point forecasts
Distribution-edge Forecasting	Identifies local overloads before failures, supports transformer planning
AI-assisted Automated Planning Analytics	Compress planning cycle times from years to months
Digital Twin of Distribution System	Real-time simulation of load, DERs, weather impacts
Integrated Forecasting + DERMS Market Signals	Aligns planning with real-time operations and markets
AI/ML Forecasting Engines	Learns emerging load patterns faster than traditional models
Automated NWA Marketplace Platforms	Bids DERs, DR, storage as virtual capacity in planning process
Integrated Gas/Electric Forecasting	Models cross-impacts of electrification on gas demand and stranded risk

From Forecast to Flexibility: Modernizing Grid Planning for a Nonlinear Future

We need adaptive, data-driven planning tools with real-time DER visibility and flexible resource integration to achieve cost-effective, resilient grid investments in a rapidly evolving and uncertain demand environment.

SOLVE

Planning tools are no longer just spreadsheets and static forecasts—they are the strategic engine that will determine whether utilities can build the grid of the future affordably, reliably, and equitably. Yet today, most planning processes remain built for an incremental past: slow, deterministic, and blind to distributed energy resources, flexible demand, and non-linear load growth. This disconnect is now critical. Utilities are being asked to make multi-billion-dollar bets on substations, feeders, and grid infrastructure, under extreme uncertainty driven by data center load, EV adoption, climate extremes, and DER proliferation.

Failing to modernize these tools puts the system at risk on multiple fronts: stranded infrastructure from overbuilds, emergency upgrades from underbuilds, cost pressure on customers, and eroding trust from regulators and stakeholders. Worse, the longer these planning systems remain misaligned with operational reality, the more out-of-sync investment decisions become, amplifying the risks of both steel and digital stranded assets.

Modernized planning platforms must become real-time, scenario-driven, and probabilistic. They must integrate DER visibility, flexible load forecasting, climate-informed modeling, and AI-assisted automation. These aren’t bells and whistles, they are prerequisites for surviving the next decade of grid transformation. When done right, they unlock better use of existing assets, reduce capital risk, accelerate timelines, and create a data-rich foundation for regulatory credibility. Utilities must start treating planning tools not as a side project, but as critical infrastructure in their own right.

Key Take-Away

Planning is no longer just a process—it's a core capability that determines whether we stay ahead of grid disruption or fall behind it.

Those that build adaptive, data-rich, and DER-integrated planning systems will avoid stranded investments, strengthen regulatory trust, and reduce system costs. Those that don't will face compounding delays, missed opportunities, and a shrinking ability to guide the energy transition at speed and scale.

008

Challenge Statement

Flexible Customers: Engaging Customers in a Dynamic Grid

We need integrated affordability strategies and customer-centric service models to achieve equitable, financially sustainable grid modernization for all customer classes and delivers value in a competitive, digitized energy landscape.

Themes

01

Affordability as a KPI: Bills must stay within measurable burden thresholds (≤6% income).

02

Electrification Load Growth: More customers are facing higher monthly bills due to EVs, heat pumps, and electrified appliances, creating a perception of lost affordability unless offset with smarter rate design and better data/service.

03

C&I Dynamics: Large data center loads and competitive retail choice raise risk of cost shifts to households.

04

Customer-Centric Service: Proactive notifications, personalized insights, and differentiated offerings make the utility a trusted partner rather than just a bill collector.

Challenge 008 Overview

Overview

As utilities invest heavily in grid upgrades to support electrification, resilience, and digitalization, they must keep energy affordable across all customer classes.

At the same time, customer expectations are rising, households demand personalized service and insights, while large commercial and industrial customers are exploring alternatives to utility supply. Without a strategy that integrates affordability with modern, customer-centric offerings, utilities risk losing trust, relevance, and financial stability.

What's at Risk

Without a proactive affordability and customer engagement strategy, utilities face rising arrears, widening equity gaps, and declining customer satisfaction. Households may blame the clean energy transition for higher bills, eroding public trust and slowing policy momentum. Meanwhile, loss of C&I customers could shift fixed costs onto more vulnerable ratepayers, compounding affordability risks and undermining utility revenue stability.

CHALLENGE

Beyond Affordability: Competing for the Customer in a Modern Grid Economy

SOLVE

Current State

Regulators in states like New York and California now require affordability to be measured and embedded in utility programs, including income-based rates and caps on energy burdens. Yet, most utilities still offer one-size-fits-all pricing, limited customer engagement tools, and reactive communications, leaving customers exposed to cost shifts.

Desired Outcome

Utilities should deliver affordability through data-driven, customer-centric service models. This means tracking energy burden KPIs, automating enrollment in support programs, and offering tailored digital tools that help customers manage usage and bills.

For C&I customers, utilities could offer premium services, like power quality guarantees or green energy options, to retain load and protect the broader customer base. The goal is to keep energy costs fair, transparent, and aligned with customer expectations in a digitized economy.

Challenge 008

CHALLENGE

XCEL

We need to enhance their service offerings and technology interfaces to meet the growing expectations of customers for greater control and interaction with their energy services to provide customers with the tools and information necessary to manage their energy usage effectively and make informed energy choices..

SOLVE

CHALLENGE

PSEG

We need to maintain customer bill affordability while transitioning to cleaner energy sources to ensure that the financial burden on customers does not increase during the shift towards a more sustainable energy model..

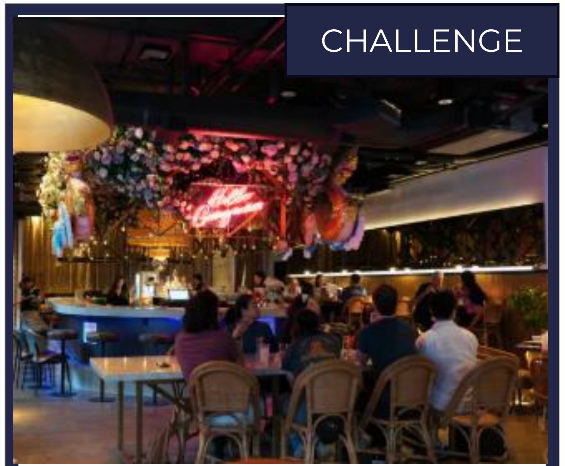
SOLVE

CHALLENGE

Central Hudson

We need to identify and implement cost management strategies to prevent increases in customer bills to ensure affordability and customer satisfaction.

SOLVE



CHALLENGE

Portland General Electric

We need to upgrade substations and lines, and add smart switches to improve operating flexibility and capacity to enable bi-directional power flow from future DERS

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Interested in learning more about these challenges? Click on the SOLVE button to learn more at the InnovationWorks platform.

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CHALLENGE

Beyond Affordability: Competing for the Customer in a Modern Grid Economy

We need integrated affordability strategies and customer-centric service models to achieve equitable, financially sustainable grid modernization for all customer classes and delivers value in a competitive, digitized energy landscape.

SOLVE

Tech Stack 008

BAU Options	Traditional Approaches and Results
Traditional Bill Discount Programs	Provides relief, but under-enrolled; reactive (manual enrollment)
Volumetric-only Rate Recovery	Rising bills as capex grows; no relief for electrification

Modernization Levers*	Description of New Solutions
Automated Low-Income Enrollment	Expands affordability reach; reduces arrears
Default TOU Rates	Shifts loads, lowers peak costs, supports EVs/heat pumps
Income-Graduated Fixed Charges	Stabilizes bills, lowers per-kWh price
Proactive Bill Notification	Prevents bill shock, alerts on forecasted spend
Enhanced Customer Portals and Apps	Transparency empowers choice, usage/rate comparisons
Managed Electrification Programs	Keep bills affordable as load grows' improves system efficiency
Behavioral Efficiency / Energy Education	Empowers customers to reduce waste
Appliance-level Insights (AI/Disaggregation)	Shows devices that could drive actionable savings
Subscription-style Energy Plans	Flat rate tiers, bill predictability and competitive REPs
Power-Quality-as-a-Service	C&I data centers, premium service for hyperscale loads
Reliability-as-a-Service	Monetizes reliability with generator and battery integration
Customer-facing AI (Energy Coaches)	Personalized insights to help customers lower costs or use energy more efficiently

Affordability and equity are no longer peripheral concerns; they are now central to the success of grid modernization. As customers adopt EVs, heat pumps, and electric appliances, many experience rising monthly bills, even if electrification is more cost-effective over time. This shift threatens to erode public support for the energy transition if customers feel the grid is becoming more expensive and less responsive to their needs.

Traditional bill credits and affordability programs are not enough; they tend to be reactive, underutilized, and disconnected from how energy use is changing. To meet this moment, utilities must take a proactive, customer-centric approach. This includes real-time usage insights, personalized bill forecasts, modernized rate design, and new value-added services that make utilities feel more like trusted energy partners than commodity providers.

Unlike the supply-side focus of distribution upgrades, this challenge is about how customers experience affordability. If ignored, utilities risk losing C&I load, shrinking their rate base, and deepening inequity. But if addressed head-on, affordability and transparency can become tools for customer retention, trust, and long-term financial stability.

Key Take-Away

Utilities that embed affordability into modern, customer-focused service models will not only protect vulnerable customers, but they will also retain large ones, sustain revenue, and earn long-term public trust.

Customer experience is now a competitive advantage in the dynamic energy transition economy.

009

Challenge Statement

Securing the Flexible Grid: Meeting the future of OT/IT convergence

We need real-time internal network monitoring, vendor risk management, and DER cybersecurity alignment to achieve end-to-end grid resilience and compliance in a digitized, threat-exposed operational environment.

Themes

01

Aging Infrastructure: Many substations still run on legacy serial comms, radios, or leased lines, providing limited bandwidth and poor security

02

Visibility Gaps: Lack of unified situational awareness across OT and IT environments means cyber threats often go undetected until too late

03

Compliance vs. Resilience: Utilities could be incentivized toward orient cyber programs narrowly focused on passing NERC CIP audits rather than building adaptive resilience.

04

Supply Chain Exposure: Vendor firmware, comms modules, and third-party access remain key weak points.

Challenge 009 Overview

Overview

As utilities digitize operations and deploy increasingly interconnected grid technologies cybersecurity and communications infrastructure are no longer back-office concerns but core reliability risks. The transition from legacy OT systems to IP-based, real-time platforms has outpaced utilities' traditional cyber protections, opening vulnerabilities at both the core (substations, SCADA) and edge.

What's at Risk

As utilities digitize operations and interconnect more devices, the grid's cyber attack surface is rapidly expanding. A successful cyber intrusion, whether targeting a substation, DER system, or operational network—could cause widespread outages, compromise critical infrastructure, and damage public trust.

The stakes are rising as adversaries, including state-sponsored actors, exploit internal network weaknesses to evade detection.

Securing the Flexible Grid: Meeting the future of OT/IT convergence

SOLVE

Current State

Most utility operational environments were not designed with modern cybersecurity in mind. Substations often rely on unencrypted, serial-based communications and aging field devices that lack segmentation or authentication. Network visibility is focused on perimeter defenses, with minimal monitoring of "east-west" traffic within substations and control centers—where threats often move undetected. DER and EV infrastructure at the edge creates new points of vulnerability.

Desired Outcome

Utilities need to evolve to a modernized, resilient cyber architecture that goes beyond compliance. This includes deploying Internal Network Security Monitoring (INSM) to gain real-time visibility across OT environments, detect lateral movement, and enable rapid incident response. Encrypted communications, IP-based networks with built-in segmentation and zero-trust principles. The goal is to build a grid meets new CIP-015 requirements and can recover from advanced threats.

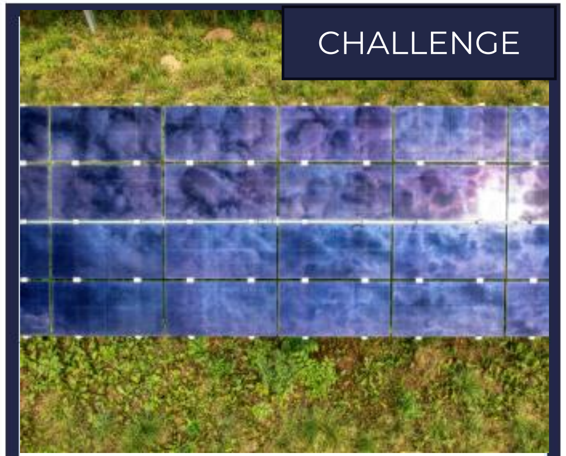
Challenge 009

CHALLENGE

National Grid

We need to bolster cybersecurity standards, processes, and tools to effectively reduce the risk of cyber intrusions to protect the grid from potential cyber threats and ensure the integrity of operations.

SOLVE



CHALLENGE

Southern Company

We need to develop architectures and requirements to implement internet-based controls from SCE's back office securely to enhance operational security and ensure safe interactions between back-office systems and internet-based controls.

SOLVE

CHALLENGE

Exelon

We need to protect customer information and their electronic and physical assets in to ensure the integrity and security of energy delivery systems, which are critical national infrastructure.

SOLVE

CHALLENGE

PPL

We need to enhance their cybersecurity strategy to effectively manage and respond to evolving cyber-related risks to protect their systems and assets from potential cyberattacks and ensure operational resilience.

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CHALLENGE

Securing the Flexible Grid: Meeting the future of OT/IT convergence

We need real-time internal network monitoring, vendor risk management, and DER cybersecurity alignment to achieve end-to-end grid resilience and compliance in a digitized, threat-exposed operational environment.

SOLVE

Tech Stack 009

BAU Options	Traditional Approaches and Results
Harden Legacy OT Networks	Basic uplift for legacy systems (segmentation, VPN, firewalling)
Patchwork NERC/CIP Compliance	Meet minimum compliance only, manual audits and tactical fixes
Device Identity & Authentication	PKI, digital certificates and role-based permissions for devices

Modernization Levers*	Description of New Solutions
Utility-Owned Fiber Backbones	Highly secure, high bandwidth comms
Private LTE/5G Utility-Grade Networks	Built-in security like data packet control and network segmentation
OT-Aware SOC	Continuous monitoring, OT+IT incident response
SBOM/Firmware Signature Scanning	Identifies banned or high-risk components (supply chain assurance)
Zero-Trust Architecture	Identity-based micro segmentation enforces least privilege trust rules
Cloud-Native Cyber Platforms (AI/ML)	Anomaly detection, detects Volt-Typhoon style east-west attacks
DER-Integrated Security	Secures edge devices (PV, EVSE, storage) per IEEE 1547.3/UL 2941
SIEM Integration & Response	Event correlation and automation
DER Vendor Compliance Governance	NIST-based validation for third-party assets
Penetration Automation Testing	Simulate attacks, measure resilience
Zero Trust Remote OT Access	Secure field/vendor access without VPNs

SOLUTION | Published

Enhancing Cybersecurity for Distributed Energy Resources Details Page

Previous Page

Featured Solver

Title: Enhancing Cybersecurity for Distributed Energy Resources

Company: NREL

Website: https://docs.nrel.gov/docs/fy24osti/87808.pdf

Source: CEATI S&I Conference

Workspace: CEATI S&I Conference 2025

Submitter: InnovationWorks AI

Overview | Solution Pilot Details | Challenge Matches 5 | Challenge Builder Matches

Challenge Statement

Customers need a comprehensive cybersecurity framework to ensure the integrity and security of distributed energy resources in order to prevent cyberattacks that could disrupt energy production.

Challenge Overview

The increasing adoption of distributed energy resources (DERs), particularly solar photovoltaic systems, has transformed electric grids towards cleaner energy. However, this transition also brings significant cybersecurity risks, as cyberattacks can compromise system integrity and disrupt energy production. With over 90 GW of DERs installed in the U.S., the threat of cyberattacks on this infrastructure is a critical concern that must be addressed.

What is the Risk of Not Addressing this Challenge?

If this solution is not implemented, the risk of cyberattacks on DER systems increases significantly, potentially leading to disruptions in energy production and compromised system integrity. This could result in financial losses, damage to infrastructure, and a setback in the transition to cleaner energy sources. Without robust cybersecurity measures, the reliability and safety of the energy infrastructure could be severely jeopardized.

What is the Desired Outcome?

The intended outcome of this solution is to enhance the cybersecurity posture of DER systems, ensuring their resilience against cyber threats and maintaining the reliability of energy production. By implementing the DER-CF, organizations can effectively assess their cybersecurity measures and prioritize improvements.

Solution Overview

The Distributed Energy Resource Cybersecurity Framework (DER-CF) is a free, interactive web tool designed to help federal facilities perfo
existing DER systems. It provides system-specific cybersecurity controls, generates prioritized action items, and offers an interactive das
areas for improvement. This structured approach enables organizations to enhance their governance, technical management, and phys

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Featured Solver

Overview | Solution Pilot Details | Challenge Matches 37 | Challenge Builder Matches

Title: Quantifying Resilience in Critical Infrastructure

Company: Criticality Sciences, Inc.

Website: https://www.critsci.com/

Source: https://www.critsci.com/

Workspace: Criticality Sciences, Inc.

Submitter: InnovationWorks AI

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Challenge Statement

Customers need a network science-based solution in order to quantify and enhance enterprise resilience against cascading failures.

Challenge Overview

The core challenge is the inability for enterprises to measure and improve the resilience of complex networks effectively. Without an exact method, predicting failures, assessing risk, and making informed security investments is challenging, leading to potential vulnerabilities.

What is the Risk of Not Addressing this Challenge?

Without implementing this solution, organizations face inadequate assessment of network resilience, leading to increased vulnerability to cascading failures and significant operational disruptions and resulting in potential financial and reputational losses.

What is the Desired Outcome?

The intended outcome is to transform network security from a cost center into a profit center by accurately quantifying and improving resilience, thus ensuring continuity and safeguarding against large-scale disruptions.

Solution Overview

The solution, Criticality Sciences℠ **Resilience Intelligence Platform**, quantifies threshold resilience in complex networks. It integrates risk measures from individual assets and cross-system propensity for cascading failures, providing metrics for resistance and recovery. It enables characterization, prioritization, stress testing, and modification review, aiding decision-makers in enhancing network security and resilience.

Why is this Better than Previous Solutions?

This solution is better because it transitions resilience assessment from guesswork to an exact science, with precise measurement tools for enabling informed decision-making for network security investments.

Case Studies and Other Content

The grid's digital transformation is outpacing traditional cybersecurity strategies. What was once a compliance checkbox is now a frontline defense issue that directly affects reliability, safety, and national security. As regulatory standards like NERC CIP-015 mandate internal visibility and edge security, utilities must act swiftly, not only to comply, but to future-proof operations. Investing in INSM, secure communications, and certified DER protocols is not just a cost of doing business, it's foundational to earning public trust, enabling the dynamic energy transition, and maintaining operational resilience in the face of escalating threats.

Hybrid 5G with programmable data control, cloud-native security platforms, and device-level trust mechanisms represent the next leap forward in utility comms and OT cybersecurity convergence. Taken together, utilities can move beyond compliance and toward architectures that are inherently flexible, resilient, and future-proof — ready for a high-DER, high-electrification grid.

Key Take-Away

Taken together, 5G, hybrid enrivonments with programmable data control, cloud-native security platforms, and device-level trust mechanisms represent the next leap forward in utility comms and OT cybersecurity convergence.

They move utilities beyond compliance and toward architectures that are inherently flexible, resilient, and future-proof — ready for a high-DER, high-electrification grid.

010

Challenge Statement

Grid Workforce: Enabling the Workforce of the Future

We need to replace retiring expertise and develop the new digital, cyber, and analytics skills needed to operate the modern grid

Themes

01

A retiring workforce and puts important "tribal knowledge" at risks without systematic capture of expertise around the ability to safely and efficiently maintain critical assets.

02

Skills for the Digital Grid Future: shift to data, AI, analytics and OT/IT conference requires upskilling toward a future-proofing of the workforce that is more data-driven, distributed and dynamic.

03

Talent Pipeline: utilities face stiff competition for technical and digital talent from the tech sector and energy startups.

04

Safety, Reliability & Public Trust: any undocumented or understaffed skill gap could translate into safety risks for workers and the public and jeopardize restoration or response times.

Challenge 010 Overview

Overview

Utilities are facing a dual workforce challenge: a wave of retirements from experienced line workers, engineers, and operators, and a growing need for new digital skill sets to manage advanced technologies.

The knowledge gap between legacy expertise and modern grid requirements is widening. Training programs, knowledge capture, and new hiring pipelines must keep up.

What’s at Risk

Failing to address workforce transition leaves utilities exposed to significant operational, safety, and financial risks. As veteran employees retire, critical operational knowledge will disappear, creating gaps in day-to-day reliability and long-term planning. New grid technologies such as DERMS and ADMS will fail to deliver promised ROI if employees lack the training to use them effectively.

CHALLENGE

Grid Workforce: Enabling the Workforce of the Future

SOLVE

Current State

Decades of accumulated “tribal knowledge” about field operations and asset management are at risk of being lost, as much of this expertise remains undocumented. Existing training programs tend to be reactive and fragmented, leaving many employees underprepared for new responsibilities.. The result is a growing mismatch between the workforce utilities have and the one they need to modernize the grid.

Desired Outcome

A workforce that blends the deep operational knowledge of legacy utility employees with the digital fluency required to manage the modern grid. Knowledge transfer programs should capture the expertise of retiring workers through AI-assisted documentation, augmented and virtual reality training modules, and structured mentoring programs.

Challenge 010

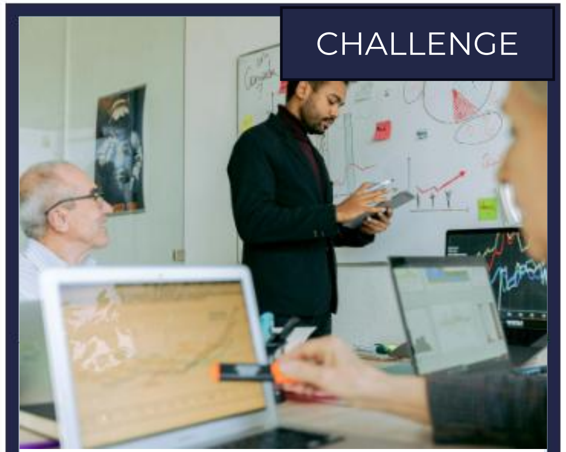
CHALLENGE

SCE

We need to develop a skilled workforce capable of delivering electrification upgrades to meet the necessary pace and scale of electrification efforts.

SOLVE

CHALLENGE



National Grid

We need to develop strategies to attract, hire, and retain the necessary talent to construct, operate, and maintain a smarter and cleaner energy system to support the significant investments in the electrical network and ensure the successful implementation of the Future Grid Plan.

SOLVE

CHALLENGE

XCEL

We need to ensure that their teams possess the necessary skills and knowledge to operate effectively as the grid evolves to adapt to the changes brought by the adoption of distributed energy resources and electric vehicles..

SOLVE

CHALLENGE

Consumers

We need to ensure that its field resources, both internal and contracted, are adequately planned and aligned with the forecasted work demand to support its electric distribution investment strategy effectively.

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Enabling the Workforce of the Future

We need to replace retiring expertise and develop the new digital, cyber, and analytics skills needed to operate the modern grid

SOLVE

Tech Stack 010

BAU Options	Traditional Approaches and Results
Tribal Knowledge	Undocumented training or capture of knowledge
Documents Share	Unorganized upload of documents after an employee retires
Traditional Recruitment Pipelines	HR and recruiting pipelines

Modernization Levers*	Description of New Solutions
AR/VR	Goggles and technologies for training and remote assistance
AI Assisted Documentation	Fill documentation gap with AI tools to create training
Continuous Learning Platforms	Learning management systems capture and test to develop new skills
Digital Twins	Simulation of real-situations, guidance of what to expect
Workforce Planning Tools	Develop retirement planning and recruitment
Digital Field Guides	More interactive field training that is tablet/digital based
Real-time Access to Data Models	Data and forecasting tools can train what to expect
Simulation Tools & Apprentice Programs	Apprentice and training can be augmented with real-life scenarios
Gamified Training Programs	Create upskilling or reskilling incentives
Online Training and Certifications	Learn digital, AI or new data skills through online programs
Continuous Education Programs	Support leaders being upskilled through continuous education programs
Partnership with Universities or Labs	Partner with labs to augment missing knowledge gaps
Internship Programs	Partner with universities to compete in the talent pipeline
AI Coaches Based on Peer Knowledge	Create AI coaching based on “tribal” knowledge, codify this knowledge

The grid of the future cannot be built without the workforce of the future. Utilities face a dual challenge: replacing the deep institutional knowledge being lost to retirements while simultaneously building new capabilities in data, digital systems, and distributed energy management. If unaddressed, this gap risks slowing modernization efforts and undermining reliability.

Artificial Intelligence (AI) offers a way to bridge the widening gap. AI-enabled tools can capture and digitize decades of operator and field experience, turning it into living knowledge systems that new workers can access in real time. Predictive analytics can reduce reliance on institutional memory by flagging asset failures before they occur. AI-powered training (including AR/VR simulations) can accelerate learning curves for new engineers and line workers, preparing them to operate in increasingly complex, data-rich environments.

The path forward requires a multi-pronged workforce strategy:

- Knowledge capture platforms to preserve legacy expertise before it’s lost.
- AI-driven training and simulation programs to rapidly upskill new hires.
- Digital twins and decision-support tools to augment workforce productivity and safety.
- University and technical partnerships to build hiring pipelines for next-gen grid professionals.
- Regulatory support for workforce investments tied to measurable outcomes.

A modernized grid demands a modernized workforce. By investing in people and equipping them with AI-powered tools, utilities can ensure institutional knowledge is preserved, new skills are built, and the sector is prepared to manage both today’s reliability needs and tomorrow’s dynamic energy transition.

Key Take-Away

The energy transition is not just about the electrons; it’s about the people.

Utilities must capture legacy expertise while equipping a new, AI-enabled workforce with the digital skills to manage a more complex, data-driven grid. Investing in people with the same urgency as infrastructure is essential to securing reliability, resilience, and modernization. The technology challenge, is also a people challenge.

Data Architecture

A Blueprint for the Future

The future grid will run on data as much as steel. Get your architecture ready to meet the future.

The Future Grid Runs on Data — Not Steel

As this report lays out through each challenge, the foundation of modern grid affordability and innovation is no longer copper wire or steel poles, it's data. In today's utility environment, every constraint, from aging assets and wildfire risk to grid congestion and DER integration, is increasingly solvable not with more capital infrastructure, but through smarter, system-wide use of data.

Due to the complexity and the operational nature of past system, most of the industry is still operating in fragmented data silos that are slowly being broken down. A unifying architecture and clear plan would be helpful to unlock the valuable information that remains locked inside legacy systems and made accessible to the platforms and microservices who need it most. The opportunity ahead is to shift from treating data as a byproduct of operations to treating it as a core utility asset, one that must be made usable across the enterprise and capitalized. Data is the new gold, but only if it's accessible, connected, and works in today's regulatory business models.

Utilities are rapidly evolving into data operators: using open, modular architectures to unify and mobilize data across AMI, OMS, EMS, DERMS, field operations, customer experience platforms, and third-party sources. Microservices-based platforms, like the Grid.AI architecture outlined on the next page, allow utilities to build real-time "data services" across these domains, delivering situational awareness, predictive insights, and optimized decision-making at both the edge and enterprise levels.

Rather than rebuilding the grid with more steel, we now can virtualize intelligence across the network more affordably, creating a digital layer where every sensor, device, and interaction contributes to lower costs, improved reliability, and faster decarbonization. This isn't a future vision, it's already well underway at leading utilities across the country.

Microservices Based Architecture for Solution Design

Operational Workflows

- Unified Analytics
- OMS
- EMS
- Energy Audits and Losses
- NRW Losses
- Consumption
- Power Quality
- KPS/SLAs
- DERs
- Assets
- Device Calibration and Firmware Management
- Task Management
- Reliability

Field Service Applications

- Contractors
- Consumer Indexing & Asset Surveys
- Meter/Asset Installation
- Inventory
- Scheduling and Dispatch
- Health and Safety
- Take5s
- Assets
- Work Allocation and Ticketing
- Preventive Maintenance
- Tracking

Consumer Engagement

- User Profile
- Consumption
- TOU
- Inventory
- Alerts
- Outage
- Billing
- Payment
- Dynamic Pricing and Tariffs
- Savings and Tips
- Service Request

Application and UI Layer

Design solution oriented applications

Grid.AI

Automation Layer

Build utility specific workflows on custom rules and integrations

Grid Data Warehouse

Support flexible data model to store and manage data

- Energy, Water, Gas
- Consumer and Billing
- Inventory and Assets
- Traffic and Street lights
- Project Data, GIS
- Employee Information

SFTP MQTT XML LoRa

Integrations Engine

Technology based integrations and connectors

Implementation

Implementing the Blueprint for the Future

Put this playbook into action at your utility. We’re here to help.

Your Roadmap Starts Here: Use this as Your 2026 North Star

Every utility faces a unique mix of local pressures, load growth, reliability mandates, aging infrastructure, workforce transitions, or rapidly shifting customer expectations. But while every utility is different, none are alone. The core challenges facing the grid are shared across the industry. That's why collaboration matters now more than ever.

This report is just a starting point, a playbook to spark action. It's built from real-world use cases and proven tech stacks, drawn from InnovationWorks: a living platform where utilities can go beyond the static report and dive into what's working, what's emerging, and what's possible.

Inside InnovationWorks, you can:

- Explore your utility's top challenges in a structured, searchable way
- See what others are testing — and what's already showing results
- Share solutions across teams and peers to build buy-in and reduce decision cycles
- Connect with industry-curated AI support to accelerate from idea to pilot

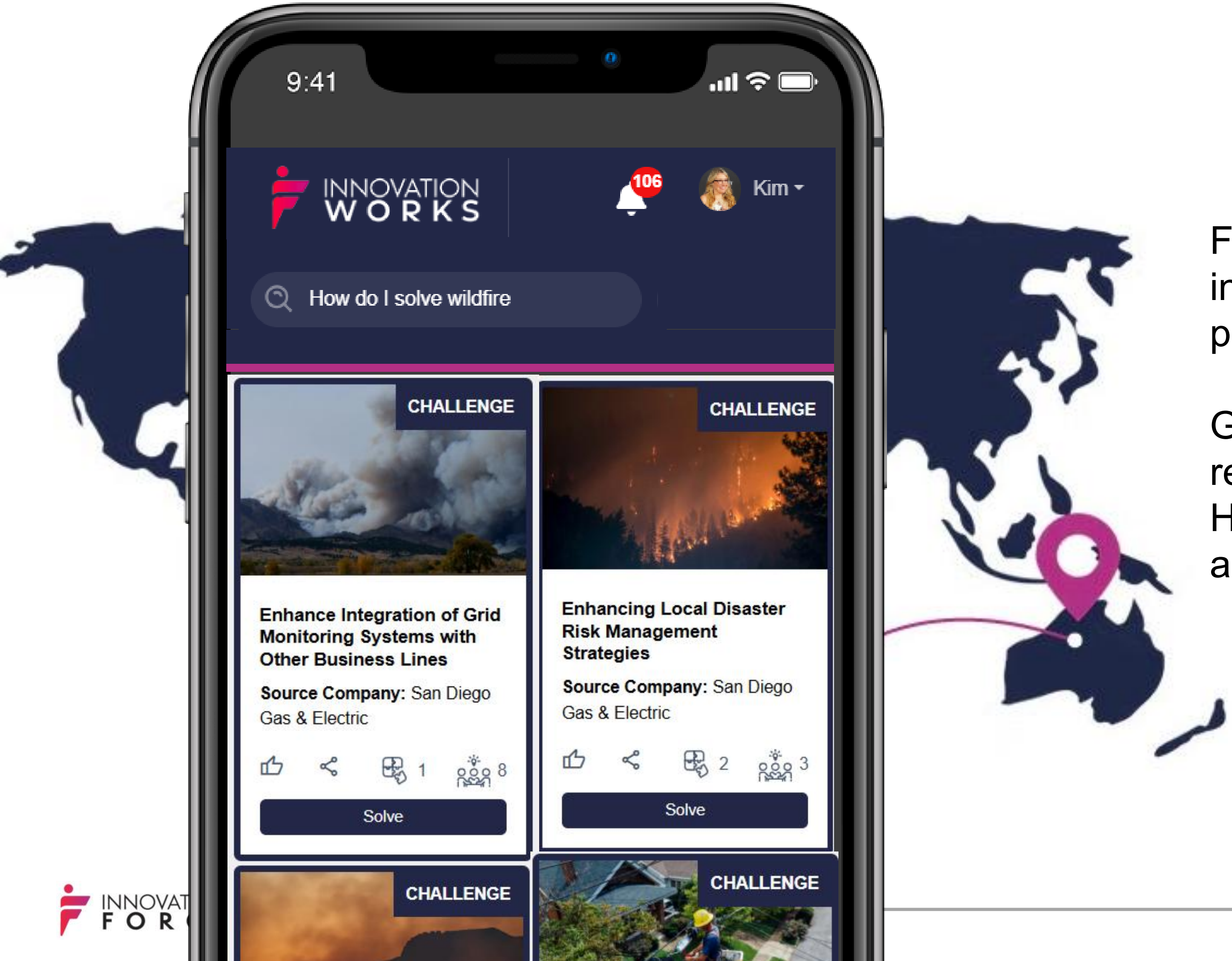
Need more help? InnovationForce can put this entire playbook into action for your utility through our Innovation-as-a-Service. Allowing you to select your top challenges and tech stack layers, we can match you to the right solutions and guide rapid piloting and learning to solve challenges faster.

So, take the next step:

- Create your free account.
- Start building your use cases in InnovationWorks and collaborate (upgrade to a free 30-day trial to start developing your use cases).
- Contact us to set up a meeting to review your plan and insert the additional help you may need to reach your 2026 goals.

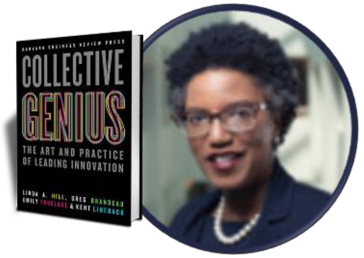
The future of the utility sector depends on the actions we take now. We're here to help.

InnovationWorks is Your Innovation Copilot



First innovation-focused AI trained to create industry-specific challenges using a proprietary small language model.

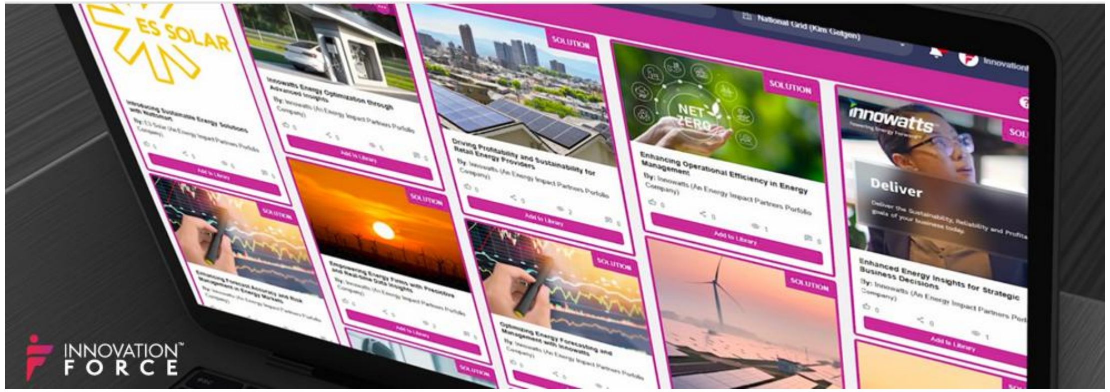
Guided by a workflow backed by world renowned innovation professor Dr. Linda Hill, we can hep you drive better pilot adoption.



Harvard Business School

We Offer Innovation-as-a-Service

Put Use Cases into Action



Tailored to your Unique Needs

Our small language model is trained on industry-specific data (regulatory filings, conference abstracts, annual reports)

We Connect you to the Right Solutions

Following the tech stack in each challenge, we offer the solutions that you'll want to pilot.

Pilot Management

We offer pilot management through our InnovationWorks platform and innovation management oversight to keep pilots on track and valuable learnings captured.

BOOK A MEETING

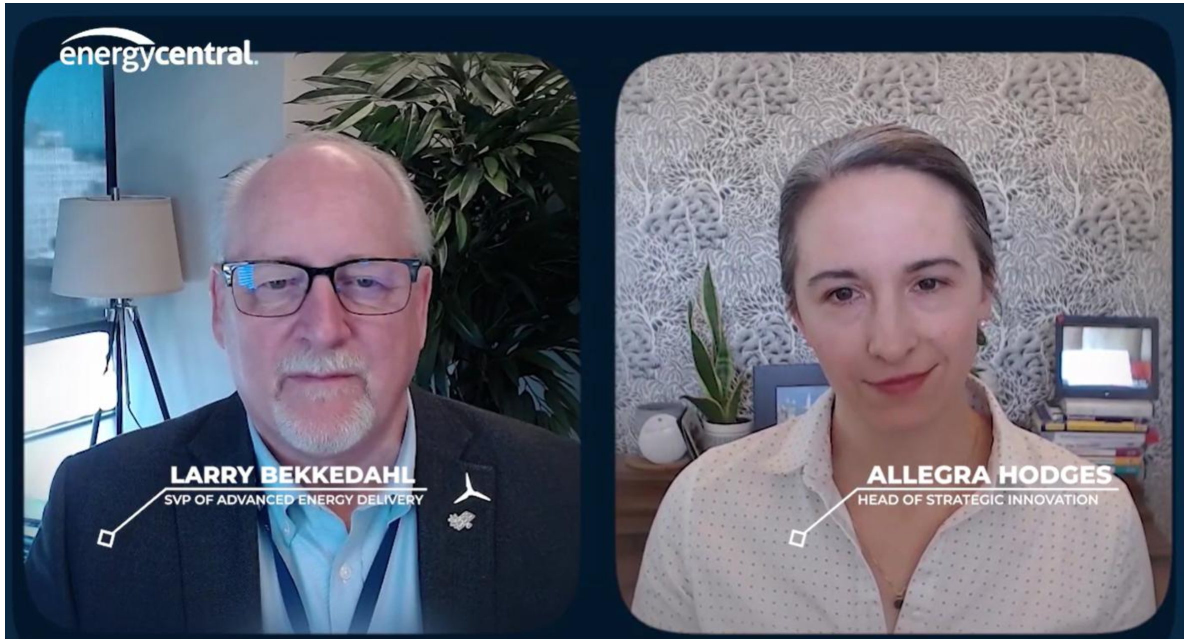
Get started by booking a meeting with us to learn more!

Learn From Portland General Electric

Portland General Electric (PGE)

- 50% of Pilots Received a “Go”
- Pilots completed 62% Faster
- Use cases and pilots grew 330%

 Podcasts



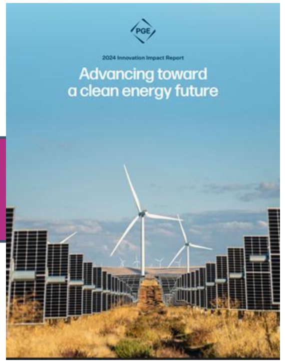
Hear more on the Piloting the Future Podcast episode with PGE

MAY 22

Piloting the Future: If you're not innovating, you're dying, ft. Portland General Electric

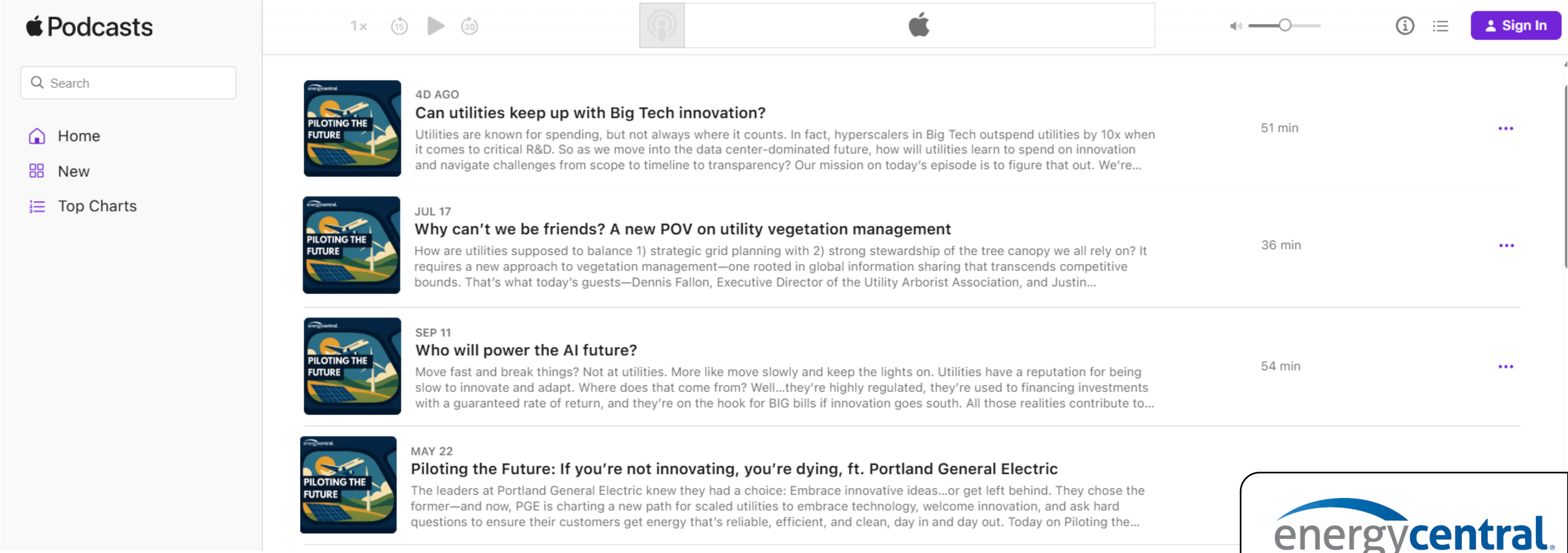
The leaders at Portland General Electric knew they had a choice: Embrace innovative ideas...or get left behind. They chose the former—and now, PGE is charting a new path for scaled utilities to embrace technology, welcome innovation, and ask hard questions to ensure their customers get energy that's reliable, efficient, and clean, day in and day out. Today on Piloting the...

Download the PGE Impact Report



Continue the Learning by Subscribing to our Podcast Series

If you care about innovation, subscribe to the Energy Central Podcast channel and follow along to hear from some of the solvers in this report sharing the pilot stories and deep dives on how we'll power the new AI driven future!



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Subscribe!

Appendix

The 60+ Public Plans and Regulatory Filings

Source	Plan
Alabama Power	Alabama Power IRP
Ameren	IRP Annual Update 2024
APS	IRP 2023
ATCO	2023 Sustainability Report
Bonneville Power	2024 Annual Report
Brookfield	2024 Annual Report
California PUC	CA Electric Program Investment Report 2023
Central Hudson	Distribution System Integration Plan 2020
Chelan Co	2024 Annual Report
ComEd	ComEd Grid Plan
conEdison	Integrated Long Range Plan 2025
Constellation	2023 Sustainability Report
Consumers	Electric Distribution Infrastructure Investment Plan 2024-2028
Dominion	Dominion Grid Transformation Plan Phase 2
Maryland	Maryland Electric System Planning Report 2022
National Grid	Future Grid Plan 2023
Hydro One	2023 Sustainability Report & 2021 Transmission Plan
DTE	DTE Electric Distribution Grid Plan 2023
Duke Energy	Duke Energy Indiana IRP 2024

Utility	Plan
Entergy	Entergy Louisiana IRP Final Report 2023
ENMAX	2023 Financial Report
EPCOR	2023-2027 Distribution System Plan
Eversource	Electric Service Modernization Plan 2024
Exelon	Sustainability Report 2023
Fortis BC	2024 Annual Report
FPL	Ten Year Site Plan 2024
Grant County PUD	2024 IRP
HECO	Hawaii Integrated Grid Plan May 2023
Hydro One	2023 Sustainability Report & 2021 Transmission Plan
Idaho Power	2025 IRP and 2024 Demand Side Report
Lewis County PUD	2024 IRP
Manitoba Hydro	2040 Strategy
Maryland	Maryland Electric System Planning Report 2022
National Grid	Future Grid Plan 2023
Northwestern Energy	2024 Annual Report
NJBPU	Grid Modernization Final Report
NYPA	Sustainability Integrated Report
NYSEG	System Implementation Plan 2023
NYSERDA	Grid Modernization Central Hudson Evaluation Case Study
PA	Electric Reliability Report 2024 Final

Utility	Plan
Pacific Corp	2025 IRP and Clean Energy Plan Progress
PG&E	EPIC Annual Report
PG&E	Distribution Grid Needs Assessment 2023
PG&E	Grid Modernization Report April 2024
PGE	Distribution System Plan 2024
PPL	Sustainability Report 2022
PSEG	Sustainability Report 2023
Salt River Project	2023 Integrated System Plan
Santee Cooper	2024 IRP and 2024 Sustainability Report
SCE	EPIC Annual Report
SCE	2025 Rate Case
SCE	Wildfire Mitigation Plan 2025
SDG&E	Wildfire Mitigation Plan 2023-2025
SDG&E	Wildfire Mitigation Plan 2025
Seattle City & Light	Grid Modernization Roadmap 2021
SoCalGas	Compliance Plan 2024
Southern Co	Net Zero Report
Tacoma Power	2022 Integrated IRP and 2023 Clean Energy Implementation Plan
TVA	2019 Integrated IRP
XCEL	Integrated Distribution Plan 2023

Thank You to Our Partners

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Leading Cities

RTI INTERNATIONAL

STEFFES

Grid.

GRIDWRAP

ENGINEERED INTELLIGENCE

SWITCHED SOURCE

INTEGRAL ANALYTICS

systems with intelligence

Criticality SCIENCES

Edge Zero

Building Lens

Arbor Day Foundation

Enscryb
A Nokia Venture

Kim Getgen, CEO & Founder

Book a Meeting Link

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