EPIC 4 Wave 1

Public Workshop

January 16, 2024

This program is funded by California utility customers under the auspices of the California Public Utilities Commission.

Safety

Reminders

1. This is a long call. Please be aware of ergonomic risks and risks associated with sitting for long periods of time.

SAFETY CONSIDERATIONS	
Earthquake: ❑ Know the safest places to duck, cover and hold, such as under sturdy desks and tables	**Active Shooter**: ❑ Get out, hide out, take out ❑ Call 911, if possible
Fire: ❑ Know your exits and escape routes ❑ Have a compliant fire extinguisher to be used only when safe to do so ❑ Most importantly, get out of the building and call 911	**Medical Emergency**: ❑ Are you alone or is someone else present to perform first aid/CPR as needed? If alone, be prepared to call 911 ❑ Do you have an AED? If so, ensure that your family or housemate knows where it is and how to use it.

Agenda

Desired Outcomes

1. Attendees are aware of and understand projects that PG&E is considering to launch as the first wave of the EPIC 4 Portfolio.
2. Attendees have the opportunity to provide feedback on proposed projects before scoping is finalized and they are launched.

Please note that this meeting is being recorded.

Agenda

ITEM	SESSION	TIME	MINUTES	DETAILS
1	Welcome and Introduction	8:30 AM	15	Safety & Introduction, Introduction to EPIC and the Strategic Objectives
2	***Create a More Nimble Grid to Maintain Reliability as CA Transitions to 100% Clean Energy***	**8:45 AM**	**70**	**Clean, Dispatchable Resources (2 projects)** **Grid Modernization (5 projects)**
3	BREAK	9:55 AM	10	
4	***Increase the Value Proposition of Distributed Energy Resources to Customers & the Grid***	**10:05 AM**	**60**	**DER Integration and Load Flexibility Initiative (4 projects)** **Transportation Electrification (2 projects)**
5	BREAK	11:05 AM	10	
6	***Inform California's Transition to an Equitable, Zero-Carbon Energy System that is Climate-Resilient and Meets Environmental Goals***	**11:15 AM**	**70**	**Climate and Environment (7 projects)**
7	Close	12:25 PM	5	Concluding Comments, Next Steps

What is EPIC?

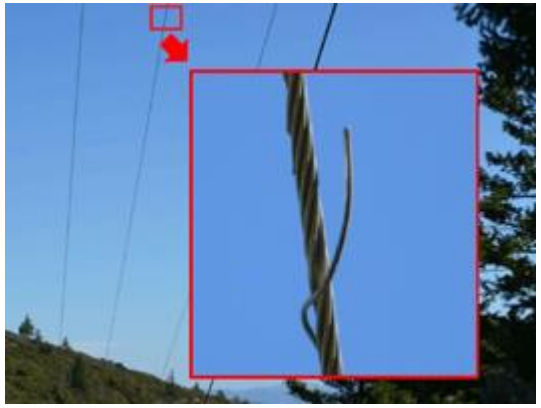
The Electric Program Investment Charge (EPIC) is a California statewide program that enables energy utilities and the California Energy Commission (CEC) to invest in & pursue new/novel emerging energy solutions to benefit electric ratepayers and support California's energy goals

Five guiding principles have been formally established to guide all EPIC work:

Increased Safety • Improved Affordability • Greater Reliability
Environmental Sustainability • Equity

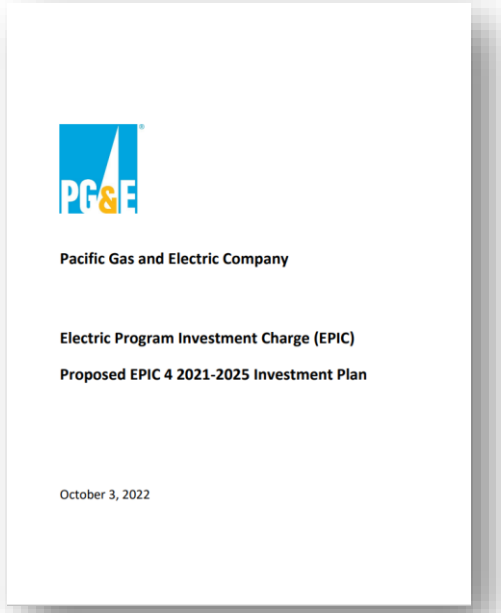
Redwood Coast Airport Microgrid (RCAM)

Vegetation Management Innovations



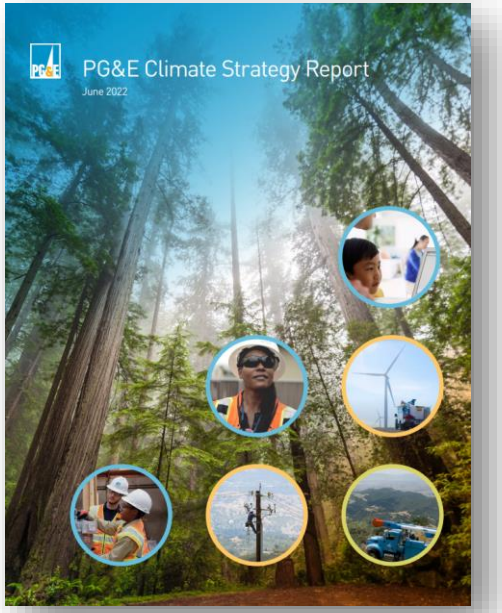
Line Degradation Sensors

EPIC 4 Areas of Focus



Link: PG&E's EPIC 4 Investment Plan

Link: Research & Development Strategy Report



Link: Climate Strategy Report

1. Create a More Nimble Grid to Maintain Reliability as California Transitions to 100% Clean Energy
2. Increase the Value Proposition of Distributed Energy Resources to Customers & the Grid
3. Inform California's Transition to an Equitable, Zero-Carbon Energy System that is Climate-Resilient and Meets Environmental Goals

Context of Today's Presentations

- On November 30, 2023, California Public Utility Commission (CPUC) approved PG&E's EPIC 4 Investment Plan. The Plan details 23 Research Topic Areas, in which PG&E can pursue technology demonstrations.
- PG&E is planning to execute ~30-35 total projects as part of EPIC 4 Portfolio.
- Today, PG&E subject matter experts will present 20 project proposals that were selected from 85 internal idea submissions, that went through an internal screening, refining and scoring process.

- **Attendees have the opportunity to provide feedback on proposed projects before scoping is finalized and they are launched**

- Candidates for future waves of PG&E EPIC 4 projects will also be presented in public workshops, prior to launch.
- This program is funded by California utility customers under the auspices of the California Public Utilities Commission.

Presentation Format

10 Minutes for each project

For Each Project Proposal:

3-5 minute project overview, Followed by audience Q&A:

Please state your name and organization when asking questions or making comments.

Option 1: Use Raise Hand function, and moderator will call on you and un-mute you.

Option 2: Submit written questions in the Q&A function

For additional questions/comments for projects:

Please email Epic_Info@pge.com until EOD, January 30th

Create a More Nimble Grid to Maintain Reliability as California Transitions to 100% Clean Energy

Battery Energy Storage System for Voltage Support on Radial Feeders

Develop controls for Battery Energy Storage System (BESS) to enable increased capacity and voltage control on constrained distribution lines.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Reduce the need for conventional capacity upgrades using battery energy storage systems (BESS): Electrification is expected to increase load across PG&E's service area by ~70% over the next 20 years, straining the limits of the existing transmission and distribution system and necessitating significant investment in upgrades to accommodate the new load.
Objective	Demonstrate new controls for battery energy storage system for capacity and voltage support to eliminate the need for conventional wires capacity upgrades
Project Description / Scope of EPIC Demonstration	• Develop new controls layer for battery energy storage system for stacked benefits of feeder capacity, voltage support, and short circuit ratio • Perform power system simulations and power/control hardware-in-the-loop • Implement and commission on one distribution circuit
Estimated Cost	$1M
How PG&E can scale to full deployment (Path to Production)	Operate on distribution circuit and verify new load applications can successfully connect Determine where the new controls could be used to support capacity, voltage, and short circuit ratio
New / Novel	Using a new control scheme for battery energy storage on distribution for simultaneous benefits of feeder capacity, feeder voltage support, and short circuit ratio is new and novel. It may reduce the need for conventional capacitor banks.
Urgency	Needed to alleviate capacity constraints, which delay customer service applications. Example: Customers waiting for freed up capacity on the Garberville 1102 circuit for their service application to proceed.
Benefits	Reduction in customer outages (measured via System Average Interruption Duration Index (SAIDI)) 2% O&M Reduction Bill Compound Annual Growth Rate (CAGR) - cost avoidance of approx. $90 million in capital Benefits to DACs & LI Customers: Support with Electrification, Economic Development (rural circuits)

Service Transformer Sited Energy Storage

Develop front-of-the-meter (FTM) grid management assets (e.g. battery storage) to increase reliability and decrease stress on the grid, in hyper-local applications

TOPIC	DESCRIPTION
Concern / Gap Addressed	1. Enhanced Power System Safety Settings (EPSS) and Public Safety Power Shutoffs (PSPS) are impacting PG&E reliability for customers in high fire threat districts (HFTD). PG&E is exploring the deployment of thousands of behind-the-meter (BTM) batteries to solve this issue in the next 1-3 years however, individual customer adoption rates are low and remain challenging. FTM Storage is a potentially viable and cost-effective alternative making outages invisible at the transformer serving multiple customers. 2. Capacity to support vehicle and building electrification is requiring massive grid investments to satisfy a peak load design causing customer rates to escalate. There is a need to increase energy storage on the electric grid to help reduce peak load on the local distribution grid, manage variable voltage from renewable generation and increased loads on small conductors, and increase utilization rates on existing infrastructure helping to reduce grid investments therefore reduce increases to customer rates.
Objective	Develop front-of-the-meter (FTM) grid management assets and provide hyper-local capacity and microgrid capabilities. This provides an opportunity to improve reliability for customers frequently impacted by EPSS/PSPS, and other outage events while providing an opportunity for utilities to leverage these assets for local capacity and grid smoothening at scale.
Project Description / Scope of EPIC Demonstration	•Issue Request for Proposal for distributed battery solution and enclosure (e.g. pad-mounted) to serve common sized distribution transformers •PG&E testing to confirm safety, cost-effectiveness, and control/islanding capabilities. •Enroll customers in disadvantaged and low-income communities to extent feasible and customers in high fire threat districts frequently impacted by EPSS to enable field demonstration •Measure performance, impact, and record learnings from outage and capacity management in relation to alternatives •Integrate battery monitoring and controls into utility systems (e.g. Advanced Distribution Management Systems, Distributed Energy Resources Management Systems (DERMS)) •Aggregate batteries into virtual power plants (VPP) and evaluate VPP use cases •Determine processes for scaling as a program for disadvantaged, vulnerable communities, low-income communities, EPSS and PSPS affected customers, and capacity constraints
Estimated Cost	$4M
How PG&E can scale to full deployment (Path to Production)	1.Determine the best methodology and sizing of systems for different distribution transformer configurations, 2.Determine regulatory path for approval if needed for use as both local customer resilience and grid support 3.Integrate with Advanced Distribution Management System for outage information and DERMS or Demand Response programs for capacity support. 4.Develop standardization, documentation, and training for installing and maintaining solutions at scale

Service Transformer Sited Energy Storage

Develop front-of-the-meter (FTM) grid management assets (e.g. battery storage) to increase reliability and decrease stress on the grid, in hyper-local applications

TOPIC	DESCRIPTION
New / Novel / Urgency	Utility-owned and operated batteries at this scale (transformer level) have not been widely deployed or tested and would require new technology for managing and monitoring this novel application of battery storage. This is a potentially entirely new class of front-of-meter batteries would require development of new processes to manage the entire asset lifecycle from planning to deployment to operations.
Urgency	Block/transformer level microgrids that can also be leveraged by the utility to manage loading on transformers and/or aggregated as part of a VPP to address local capacity or system capacity. This co-optimization of BESS toward multiple objectives would be a new application of battery storage for PG&E.
Benefits	• Customers: Provide added resilience for customers frequently impacted by EPSS especially Disadvantaged Communities and Low-Income Communities • Affordability: At scale could provide method for PG&E to address both local grid and system peak loading issues when aggregated. Also, could redirect funds that go to paying for BTM storage to FTM storage that has a more beneficial impact to more customers. • Reliability: Added reliability for customers in HFTDs, potential to manage loading at the transformer level to detect and potentially avoid transform failure. • Disadvantaged Communities (DACs) and Low-Income Communities (LI): Target DACs / LI's in High Fire Thread Districts to help with reliability issues created by EPSS/PSPS programs.

Advanced Load Management Analytics (ALMA)

Build an analytical platform to integrate load management (LM) solutions with generation, transmission, and distribution planning.

Design and implement customer pilot programs to refine LM program design, available potential, and cost.

TOPIC	DESCRIPTION
Concern / Gap Addressed	This project is designed to support integrated planning by addressing two key gaps: 1. LM programs and technologies operate in silos without a comprehensive understanding of how they contribute to a 100% net clean system: • LM is typically an input in the demand forecast, which drives resource adequacy and procurement obligations, rather than optimized alongside supply or transmission and distribution (T&D) investments. • Modeling tools either do not provide this capability or do not exist to compare and optimize different LM solutions. 2. The capability of aggregated behind-the-meter (BTM) resources to provide incremental MWs and support grid needs is not well understood. • Aggregation, in the form of virtual power plants (VPPs), is in its early stages as a grid service; technological capability and customer acceptance are not well understood. • Are VPP megawatts incremental to baseline behavior? At the system level, what scale is needed to become economically viable?
Objective	1. To address the first gap, we are developing the analytical capabilities for integrated planning and answering key questions about the value of a wide range of LM solutions. 2. To address the second gap, we have identified key areas for LM pilot development with focus on validating incrementality, cost, and customer response.
Project Description / Scope of EPIC Pilot	1. To address these gaps, this project will develop analytical approaches, modelling assumptions, and tools to enable a wide range of LM solutions to function as candidate resources, which allows them to be: • Co-optimized with supply side resources to understand the interaction between alternatives (e.g., traditional supply side resources, new technologies such as hydrogen, carbon capture, etc.) • Evaluated as alternatives to identified T&D upgrades • Tested for effectiveness in addressing reliability requirements and achieving greenhouse gas emission reduction goals to develop a portfolio of cost-effective LM solutions
Estimated Cost	$6M

Advanced Load Management Analytics (ALMA)

Build an analytical platform to integrate load management (LM) solutions with generation, transmission, and distribution planning.

Design and implement customer pilot programs to refine LM program design, available potential, and cost.

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	Range of activities to operationalize the results of this project, if successful: • Incorporate best available data early and often, with increased granularity over time, for a more accurate understanding of which LM solutions can help meet California's 100% net clean goal by 2045. • Inform what LM solutions to continue to pursue, advance, and scale; those that should evolve and/or sunset; and those where pilots are necessary to test and learn more about customer behavior, load elasticity, technology readiness, grid impacts, etc.
New / Novel	• This project addresses the current planning analytical gaps by enhancing existing planning tools and creating new tools to address known gaps. • LM programs and technologies are generally included within the demand forecast as an input rather than selected by the optimization, and not optimized alongside supply and infrastructure investments.
Urgency	This project supports a near-term objectives to develop a pilot roadmap informed by robust analytics that take into account new LM solutions as alternatives to supply and maximize utilization of existing and future investments and accelerates greenhouse gas emission reductions.
Benefits	By design, the project is aimed at providing integrated analysis to support the least-cost and reliable path to decarbonization.

Automated Unmanned Aerial Systems (UAS) Deployment System for Alarm-Triggered Events

Enable autonomous deployment of unmanned aerial systems (UAS) to specific alarm locations as an efficient first mode of investigation in hard-to-reach locations

TOPIC	DESCRIPTION
Concern / Gap Addressed	Although we have made significant strides in developing the capabilities for beyond visual line of site (BVLOS) operations there are still opportunities to enhance drone operations through autonomy and automation. Our current manual operations are labor intensive, limiting operational frequency and preventing us from fully maximizing the value of our UAS. Additionally, as more and more advanced monitoring systems and sensors are being deployed on the grid, there is a growing need for a more efficient first mode of investigation than traditional methods like helicopter patrols or truck rolls. Embracing autonomy and automation can address these challenges, providing a pathway to more streamlined and responsive grid management. This project will connect multiple R&D project statements aimed at addressing wildfire challenges. It encompasses tackling the limitations or overhead inspections, the necessity for continuous monitoring, and the goal of eliminating ignitions. Furthermore, it targets the gap in ignition notifications, pinpointing fault locations, and enhancing response capabilities.
Objective	The aim is to enable autonomous and remote deployment of unmanned aerial systems (UAS) to specific alarm locations based on their corresponding geographical coordinates. By achieving this objective, we will streamline the process of UAS deployment, allowing for efficient and automatic response to alarms in various operations.
Project Description / Scope of EPIC Demonstration	• Collaborate with UAS manufacturers to develop and integrate an autonomous UAS deployment system allowing for the automatic deployment of UAS to the location of precise alerts triggered by alarms. Utilizing these systems for investigating highly precise alert locations. It will also encompass various aspects, including system integration, flight planning, safety considerations, testing, documentation and ongoing optimization. • Test and evaluate range extension and base hopping capabilities for the UAS platform. Showcasing cost effective options by mounting UAS base stations on PG&E assets located outside of substations. • Identification of specific areas within our service territory that are most conductive to testing alert integration, range extension, and networked operations. Optimizing the deployment of a select number of drones seamlessly operating within a network of strategically placed station.
Estimated Cost	$4M

Automated Unmanned Aerial Systems (UAS) Deployment System for Alarm-Triggered Events

Enable autonomous deployment of unmanned aerial systems (UAS) to specific alarm locations as an efficient first mode of investigation in hard-to-reach location

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	Acquisition of UAS, widespread deployment of base stations, and the establishment of IT systems to facilitate smooth integration and effective data management. Collaboratively defining the functional and technical requirements for the autonomous UAS deployment system in conjunction with UAS manufactures. Specifying alarm integration, communication protocols, flight plans, capabilities, safety features, and performance benchmarks to ensure the system operates seamlessly and meets stringent standards for reliability and efficiency.
Key Potential Benefits	Utilizing UAS for range extension, alert integration, autonomous capabilities, and beyond visual line of sight opportunities holds immense potential for improved safety, reliability adorability and environmental benefits. The range extension of UAS enables wider coverage of assets, reducing the need of human presence in hazardous or hard to reach locations, enhancing safety. The seamless integration of utility alerts with UAS empowers real time monitoring promptly identifying issues and ensuring a reliable response will lead to system reliability. Autonomous capabilities will streamline operations, minimizing human intervention lowering operational costs contributing to affordability. Embracing BVLOS opportunities allows for comprehensive data collection over vast areas, allows for the reduction of emissions from traditional crewed operations resulting in positive environmental impacts. Overall, the integration of these systems foster a safer, more reliable, cost effective and environmentally conscious approach to aerial operations.
New and Novel	Autonomous deployment of UAS is a novel capability for PG&E and can enable streamlining operations, minimizing human intervention lowering operational costs contributing to affordability.
Urgency	This project's success will enable us to optimize our operations, better comprehend the risks and health of our assets and significantly expedite issue investigation. This in turn will lead to saving valuable time and resources, ultimately reducing costs and enhancing overall efficiency. The urgency lies in seizing this opportunity to propel our operations to new heights and maximize the benefits from the approvals we have obtained.

Non-Wires Alternatives Integration into Distr. Planning

Expand capabilities of existing planning tools to improve the forecasting and use of non-wires alternatives (NWA), including load flexibility and distributed energy resources (DERs).

TOPIC	DESCRIPTION
Concern / Gap Addressed	Current distribution planning/forecasting tools were not designed to fully consider non-wires alternatives (NWA) such as load flexibility or DERs. 1. Limits our ability to accurately determine and forecast grid needs. 2. Limits our ability to propose solutions as alternatives to capacity upgrades. The distribution grid is both capacity-constrained and underutilized, while conventional upgrades are expensive and long. NWA, which can potentially defer or avoid conventional upgrades, has only been considered on an ad-hoc basis due to limitations of current planning/forecasting tools.
Objective	Reduce the need for conventional capacity upgrades by equipping planners with the capability to dynamically model distribution capacity: • Increase capacity utilization of the grid (rather than planning and building for peak) • Avoid or defer costs of conventional capacity upgrades by using alternative solutions • Reduce time to interconnect new load and generation on capacity-constrained feeders
Project Description / Scope of EPIC Demonstration	1. Incorporate load flexibility, load management, and dynamic rating directly into distribution forecast and distribution tools used by distribution planners to reduce grid needs. 2. Identify opportunities for various DER technologies and customer flexible load interconnection as an alternative or bridge to conventional upgrades (NWA). • Determines limited load/generation profiles and locations.
How PG&E can scale to full deployment (Path to Production)	• Builds on existing functioning planning platforms • Internal subject matter expert providing product management and vendor selection and management • Built using existing IT infrastructure already in place

Non-Wires Alternatives Integration into Distr. Planning

Expand capabilities of existing planning tools to improve the forecasting and use of non-wires alternatives (NWA), including load flexibility and distributed energy resources (DERs).

TOPIC	DESCRIPTION
Estimated Cost	$2M
Key Potential Benefits	Could improve Customer Transaction Score and Customer Satisfaction Score, by providing Customer On Time Delivery Increases available MWs achievable through Load Management The tools will allow for the use of novel solutions (e.g., load flexibility) to meet the capacity needs of disadvantaged, vulnerable communities and low-income customers and help remove barriers to electrification for these customers.
New and Novel	The project is a new functionality that improves upon an existing tool. It is novel in that it could fundamentally change the way we plan the distribution grid and meet electrification needs.
Urgency	PG&E forecasts increasing capacity needs on its distribution system, and the use of flexible loads is necessary to meet the state's electrification needs in a timely and cost-effective manner. This tool can prepare us to more accurately forecast and utilize the increasing load flexibility that DERs will provide. It could also support a more streamlined flexible load offering for a timelier interconnection for customers.

Substation Predictive Maintenance

Collect both transformer oil diagnostic data and other data in one repository, leveraging statistics/ machine learning to identify outliers needing maintenance or replacement.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Currently SCADA (Supervisor Control And Data Acquisition) is collecting data (such as loading, winding hot spot, oil temperatures, and fault magnitude/duration) for substation transformers but that data is not being leveraged to full advantage. The data provides valuable information that when used in conjunction with oil diagnostics could inform both targeted maintenance decisions and replacement strategies. It also enables continuous monitoring through a dashboard that updates automatically vs monthly or bi-monthly visual inspection cadence.
Objective	Collect both transformer oil diagnostic data and SCADA data in one repository, leveraging statistics/ machine learning to identify outliers needing maintenance or replacement. Transformers with high levels of water that experience many high-loading events can cause the excess water from the paper insulation to move into the oil. This then results in the relative saturation of water being very high causing the formation of free water and this may also occur when a heavily loaded wet transformer rapidly cools down. The collection of free water affects the dielectric properties especially around the active parts resulting in discharges that can cause long-term damage.
Project Description / Scope of EPIC Demonstration	• Data Science and Substation subject mater experts sessions to understand anomalies and failure modes at selected substation transformers • Data Science and Substation subject mater experts sessions to understand the data: Review available data in GIS systems and identify additional data needs. • Build a dashboard to visualize raw data for communications with SMEs • Implement statistical based models (anomaly detection or a machine learning model) in GIS systems to flag anomalies • Review Results: Include model results in the dashboard and review the results with subject mater experts. • Update the models based on subject mater experts' feedback
Estimated Cost	$2M

Substation Predictive Maintenance

Collect both transformer oil diagnostic data and other data in one repository, leveraging statistics/ machine learning to identify outliers needing maintenance or replacement.

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	The product requires building data pipelines to expand the scope from demonstration to all substations and potentially to other assets. Model performance will be tested with updated data and results will be validates by subject matter experts. Results will be updated in the dashboard weekly (or cadence needed by users).
Key Potential Benefits	Operations & Maintenance Reduction: predictive maintenance reduces Operations & Maintenance costs Waste Elimination: online monitoring will reduce the number inspections Reduce Outages: substation transformer failures result in long outages for customers that can be avoided or reduced with predictive maintenance, measured via System Average Interruption Duration Index (SAIDI) Customer Satisfaction Score: fewer outages or shorter duration improves customer satisfaction
New and Novel	Real time SCADA (Supervisor Control And Data Acquisition) data along with IEEE C57.106 derived limits for oil diagnosis paired with machine learning has not been used to forecast asset health at a utility per current public knowledge.
Urgency	This project supports all near to long term objectives of Substation Asset Management and Electric Transmission Operations. Current budgetary constraints makes advanced diagnostics critical to operations and company objectives. Health forecasting of power transformers would represent a benefit in terms of safety, capital expense reduction and improve system reliability.

Dynamic Line Rating (DLR) and Line Degradation Demonstration

Identify and objectively compare solutions to cost-effectively increase the thermal rating, improve the efficiency of existing grid assets in a manner that doesn't compromise system reliability, asset health, or public safety.

TOPIC	DESCRIPTION
Concern / Gap Addressed	PG&E's assets are not currently utilized to their maximum dynamic capacity, and maximizing capacity will be a critical component of affordably accommodating the projected increase in load growth. Many products are emerging that calculate dynamic line rating (DLR) through a range of approaches, and it would be very difficult to assess their relative merits without conducting an objective side-by-side demonstration. This project aims to address the issues around underutilized Transmission & Distribution infrastructure by evaluating and benchmarking low cost, DLR technology solutions. Because many DLR solutions provide enhanced asset monitoring, this project will also address the need for continuous monitoring of assets across our transmission system.
Objective	Identify and objectively compare solutions to cost-effectively increase the thermal rating, improve the efficiency of existing grid assets in a manner that doesn't compromise system reliability, asset health, or public safety.
Project Description / Scope of EPIC Demonstration	Scope 1 (Ground-truthing) – to develop a risk optimized reference DLR for a list of transmission lines •Obtain, cleanse, validate, and analyze weather data across the PG&E service area •Install measurement devices and collect field data (12 months) at selective facilities (6 to 18 sites) •Develop reference DLRs that optimally balance accuracy, costs/risks, benefits Scope 2 (Demonstration) – to benchmark DLR vendor solutions and provide recommendations •Explore and select a list DLR vendor solutions based on industry and PG&E relevant factors (e.g., solutions that can leverage Fiber Optics cables, which are already installed on over 15% of our transmission system) •Select transmission facilities (all or a subset of Scope 1 locations) for demonstrations •Install (if needed) vendor devices and collect field data (same period as Scope 1) •Compare vendor DLR calculations and recommend solution(s) for implementation At a high level, the desired technology solution(s) will allow us to calculate DLR with sufficient accuracy (as benchmarked against Scope 1 results) that balances capacity benefits while maintaining a safe, reliable grid.
Estimated Cost	$6M

Dynamic Line Rating (DLR) and Line Degradation Demonstration

Identify and objectively compare solutions to cost-effectively increase the thermal rating, improve the efficiency of existing grid assets in a manner that doesn't compromise system reliability, asset health, or public safety.

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	If successful, PG&E can develop or procure a production grade version of the recommended DLR solution and incorporate it into PG&E's implementation of the FERC Order 881 project (go-live July 2025) as a future phase-in (e.g., in 2026). Minimal need for hardware – With an eye towards scaling DLR solutions across our system, this project will focus primarily on DLR solutions that are software-based or low-cost, low-maintenance hardware solutions. Low/moderate effort/cost for production – While the integration of project results will involve changes in operational practice, we plan to build upon the soon to be developed processes/systems from the FO 881 project.
Key Potential Benefits	A low-cost DLR solution can conceptually increase the thermal rating across ALL electric transmission grid at low cost – both initial installation and ongoing maintenance – while not compromising system reliability. This yields system level benefit to multiple core TNS tenets and KPIs: •Customer satisfaction (Customer Satisfaction Score and Customer on Time Delivery) – Increased transmission capacity allows our customers to interconnect more and experience less outages •Scope 3 Emission Reduction – Increased transmission capacity allows more renewable generation and less renewable curtailments •Operational efficiency – Increased transmission capacity provides additional operational flexibility (e.g., clearances) that improves reliability •Financial benefits - Increased transmission capacity at a minimal cost reduces Operations and Maintenance cost and increases revenue Additionally, by examining the "continuous monitoring" problem statement, the project has the potential to benefit the KPIs of Wildfire Risk Reduction and CPUC Reportable Fire Ignitions
New and Novel	Low-cost DLR technology is still in a nascent stage, with few emerging vendors and no large scope demonstrations in North America. An EPIC demonstration project across PG&E's system, in collaboration with industry leaders focusing on risk-based optimization, can provide vital data on this emerging grid opportunity
Urgency	This project supports both near-term and longer-term PG&E objectives of increasing grid capacity and enabling clean energy. Timing is ripe for this project as utilities are looking for innovative ways to increase asset capacity and FERC is actively considering requiring broader adoption of DLR technology.

BREAK

Please return
in 10 minutes

Increase the Value Proposition of Distributed Energy Resources to Customers & the Grid

Alternating Current (AC) Vehicle-to-Grid (V2G) and Electric Vehicle Virtual Power Plants

Design, deploy, and test various AC V2G customer experiences. Deploy and evaluate a large-scale demonstration of an AC V2G VPP.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Increasingly, EVs can be equipped with vehicle-to-grid (V2G) capabilities, which enable electric vehicles to provide power back to the electrical grid. V2G enablement has the potential to reduce grid stress, particularly during on-peak hours, by making use of EVs' high-capacity batteries when not being used for transportation to provide power to the grid during peak demand events or to serve as a critical backup power source during outages. Existing V2G solutions in the market today can bypass the vehicle onboard charger and export power via Direct Current (DC) which requires an inverter to be installed at the site. By working with car companies to leverage the onboard charger as a bi-directional inverter, the cost of the system can be reduced, eliminating the need for an inverter at the site. There is no current tested and approved pathway for Alternating Current (AC) V2G to be implemented and scaled. EV Companies have expressed interest in AC V2G and have engaged PG&E to support launch.
Objectives	1. Create a scalable pathway for the interconnection and deployment of residential AC V2G 2. Utilize developed pathway to create large scale electric vehicle virtual power plant (EV VPP)

Project Description / Scope of EPIC Demonstration	Phase 1: Accelerate a pathway to scale interconnection
	• Develop standardized pathway(s) for AC V2G to inform enhancements to Rule 21
	  • Supporting existing longer-term UL 1741 SC effort
	  • Provide the option to explore a nearer-term UL 1741 SB "QIKP" pathway
	• Test AC V2G in the lab and demo with 2-3 field installations
	• ID opportunities to reduce cost by optimizing bill of materials or removal of protective relays (if/when possible; reference PG&E AL 7125-E filed 1/5/24)
	
	Phase 2: Demonstrate an at scale VPP (potential up to 100s to 1,000s of units)
	• Scale beyond 2-3 field installations to create an EV VPP with a focus on testing and refining a least-friction highest-value customer experience
	• Integrate to DERMS/Demand Response headend
	• Analyze economics of the VPP and lay framework for future scaling
	• Advocate at the CPUC for frameworks that enable EV VPPs

Estimated Cost	$2M

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Design, deploy, and test various AC V2G customer experiences. Deploy and evaluate a large-scale demonstration of an AC V2G VPP.

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	• Integrate virtual power plants (VPP) into PG&E DERMS • Continue to scale EV VPP enrollment (e.g., up to thousands) and expand with multiple vehicle OEMs. • Determine cost effective follow-on compensation schemes for VPP services for discussion in regulatory contexts
Key Potential Benefits	Value DERs: Development of AC V2G interconnection standards unlocks new option for V2G participation with potential to scale. • Key early and foundational learnings on V2G value at scale • Thought and industry leadership in nascent area Customers: AC Electric vehicle supply equipment (EVSE) potentially offers a substantially cheaper price point compared to DC, allowing customers to access this value for resiliency and revenue. • Learnings from project to reduce ancillary equipment costs & project timeline. Affordability: VPP can be used for grid services; e.g., capacity, load management, or resilience; reducing cost on the system due to capacity constraints • General reduction in rate pressure; e.g. offsetting peaker plants and grid infrastructure • More attainable price point for AC EVSE
New and Novel	• AC V2G standards do not yet exist, to date have been tested only in a limited fashion, and are needed to unlock and enable lower cost V2G. • Create the potential for the largest vehicle V2G VPP in the world, gaining real world V2G value capture while exploring the potential for cost-effective VPP solutions.
Urgency	Immediate – Necessary to learn and set up V2G VPPs now to be able to gain V2G value before customers make a mass transition to EV (we'd like the V2G to be embedded for most customers day 1, not after the fact because we were not ready).

Socket of the Future: Residential EV Charging

Deploy a grid edge computing platform and enable residential EV customers to avoid panel and service upgrades by coordinating their EVSE directly to "next generation" smart meters

TOPIC	DESCRIPTION
Concern / Gap Addressed	1. PG&E's meter socket is underutilized, serving primarily as a billing meter and to identify outages without existing capabilities to help integrate DERs. Next generation meters have emerging capabilities to connect to, and control or signal DERs to solve customer challenges. PG&E has yet to test and deploy such a platform. 2. Residential EV customers with 100A panels are often confronted with significant customer panel, service wire, and service transformer upgrade costs which could be avoided if their EVSE was coordinated to their panel/service ○ Typical residential panel upgrades can cost $3-5K ○ Typical residential service upgrades can be $5-8K with some scenarios costing above $20K (e.g. underground trench down and across the street) ○ Service transformer upgrades can take months and often cost ratepayers >$10k/transformer Across the system, in a complete transition to electric vehicles, the cost of panel and service work could be over $1B, leading to a significant barrier to EV adoption.
Objectives	• Ensure affordable and timely connection for every Residential Single-Family Home (SFH) customer *(note there is a separate Multi-Family Home Project)* • Enable a <$1,000/site home EV charging solution that connects a Smart Meter via Wi-Fi to customer owned EV charger over OCPP to avoid a customer panel and/or service upgrade
Project Description / Scope of EPIC Demonstration	• Deploy updated AMI meter software platform (head end) that enables edge computing • Lab and limited field test the meter application with a few EVSE charging partners and confirm it meets the requirements of electric code and utility standards to avoid an upgrade • Extended pilot (in production) up to 1,000 sites as an option for customers to avoid a panel/service upgrade • Design/develop/explore pathway for standard process scaling past 1,000 units
Estimated Cost	$6M
How PG&E can scale to full deployment (Path to Production)	1. Coordinate solution with customer enrollment flow and rest of business, identify customer programs to develop and business partners to leverage EV charging solution and scale 2. Create roadmap for Socket of the Future feature deployment, work with business to adopt into GRC or other path 3. Scale additional Socket of the Future functions via meter swapping program

Socket of the Future: Residential EV Charging

Deploy a grid edge computing platform and enable residential EV customers to avoid panel and service upgrades by coordinating their EVSE directly to "next generation" smart meters

TOPIC	DESCRIPTION
Key Potential Benefits	• Connecting EV load immediately at low cost to customer/utility; DER enablement at low cost • Avoid costly and time intensive distribution transformer upgrades • Significantly lower cost/barrier to entry for EVs, enable customers to charge at home for less • Significantly reducing charging costs for EV could have pronounced impacts to low-income/disadvantaged communities, coupled with other options to bring down EV cost
New and Novel	Redefining the interface between PG&E and the customer, fundamentally reducing the cost of electrification and DERs Orchestration of EV charging for distribution upgrade deferral.
Urgency	Immediate – EV customers cannot connect without costly upgrades and when they do connect it pushes capacity crunch up to the service transformer.

Local Grid Orchestration

Evaluate and demonstrate distribution mechanisms and the technical capabilities required to efficiently and reliability interact with distributed energy resources (DERs) to manage local grid constraints.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Today PG&E does not have a mechanism to engage with existing or target the deployment of new distributed energy resources (DERs) and/or load management programs (e.g. demand response, energy efficiency, managed EV charging) at a distribution level or value 3rd party DER solutions which could replace and be deployed faster than conventional grid upgrades. Additionally, PG&E does not have any method to prioritize loads and/or DER dispatch on constrained distribution feeders. Engaging with local DERs and customer load management will be a central capability to manage electrification load growth in the coming years and if PG&E does not explore orchestration mechanisms, we will not be ready to optimize/orchestrate the distribution grid as the CPUC, State, and ratepayers begin to expect these solutions.
Objective	Evaluate and demonstrate distribution mechanisms and the technical capabilities required to efficiently and reliability interact with multiple DERs to manage local grid constraints, as a foundation to a future local grid orchestration, that efficiently allocates available capacity among flexible loads and DERs and sets the value for grid services while providing strict limits to avoid grid issues. Determine cost effective mechanism(s) as an alternative to traditional grid upgrades and other methods for providing local capacity such as the Distribution Investment Deferral Framework.
Project Description / Scope of EPIC Demonstration	• Develop, model and evaluate enrollment and compensation schemes for participation local distribution orchestration such as a local capacity auction (e.g. flexibility market similar to UK), a flat or time-of-use rate with reduced $/kWh in exchange for dispatch rights, peer to peer transactive energy market, real time pricing, upfront payment + performance or other distribution plus transmission-based mechanism for the purposes of evaluating technical feasibility, customer experience and compensation models at the distribution level. • Based on initial study/evaluation determine preferred model to demonstration in the field (go / no go stage gate) • Create Distributed Energy Resource Management System (DERMS) integrations and capabilities as needed for demonstration purposes • Select demonstration location with high penetrations of DERs and flexible loads • Enroll multiple diverse customers and/or aggregators within a constrained area with flexible loads to participate in a local distribution orchestration mechanism to address hourly capacity constraints • Set a reduced feeder limit and call upon the resources and allocate capacity among participants in an automated fashion • Measure performance, impact, and record learnings
Estimated Cost	$3M

Local Grid Orchestration

Evaluate and demonstrate distribution mechanisms and the technical capabilities required to efficiently and reliability interact with distributed energy resources (DERs) to manage local grid constraints.

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	Pending positive results, advocate for and launch a system on a limited number of circuits as part of a V1 Local Grid Orchestration and determine regulatory path for approval for using new orchestration mechanism to offset or defer grid upgrades 1. Pursue regulatory pathways for approval of proposed local grid orchestration mechanism 2. Integrate market or grid availability coordination engine or both into production DERMS and other relevant systems 3. Coordinate with Engineering on locations where distribution orchestration of DERs/Flexible Loads would be viable alternatives to traditional upgrades 4. Develop interface for customers to participate 5. Scale system with interested customers in relevant geographies
Key Potential Benefits	Customers: Cost-effectively serving customers faster. Affordability: Ratepayers get more utilization of the existing infrastructure to deliver more energy which has a downward influence on rates. Value DERs: Coordinate DERs to bring maximum value to the local distribution system, opening up a new value stream Affordability: Ratepayers get more utilization of the existing infrastructure to deliver more energy which has a downward influence on rates. Project could explore deploying field demo in low-income/ disadvantaged communities, however it is possible that will not be feasible as it will be site specific.
New and Novel	Testing of multiple new/novel types of enrollment and compensation methods for our territory Dynamic value coordinated to distribution grid constraints (not just transmission) Novel DERMS applications to allocate constrained capacity and integrate with multiple DERs and 3rd parties
Urgency	Immediate – We need to learn more about which customer mechanisms and technical capabilities are needed, how they work, and how best to enable and interact with DERs now so that we can advocate for and be prepared to scale alternatives to conventional upgrades in the future. New load is coming onto the network and customers are adopting DERs (e.g. storage) including flexible load management technologies (e.g. EVs, smart devices) at ever increasing rates. This EPIC project serves to answer some of the questions on how to best open up that available capacity most effectively and how best to engage flexible load customers and DERs in the opportunity. The project will position PG&E with data, experience and technical capabilities to be proactive in the active regulatory environment the is looking to determine future local orchestration models.

Managed Electric Vehicle Charging at Home

Enable further adoption of level 2 single-family home (SFH) charging by mitigating distribution capacity limitations, thus reducing capital cost and eliminating timeline associated with upgrades.

TOPIC	DESCRIPTION
Concern / Gap Addressed	New distribution capacity is costly and has a long lead time. Utilize load management to more efficiently operate under given asset capacity constraints and extend lifetime of distribution assets, enabling more adoption of level 2 electric vehicle supply equipment (EVSE) that will be needed to meet the increase of electric vehicles on the grid.
Objective	• Ensure affordable and timely connection for every customer • Manage electric vehicle (EV) loads to protect distribution assets • Enable further adoption of level 2 single family home charging by mitigating distribution asset capacity limitations, thus reducing capital cost and eliminating timeline associated with upgrades

Project Description / Scope of EPIC Demonstration	• Project Set up: 1) Identify candidate transformers, 2) enablement of real time telemetry to determine time-varying capacity availability on a given asset and 3) develop real time load shapes for electric vehicle service providers (EVSPs).
	• Orchestrate load limiting level 2 charging based on real-time available capacity on constrained assets.
	  • Seek partnership with a vendor willing to respond to PG&E load shapes
	  • Deliver real-time load shapes for electric vehicle service providers to follow, thus remaining under asset limitations.
	• Develop framework to quantify avoided cost of an upgraded asset to inform cost-effective/optimal customer incentive design for managed charging programs.
	• Develop framework to scale

Estimated Cost	$3M

Managed Electric Vehicle Charging at Home

Enable further adoption of level 2 single-family home (SFH) charging by mitigating distribution transformer capacity limitations, thus reducing capital cost and eliminating timeline associated with upgrades.

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	Pending positive results: 1. Scale to additional distribution assets utilizing the capabilities built/learned from the project 2. Seek additional partnerships with aggregators to expand participation or turn this into a procurement resource (e.g. standard offer contract) 3. Integrate with production DERMS and other relevant systems 4. Scale system with interested customers in relevant geographies
Key Potential Benefits	• Avoid costly and timely distribution capacity upgrades • Addresses one of main barriers to PG&E's goal of enabling 3 million EVs deployed
New and Novel	• Delivery of desired behind-the-meter load shape to 3rd Party has not been done before at PG&E • Orchestration of EV charging for distribution upgrade deferral is new
Urgency	Solutions would be critical in alleviating stress on the grid as electric vehicle ownership increases. Effectively managing EV loads optimizes the overall performance and endurance of existing assets.

Propensity Modeling for Electric Vehicle Adoption

Predict customer Electric Vehicle adoption at granular level and build a temporal heatmap tool (for future load management and Vehicle-Grid Integration)

TOPIC	DESCRIPTION
Concern / Gap Addressed	In 2030, electricity consumption from passenger electric vehicle (EVs) charging in CA increases electricity demand by up to 20–25 percent. Single-family homes may encounter unanticipated and significant costs and wait times to complete the on-site electrical work and may unknowingly create challenges for the broader system as service transformers become increasingly constrained, resulting in added costs to PG&E to upgrade existing infrastructure. There is currently no predictive analysis on the propensity of passenger EV adoption by customer at a regional level i.e premise, zip code, county. Consequently, the load shift prediction due to EVs coming online at the local levels of the grid is unknown. Available analytics are disparate. Internal analysis are currently limited to EV adoption forecast at system level and the charging load estimation at county/zip code level for current EVs.
Objective	To maximize EV adoptions and optimize the new grid load using EVs as energy storage, we require an estimate of where and when EVs come online. This can be achieved by predicting the likelihood a PG&E customer adopting an Electric Vehicle using machine learning algorithm.
Project Description / Scope of EPIC Demonstration	• Identify current customers who own EV either through EV rates, EV incentive programs, or EV detection based on load shape and energy consumption patterns (for this step we also leverage available vendor-provided data for charging). If needed, purchase DMV data (currently under discussion) of existing EV sales and registration for the most accurate and complete picture of current adoption. • Build a predictive model to map potential EV adopters at customer premise level to the grid (feeder and Transmission & Distribution level). Include heatmap for current and future EV adoptions at granular level. • Results will inform the future load shift at a localized grid level as well as inform the load management and vehicle-to-grid integration strategies.
Estimated Cost	$3M
How PG&E can scale to full deployment (Path to Production)	The demonstration above will have generated a customer propensity score from 0 to 100% which indicates the probability of a customer purchasing an EV. The first decile (above 90%) are considered next EV adopters. All PGE customers will be assigned a propensity score. The input data pipeline will be refreshed dynamically, and the customer score outcome of model will be refreshed twice a year via GIS systems. The insight will be delivered to Clean Energy Transportation for making decisions on vehicle-to-grid integration strategy, to design/update Clean Energy Programs, and for effective customer connection services. The data will also be delivered to Distribution planning tools which informs projected loads at distribution grid. This project does not require any change in the current processes because it provides an insight that currently doesn't exist.

Propensity Modeling for Electric Vehicle Adoption

Predict customer Electric Vehicle adoption at granular level and build a temporal heatmap tool (for future load management and Vehicle-Grid Integration)

TOPIC	DESCRIPTION
Key Potential Benefits	By identifying future EV adopters and non-adopters, PG&E can strategically focus outreach for clean energy and EV access programs for identified “non-adopter” customers. Identifying areas of future EV adoption informs the grid strategy & planning for better Vehicle-Grid integration and saves cost for the grid and customer.
New and Novel	Developing a data science approach to predict future EV adoptions is a novel capability for PG&E, which will benefit many departments and planning processes. Leveraging GIS system platforms enables the customer propensity scores, the EV-to-grid data mapping, and the EV temporal heatmap solutions to be streamlined, dynamic and readily available for the PG&E departments (Clean Energy Transportation, Integrated Grid Planning, Distribution Planning, Load Management)
Urgency	As EV adoption spreads, increasing charging load can lead to service transformer failures that can cause widespread outages and costly repairs for PG&E. Identifying customers with high propensity of EV purchase in near future can help ensure affordable and timely connection for every customer by increasing educational opportunities focused on the electrification process, and addressing grid capacity constraints before it occurs.

EV Charging Solutions for Parking-Constrained Residences

Test and evaluate on-site and off-site EV charging solutions for residents of a) Multi-family housing (MFH) and b) Single-family housing with parking constraints, to help determine PG&E's path to rapid residential EV adoption

TOPIC	DESCRIPTION
Concern / Gap Addressed	• Ensuring affordable and timely connections for customers who lack access to charging. • Today, customers living in parking-constrained areas lack the ability to install EV charging in on-site and off-site locations. Understanding and addressing these barriers, and how PG&E can best support solutions to them will increase customer access to EV charging.

Objective	• Test a variety of EV charging solutions to address the lack of accessible charging at MFHs and single-family housing without dedicated access to parking.
	  ○ On-site solutions might include but are not limited to: 1) plug/smart outlet 2) smart breaker, 3) L2 charging w/ load management
	  ○ Off-site solutions might include, but are not limited to: 4) streetlight L1 & L2 5) curbside L1 & L2 with bring your own (BYO) cable
	• Identify which solution or portfolio of solutions can be scaled for deployment.

Project Description / Scope of EPIC Demonstration	Phase 1: Project Discovery • Activities: Conduct customer and product solution research. Develop common framework to assess solutions in Demonstration stage • Outcomes: Publish white paper to generate industry interest & communicate PG&E's objectives. Use learnings to inform Demonstration plan. Phase 2: Demonstration • Activities: Design, test, execute, and assess demonstration projects • Outcomes: Learn and confirm or disprove hypotheses. Use learnings to inform PG&E strategy & create list of selected solutions
Estimated Cost	$6M
How PG&E can scale to full deployment (Path to Production)	Phase 3: Scaling Solutions • Activities: Determine appropriate path to production for selected solutions – demonstration, program, partnership, other. • Outcomes: Publish final report in compliance with EPIC guidelines. Execute on path to production for selected solutions

EV Charging Solutions for Parking-Constrained Residences

Test and evaluate on-site and off-site EV charging solutions for residents of a) Multi-family housing (MFH) and b) Single-family housing with parking constraints, to help determine PG&E's path to rapid residential EV adoption

TOPIC	DESCRIPTION
Key Potential Benefits	• Provide L1 or L2 charging to hard-to-serve residents who currently lack access to adequate charging • Encourages EV adoption and reduces range anxiety among an underserved population of EV owners • Low-Income (LI)/ Disadvantaged Communities (DACs): This project has high benefit potential for LI/DAC residents who are likely to be renters and thereby have less control over their charging options. Would need to be coupled with other programs to reduce EV cost/barriers to access.
New and Novel	1. Plug/Smart Outlet • Redefining the interface between PG&E and the customer, create a new type of electric service – EV direct metered outlets 2. Smart Breaker • Bypass need for EVSE, thus potential for cost savings 3. Streetlight & Curbside • Curbside charging is not yet widely adopted and is not yet demonstrated in the service territory at scale • Bring your own (BYO) cable not common in North America • New Revenue Development (NRD) opportunity with PG&E owned streetlights to explore potential for further ratepayer benefits
Urgency	PG&E seeks scalable charging solutions specifically designed to be used by our customers in multi-family homes that can effectively manage billing and load concerns as charger accessibility is paramount to meeting both state goals and PG&E's goal of and PG&E's goal of enabling adoption of 3 million EVs across our system by 2030.

BREAK

Please return
in 10 minutes

Inform California's Transition to an Equitable, Zero-Carbon Energy System that is Climate-Resilient and Meets Environmental Goals

Fluid-free, Steerable Boring

To support cost-effective undergrounding efforts, compare cost and efficiency of fluid-free, steerable boring to conventional Current Horizontal Directional Drilling (HDD).

TOPIC	DESCRIPTION
Concern / Gap Addressed	Current Horizontal Directional Drilling (HDD) technology produces large amounts of liquid spoils (bore gel) which is expensive to dispose of ($270/ton, over ten times the cost of dry clean soil disposal). Additionally, conventional HDD technology requires large quantities of water and additives as inputs; these are expensive and difficult to source on logistically challenging 10k undergrounding jobs. Provision of inputs and disposal of liquid waste necessitates large amounts of trucking activity, conducted over long distances on challenging mountain roads. HDD also carries the potential for liquid spoils to escape from the bore hole through fracturing of the surrounding substrate. In sensitive areas this can lead to environmental damage and/or fines.
Objective	• Compare cost and efficiency of fluid-free, steerable boring to conventional HDD. • Partner with vendor to provide field testing on actual 10k undergrounding job sites. • If field tests are successful, integrate new solution into Undergrounding operations at scale by 2025.
Project Description / Scope of EPIC Demonstration	This project intends to demo fluid-free, steerable boring systems to move through the ground without the need for bore gel, meaning it neither requires the expensive inputs of HDD nor produces the costly liquid spoils. The removal of these factors would allow trucking to be reduced, which lowers cost, CO2 emissions, and increases safety. By lowering the cost per mile of Undergrounding work, this technology could benefit customers by increasing the speed of execution of the Undergrounding program.
Estimated Cost	$2M

Fluid-free, Steerable Boring

To support cost-effective undergrounding efforts, compare cost and efficiency of fluid-free, steerable boring to conventional Current Horizontal Directional Drilling (HDD).

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	• PG&E to provide subject matter experts feedback during prototype development in 2023 & 2024 • In Q3 2024, vendor to field preproduction units for use on PG&E 10k Undergrounding work. • Following Preproduction demos, vendor to finalize production design and manufacture of a commercially available unit.
Key Potential Benefits	• Elimination of HDD related spoils • Reduced water consumption • Reduced rural driving hazard • Reduced Emissions • Removal of environmental risk • Reduced cost per mile for 10K • If successful, this solution will lower the cost of distribution underground construction. The downstream impact would reduce the amount of cost passed through to the customer, which would be most impactful to disadvantage and low-income customers.
New and Novel	This technology is currently only in use with the military, and has not been deployed for construction. Development of this technology into a viable construction tool would be a genuine innovation, and the ability to accomplish trenchless install without producing wet spoils would have high impact on the entire industry.
Urgency	Spoils, especially wet spoils, are a major driver of cost in underground construction. In order to meet our undergrounding goals at a sustainable cost, approaches to undergrounding will be needed ASAP.

Underground Water and Sewer Asset Detection

Identify and objectively compare solutions to cost-effectively and accurately detect unexpected underground sewer and water assets.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Accurate subsurface surveying and mapping are critical tools for PG&E to identify underground obstacles before finalizing route design and beginning underground construction. When obstacles and ground characteristics are known early in the design process, routes can be optimally planned and costly rework due to unexpected obstacles can be avoided. Working in rural areas presents a greater challenge as less data is available, and obstacles can be difficult to identify. Specifically, water service lines and sewer laterals <4" are especially challenging to identify through GPR and other detection methods and cause significant delays in construction when hit. There is a range of emerging vendor capabilities, and it is difficult to compare their merits without conducting a controlled, objective side-by-side evaluation in an operational environment.
Objectives	Identify and objectively compare solutions to cost-effectively and accurately detect underground sewer and water assets. Improve the efficiency of underground civil construction from survey to installation - Site survey of terrain conditions and other obstructions
Project Description / Scope of EPIC Demonstration	• Stakeholder alignment: Understand needs of different stakeholders, based on what has worked, hasn't worked in the past • Based on stakeholder needs, develop request for proposal (RFP) • Conduct RFP to select a set of water/sewer asset detection vendor solutions for demonstration based on set of requirements • Test & benchmark water/sewer asset detection vendor solutions and provide recommendations for field demos. • Select locations for demonstrations • Conduct demonstrations at 2-3 sites with 2-5 vendors
Estimated Cost	$2M

Underground Water and Sewer Asset Detection

Identify and objectively compare solutions to cost-effectively and accurately detect unexpected underground sewer and water assets.

TOPIC	DESCRIPTION
How PG&E can scale to full deployment (Path to Production)	If successful, work with Land Survey department to adopt new detection technologies and ensure land and estimating teams can receive information and improve designs based on field discoveries. Update company standards as necessary.
Key Potential Benefits	Cost-savings for PG&E's undergrounding work through avoiding delays and additional work caused by discovering unexpected water/sewer utility assets. Beyond virtually eliminating the risk of utility-caused ignitions, undergrounding offers many additional benefits to our customers and stakeholders, including reducing power outages and improving overall system reliability, reducing the cost and scale of vegetation management, and driving long-term affordability for our customers
New/ Novel	To meaningfully reduce costs, we seek solutions novel capable of providing a detailed understanding of the subsurface terrain and existing assets to better plan routes, construction methods, and off-haul plans to minimize costs associated with spoils displacement and removal.
Urgency	In order to meet our undergrounding goals at a sustainable cost, approaches to undergrounding will be needed ASAP.

X-Ray UAV System for Conductor Splices

Demonstrate the use of X-Ray cameras deployed on Unmanned Aerial Vehicles (UAVs) to enable the inspection of conductor splices while energized.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Conductor splices on overhead transmission and distribution lines fail over time due to degradation or defective installation. The loss of mechanical strength and increase in electrical resistance within a compression or automatic splice is difficult to inspect using current methods such as infrared and direct contact thermometry, as onset of failures may not be detectable by temperature measurements. Failure to identify early stage of degradation could result in a separation of conductors within a splice and a lines down event. Other inspection methods, including radiography, produce much more informative results but are not able to be used on energized lines.
Objective	To demonstrate the use of X-Ray cameras deployed on Unmanned Aerial Vehicles (UAVs) to enable the inspection of conductor splices while energized. The capability can improve the efficiency of inspections while minimizing downtime and ensuring uninterrupted electric service to customers.
Project Description / Scope of EPIC Demonstration	This project will focus on the demonstration of the combined capabilities of UAVs and X-Ray imaging to inspect for the conductor splice use case. Demonstration of the combination of both technologies will require testing on de-energized lines first to validate the X-ray mounted UAV system. Technology accuracy, reliability, and ease of inspection will be evaluated. If successful, testing on energized lines would be performed. Radiography is a proven technology for non-destructive evaluation of metallic components. X-ray images provide objective images of subsurface conditions, revealing anomalies such as cracks, voids, and separations, delamination, and more. However, traditional X-Ray tools require a qualified technician to perform the work on a de-energized line, which can be prohibitive for operations.
Estimated Cost	$1M
How PG&E can scale to full deployment (Path to Production)	- After demonstration phase, scale up X-Ray UAV system with vendor(s) and possible contractors to perform inspections at scale across PG&E. - Ensure compliance with appropriate safety teams to mitigate risks associated with X-Ray radiation and UAV operations near energized lines. - Develop training of UAV operators and X-Ray Technicians to standardize operations. - Develop workflow to accept field collected data into operational database.

X-Ray UAV System for Conductor Splices

Demonstrate the use of X-Ray cameras deployed on Unmanned Aerial Vehicles (UAVs) to enable the inspection of conductor splices while energized.

TOPIC	DESCRIPTION
Key Potential Benefits	Safety: Provides objective evaluation of conductor splice integrity to enable better decisions making on proactive maintenance, targeted repairs, and resource prioritization. Efficiency: Removes need to de-energize lines during inspections without the need for clearances, improving the overall speed of inspections. Accuracy: High Resolution X-Ray images provide much more detailed information about conditions of conductor splices compared to current inspection methods in energized scenarios. Cost Savings: Significantly reduces costs associated with planned and unplanned outages, system failures, and manual inspections.
New and Novel	While there are several radiography vendors that specialize in electric utility component inspections and UAV vendors are already being deployed for system inspections at PG&E on energized lines, the combined capabilities is a novel application for energy utilities. X-Ray power lines inspections are being utilized in the industry on de-energized lines via bucket truck inspections or on cut-outs, but there currently are no commercially-available methods currently for performing X-Ray inspections on energized lines.
Urgency	With increasing demands placed on California's power grid, coupled with the need for more resilient and reliable energy infrastructure, we need faster, cheaper, and more accurate ways to inspect splices and endpoints. This will reduce outages and ignitions due to equipment failure.

Secondary Fault Analysis

Provide real-time visibility into secondary voltage asset health, and sense precursors to risks on secondary voltage electric assets that could lead to equipment failures, outages, and ignitions.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Wildfire risk associated with secondary/service lines (i.e. from transformer to customer meter) on the electric distribution system. Currently, PG&E does not have visibility into asset health on secondary voltage line and therefore cannot monitor faults and other risks that may cause ignitions. We rely on historic failure and maintenance data to estimate secondary asset health. The potential scale of risk is unknown but could be significant, given the prevalence of secondary lines in our service territory, including in high fire threat districts.
Objective	Explore whether commercially available technology could be used in conjunction with AI/machine learning to provide real-time visibility into secondary voltage asset health, and sense precursors to risks on secondary voltage electric assets that could lead to equipment failures, outages, and ignitions.
Project Description / Scope of EPIC Demonstration	Following “fail safe” testing, pick an area in our service territory’s high fire threat districts (HFTD) to install high resolution, customer end-point monitor and/or utilize already-installed devices. Monitor internal and 3rd party applications for the purposes of this demonstration to assess secondary voltage equipment health and proactively detect any potential failures using machine learning algorithms. Assess performance, usability, cost, and other pertinent factors over the course of the demonstration to determine whether technology would be a valuable tool for risk reduction of catastrophic fires and should be scaled up. Compare performance with EPIC 3.20/EPIC 3.43 which developed in-house predictive maintenance model using existing PG&E data sources (often lower resolution) and machine learning.
Estimated Cost	$2M
How PG&E can scale to full deployment (Path to Production)	Similar Path to Production as EPIC 3.43: •Develop business case for expanded deployment •Identify funding for expanded deployment •Recommend change management strategy •Confirm product design and acquisition strategy for deployment at scale •Develop data application •Integrate tools and ownership with Asset Performance Center •Installation on a rolling basis

Secondary Fault Analysis

Provide real-time visibility into secondary voltage asset health, and sense precursors to risks on secondary voltage electric assets that could lead to equipment failures, outages, and ignitions.

TOPIC	DESCRIPTION
Key Potential Benefits	Energy Systems: Build and operate a reliable electric system resilient to climate change, and reducing the likelihood of wildfire ignition Customers: Strengthen customer trust by implementing preventive measures to avoid outages and reduce the likelihood of catastrophic failures Health & Safety: Preventive equipment management resulting into lesser outages as a norm inherently would ensure health and safety of customer and co-workers Access & Education: All customers are equally served with enhanced and resilient system via preventive maintenance Financial Benefits: Local government supporting customer would preserve resources elsewhere as opposed to spend those on outage support or response to ignitions Economic Development: Uninterrupted power supply would prevent negative impact on economy
New and Novel	It would be PG&E's first time leveraging a sensor device connected to the customer panel to derive insights about secondary voltage equipment health and safety. There is no current solution for secondary voltage. Depending on vendor selected, it may be the technology's first time applied to inform utility maintenance and operations .
Urgency	Medium-highly urgent contingent on: •Future of Rule 16, which could potentially require IOUs to take more responsibility for maintaining service and secondary facilities •Urgency further heightened because PG&E's current Undergrounding strategy does not include secondary facilities, and this provides an alternative risk reduction tool

Reducing Ground Fault Currents on Distribution Circuits in High Fire Risk Areas

Evaluate the effectiveness of neutral reactors on distribution feeders in reducing fault energy and reducing risk of wildfire ignition.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Fire ignition risk is often a function of fault energy. Fault energy is dependent on fault current and fault clearing time. Current technologies to reduce fault current, a leading cause of ignition risk, are only capable of addressing a subset of fault types, cannot de-energize rapidly enough in all cases, and are costly to deploy. Approximately 80% of distribution faults are ground faults. PG&E has already implemented very effective means of reducing fault clearing times through our Enhanced Power System Safety Settings (EPSS) program. This proposal will test the effectiveness of reducing average ground fault currents in high fire risk areas (HFRAs) using a simple method that can be rapidly scaled.
Objective	This proposal will evaluate the wildfire ignition risk reduction potential of a simpler and less expensive method of reducing ground fault currents that could be scaled across high fire risk areas (HFRAs), potentially much faster than other technology.
Project Description / Scope of EPIC Demonstration	• Study installing a neutral current limiting reactor or resistor in substations with 3 wire uni-grounded circuits feeding into HFRA's • Perform simulations to study optimum sizing of reactor or resistor and transient overvoltage risks • Produce engineering designs, material specification and cost estimate for demonstration project(s) • Install demonstration project to validate design, costs and effectiveness • PG&E has some existing neutral reactor installations used to limit fault current to less than 10,000 amps. (see example below) • During demonstration phase include a single phase distribution recloser to bypass reactor.
Estimated Cost	$2M
How PG&E can scale to full deployment (Path to Production)	After one year of demonstration results, evaluate results. If warranted create a program to install neutral reactors on banks serving three wire circuits that predominantly feed into HFRA zones. Create a program to expand into production commensurate with risk reduction and budget constraints. Perform risk reduction analysis, look at installations on banks feeding into high fire risk areas (HFRA). Evaluate percentage of circuit miles in HFRA vs non HFRA for each bank to prioritize implementation.

Reducing Ground Fault Currents on Distribution Circuits in High Fire Risk Areas

Evaluate the effectiveness of neutral reactors on distribution feeders in reducing fault energy and reducing risk of wildfire ignition.

TOPIC	DESCRIPTION
Key Potential Benefits	Wildfire Risk Reduction: Reduced ground fault currents will reduce wildfire ignitions by similar magnitudes to Enhanced Power System Safety Settings (EPSS) and reduce damage to overhead facilities and underground facilities due to faults. Coordination of protective devices should not be significantly impacted as long as EPSS settings are still applied. CPUC Reportable Fire Ignitions: Reduce wildfire ignitions by similar or greater amount than EPSS. Cost Effective: This proposal will reduce wildfire risk at a much lower cost/benefit and implemented faster than other technologies. Health & Safety: Reduced fire damage, economic impact and exposure to unhealthy air quality for all customers. Access & Education: All customers are equally served with enhanced and resilient systems. Financial Benefits: Reduced wildfire ignitions will financially benefit individual customers, businesses and governments.
New and Novel	PG&E and other US utilities make limited use of neutral grounding reactors. Some Australian utilities install larger grounding resistors or reactors as part of their standard design. SoCal Edison has many substations with low ground fault currents (60 and 150 amps) in HFRA's. This was implemented in the 1960s using grounding transformers and is not being actively expanded. This proposal will be a novel application in the US to reduce ground fault currents for wildfire risk reduction.
Urgency	This project directly impacts our Stand that Catastrophic Wildfires Shall Stop and TNS - Wildfire Risk Reduction.

Woody Supply Chain

Demonstrate cost efficiency, environmental, and safety benefits from new integrated vegetation management supply technologies, arrangements, and processes.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Wood management is a major challenge and expense for PG&E Vegetation Management, Land Natural Resources Management, and other teams, along with other California stakeholders looking to reduce catastrophic wildfire risk. This challenge peaks after natural disasters and major storms, exacerbating already challenging circumstances. Wood management-related activities are also polluting and disruptive to customers.
Objective	Demonstrate cost efficiency, environmental, and safety benefits from new integrated vegetation management supply technologies, arrangements, and processes.
Project Description / Scope of EPIC Demonstration	Co-sponsor development of a “next gen” wood supply chain concentrated in a specific region. Specifically run an RFP seeking solutions which could be integrated with a demonstration woodshed to improve the safety, environmental outcomes, and cost of the wood value chain including but not limited to PG&E operations. Technologies which could be included are remotely controlled or automated cutting solutions, zero emissions trucks, climate positive wood densification and/or remote processing such as mobile or stationary pyrolysis, yard-sited biofuels generation, and demonstration of technologies to capture value from onsite process heat. Business models which could be “stacked” include creation of joint-wood yards or depots across regional stakeholders, forward feedstock supply agreements funding landscape-scale forestry for wildfire resilience in exchange for supply security, and integration of carbon credit monetization and other wood conversion monetization.
Estimated Cost	$3M
How PG&E can scale to full deployment (Path to Production)	Replicate beneficial model in other PG&E regions leveraging precedent from demonstration 1.Refine and demonstrate new value chain models 2.Socialize replicable, beneficial aspects of model with service area vegetation and wood management stakeholders 3.Influence our own vendors to shift towards more beneficial models (through sharing of results, field visits, and/or contracting)

Woody Supply Chain

Demonstrate cost efficiency, environmental, and safety benefits from new integrated vegetation management supply technologies, arrangements, and processes.

TOPIC	DESCRIPTION
Key Potential Benefits	Customers: Reduced rate pressure, criteria pollution, trucking disruption, and/or noise pollution; potential for reduced secondary wildfire hazard risk if less wood is left onsite as a result of efficiencies Environment: Reduced criteria and greenhouse gas pollutants Wildfire stakeholders: De-risking of new and more effective technologies, arrangements, and processes enabling landscape-scale catastrophic wildfire risk reduction Health & Safety: Reduced criteria pollutions, trucking disruption, and/or noise pollution; potential for reduced secondary wildfire hazard risk if less wood is left onsite as a result of efficiencies Financial Benefits: Reduced rate pressure Economic Development: Potential for new rural jobs and industries
New and Novel	EPIC 3.47 tested some but not all new technologies for densifying and converting wood. These were also point solutions, whereas wood management is truly a systems-level challenge. This project would be the first to demonstrate integration of these category of solutions with other related supply chain improvements such as electric chipping, clean trucking (hydrogen, renewable natural gas, and/or electric), and depots to better manage uncertain wood flows.
Urgency	Wood management, and catastrophic wildfire, are significant challenges for PG&E today. This project would be designed to reduce acute challenges associated with these problems ASAP.

Rapid Wildfire Detection and Suppression

Demonstrate next generation capabilities to rapidly detect and suppress fires (even in remote and difficult locations) before they become catastrophic.

TOPIC	DESCRIPTION
Concern / Gap Addressed	Lag between wildfire ignition, detection, and resulting suppression can be the difference between a quickly suppressed spot fire and catastrophic incident. There are also locations where, even with robust regional firefighting capacity, wildfires will be difficult to quickly suppress before they spread sufficiently to become out of control.
Objective	Demonstrate next generation capabilities to rapidly suppress fires (even in remote and difficult locations) before they become catastrophic.
Project Description / Scope of EPIC Demonstration	Demonstrate emerging suppression solutions, integrating abilities to rapidly detect wildfires (e.g. new satellite technologies, AI camera analysis) with rapid autonomous suppression (i.e. purpose-made, pre-staged helicopters or drones).
Estimated Cost	$3M
How PG&E can scale to full deployment (Path to Production)	1.Demonstrate and validate next-gen fire suppression capabilities. 2.Develop new public-private partnerships models to operationalize at scale, potentially mimicking the “Quick Reaction Force” model in Southern California sponsored by SCE. 3.Develop replicable and scalable public-private partnership model with state and federal agencies and other stakeholders.

Rapid Wildfire Detection and Suppression

Demonstrate next generation capabilities to rapidly detect and suppress fires (even in remote and difficult locations) before they become catastrophic.

TOPIC	DESCRIPTION
Key Potential Benefits	Customers: Increased public wildfire safety from ANY ignition source, reduced smoke hazard, improved affordability Energy Systems: Reduced wildfire and wildfire prevention-related reliability challenges Health & Safety: Increased public wildfire safety from ANY ignition source, reduced smoke hazard Financial Benefits: Improved affordability
New and Novel	EPIC 3.45 AI wildfire detection and EPIC 3.41 drone enablement could potentially be built into this demonstration, but would be component of a larger integrated wildfire suppression solution. Integration of rapid detection and suppression capabilities is an emerging frontier as demonstrated by the XPRIZE Wildfire challenge, which only takes on technical challenges on the “bleeding edge”.
Urgency	California is still at extreme risk of catastrophic wildfire, and climatic conditions are likely to continue to degrade over time. The sooner that solutions are developed to prevent damage the better.

Close & Questions

Deck will be uploaded to pge.com/epic page by January 24th.

For additional questions/comments for these projects, please email Epic_Info@pge.com by EOD, January 30th

Thank you!