

Enhanced Grid Efficiency, Utilization & Flexibility (EGEUF)

INITIATIVE DESCRIPTION

A17-A19

- EGEUF will demonstrate and evaluate grid-enhancing technologies that increase the capacity, utilization, flexibility, and performance of existing electric infrastructure, generating the field-validated evidence needed to inform future planning, operational, and investment decisions.
- The initiative directly supports Strategic Objective 12 by identifying how utilities can increase feeder and circuit utilization, reduce peak-loading constraints, and coordinate DERs, EVs, flexible load, and grid intelligence to defer or avoid costly grid upgrades.
- Its six RTAs provide an integrated strategy that addresses the primary factors limiting feeder and circuit performance, combining capacity enhancement, sensing, protection, control, power-flow management, and load flexibility to optimize use of existing infrastructure before conventional expansion is required.

PROPOSED INITIATIVE BUDGET	\$19,054,371
% OF TOTAL BUDGET (excl. admin & overhead)	28%
# OF RESEARCH TOPIC AREAS	6

ALIGNMENT SUMMARY

STRATEGIC OBJECTIVE ALIGNMENT

A18

“Accelerate innovation, demonstration, and deployment of innovative and replicable methods to increase the capacity utilization rate of circuits/feeders and reduce circuit and feeder peak loads, and/or dynamically optimize other feeder/circuit operations in order to avoid or defer costly grid upgrades, through the coordination of DERs, EVs, flexible load, and grid intelligence.”

EGEUF combines physical capacity enhancements, system protection and control, grid sensing, and coordination of flexible loads and DERs to increase feeder and circuit utilization and optimize grid operations. Together, the RTAs will produce field-validated evidence and deployment guidance needed to determine when these approaches can safely defer or reduce conventional grid upgrades.

CPUC ALIGNMENT

A20

- CPUC policy increasingly focuses on enabling electrification, DER integration, and grid modernization while maintaining affordability, creating a need for evidence on how feeder and circuit constraints can be addressed without relying exclusively on conventional infrastructure expansion.
- EGEUF will generate field-validated evidence on capacity utilization, peak-load reduction, protection performance, operational limits, flexibility, reliability, and cost-effectiveness that can inform future distribution planning, grid modernization investments, standards development, program design, rate cases, and regulatory decisions regarding alternatives to conventional grid upgrades.
- Ratepayer-funded EPIC demonstrations are needed to validate integrated solutions under actual utility conditions before broader deployment because vendors focus primarily on individual products, federal research may not address distribution deployment, and GRC funding is better suited to proven investments.

Flexible Energy & Load on Demand

12. Optimizing Feeder / Circuit Operations

WHAT PROBLEM ARE WE SOLVING?

A41

Current demand response, managed charging, storage, and distributed-generation programs remain fragmented, with many optimized at the device, customer, or aggregator level rather than coordinated across distribution constraints and wholesale market conditions. Utilities lack a validated method to coordinate customer resources against localized distribution constraints, wholesale conditions, customer preferences, and aggregator behavior in near real time. This RTA addresses that gap by making flexible loads and DERs more predictable, dispatchable, and responsive to feeder operating needs, enabling coordinated operation that can reduce peak loading, increase feeder utilization, and defer conventional grid upgrades.

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START	2027-2028
OUTPUTS	2029-2032
MARKET READY	2030-2035

ALIGNMENT SUMMARY

WHAT IS THE DISTINCT RESEARCH APPROACH?	HOW WILL YOU KNOW YOU ARE SUCCESSFUL?	HOW WILL YOU COORDINATE?
• Demonstrate coordinated orchestration of flexible loads, EVs, storage, and distributed generation across distribution constraints and wholesale market conditions. (A41) • Validate market-aware and grid-aware control strategies that respond to local feeder needs, customer preferences, aggregator actions, and CAISO signals in near real time. (A41) • Validate an open and interoperable architecture that enables diverse DER technologies and third-party aggregators to operate as coordinated grid resources rather than independent assets. (A42-A44)	• Validated coordinated multi-resource dispatch in response to localized grid needs and CAISO-aware signals. (A43) • Show peak-load reduction, improved load factor, increased DER utilization, incremental hosting capacity, and fewer distribution-system constraints. (A42-A43) • Produce scalable orchestration architectures, interoperability specifications, and implementation guidance for broader deployment of coordinated DER operations. (A43) • Primary result: Validated multi-resource orchestration architecture. (A43) • Metrics: Peak-load reduction (MW and %); incremental hosting capacity; avoided or deferred distribution-upgrade costs. (A42-A43)	• Build on prior DER communications, IEEE 2030.5, device controls, demand response, managed charging, customer flexibility, and grid-modernization work. (A42) • Focus on unresolved multi-resource orchestration, interoperability, utility integration, market-aware control, and operational validation rather than repeating device-level research. (A42) • Coordinate with the CEC and other EPIC Administrators to align complementary work, support utility partnerships, and avoid duplicative demonstrations. (A42)

WHAT PROBLEM ARE WE SOLVING?

A35

Utilities lack validated methods for using storage, power electronics, and modular infrastructure as integrated alternatives to conventional capacity expansion. Existing products generally target individual grid needs, leaving unresolved how technologies and value streams should be combined and compared with traditional wires solutions. This RTA addresses that gap by demonstrating how storage, power electronics, and modular infrastructure can provide targeted capacity, reduce peak-loading constraints, increase feeder and circuit utilization, and serve as a cost-effective alternative to traditional grid upgrades.

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ALIGNMENT SUMMARY

WHAT IS THE DISTINCT RESEARCH APPROACH?	HOW WILL YOU KNOW YOU ARE SUCCESSFUL?	HOW WILL YOU COORDINATE?
• Demonstrate how storage, power electronics, modular infrastructure, and flexible grid resources can operate as integrated utility assets that provide local capacity, reliability, and power-quality benefits beyond any single technology solution. (A35) • Evaluate how storage, mobile assets, power electronics, and modular infrastructure can function as utility grid resources, providing targeted capacity and grid services that would otherwise require traditional infrastructure expansion. (A35) • Develop utility-grade decision frameworks that connect technical performance, interconnection, permitting, operations, asset impacts, and economics to determine when advanced grid upgrades are preferable to traditional wires solutions. (A36,A38)	• Demonstrations validate where flexible grid resources can resolve feeder constraints and provide local capacity more cost-effectively than conventional upgrades. (A37) • Results quantify capacity provided, peak reduction achieved, avoided or deferred capital investment, operational performance, and the value of stacked grid services. (A36,A37) • Findings produce repeatable deployment procedures and decision matrices for future planning and operations.(A36, A37) • Primary result: Validated deployment framework for using advanced grid upgrades to provide local capacity and defer conventional investments. (A37) • Metrics: MW/MWh of capacity provided; peak reduction achieved; avoided or deferred capital investment. (A36)	• Build on prior storage, DER integration, non-wires alternatives, microgrid, power-electronics, and grid-modernization research. (A36) • Focus on unresolved integration, deployment, decision-framework, benefit-quantification, and economic questions rather than duplicating individual technology demonstrations. (A36, A37) • Coordinate with the CEC and other EPIC Administrators to differentiate research roles, align project development, and avoid duplication. (A36)

Adaptive Grid Protection and Control

12. Optimizing Feeder / Circuit Operations

WHAT PROBLEM ARE WE SOLVING? A32

The Strategic Objective calls for improved feeder and circuit operations, but utilities often rely on conservative protection settings, static operating assumptions, and limited visibility into changing grid conditions that can prevent full utilization of existing infrastructure. Increasing DER penetration, bidirectional power flows, and changing fault characteristics create uncertainty around how to safely operate circuits closer to actual system limits without compromising reliability, safety, or protection performance. This RTA addresses that gap by demonstrating adaptive protection and control capabilities that enable more dynamic operation of feeders and circuits while maintaining safe and reliable grid performance.

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WHAT IS THE DISTINCT RESEARCH APPROACH?	HOW WILL YOU KNOW YOU ARE SUCCESSFUL?	HOW WILL YOU COORDINATE?
• Demonstrate protection systems that adapt to actual grid conditions, allowing feeders and circuits to safely operate closer to their true capability rather than relying on conservative static operating assumptions. (A32) • Validate integrated protection, communications, and control architectures that respond to power-flow management, advanced switching, and protection functions to support bi-directional power flow and high-DER operation. (A32) • Establish utility-grade deployment frameworks, interoperability requirements, communications architectures, and operating criteria needed for scalable implementation across the grid. (A32)	• Validated adaptive protection designs and operating criteria that enable dynamic feeder operations and support bidirectional power flow without compromising safety or reliability. (A34) • Demonstrated increased DER hosting capacity and feeder utilization through adaptive protection that reduces curtailment and enables operation closer to system limits.(A33, A34) • Established deployment frameworks and interoperability requirements for scalable adaptive protection implementation across distribution systems. (A34) • Primary Result: Validated adaptive protection framework for dynamic feeder operations and increased infrastructure utilization (A34) • Metrics: Increased DER hosting capacity; reduced DER curtailment; fewer false or delayed trips. (A34)	• Build upon prior SCE EPIC investments in adaptive protection, virtual protection, substation automation, process-bus architectures, and DER dynamics integration, extending earlier work through validation under real distribution-system operating conditions. (A33) • Coordinate with other EPIC Administrators and the CEC to align future project selection, avoid duplication, and leverage complementary demonstrations. (A33) • Coordinate future demonstrations through emerging IOU/CEC partnership models that connect technology demonstrations to utility-grid deployment pathways. (A33)

WHAT PROBLEM ARE WE SOLVING?

A38

Utilities lack evidence on whether DC power architectures can serve electrification loads more efficiently than conventional AC infrastructure while reducing capacity constraints and energization barriers. Many loads, including EV charging, energy storage, solar PV, and data centers, already operate on direct current, yet utilities lack validated deployment models and operating experience for integrating DC systems. This RTA addresses that gap by demonstrating whether DC power networks can increase usable capacity, reduce infrastructure requirements, shorten energization timelines, and improve feeder and circuit utilization while maintaining reliability and safety.

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• Demonstrate integrated DC distribution architectures that combine solid-state power electronics, DC protection, switching, and AC/DC hybrid systems into utility-operated solutions rather than isolated component demonstrations. (A38) • Evaluate both utility-side and customer-side DC service models to determine where direct-current delivery can reduce footprint, increase usable capacity, improve efficiency, or accelerate energization compared with conventional AC service. (A38, A40) • Generate the operational, protection, interconnection, tariff, and deployment frameworks needed to move DC power networks from vendor pilots to scalable utility deployment. (A38, A40)	• Validated field evidence on the performance, reliability, and operational characteristics of DC architectures in utility distribution applications. (A40) • Demonstrated reductions in service footprint, energization timelines, or infrastructure requirements relative to conventional AC service. (A38, A39) • Established utility guidance identifying when DC architectures provide a practical and cost-effective alternative to traditional distribution solutions. (A40) • Primary Result: Validated utility-ready DC power network architecture and deployment framework. (A40) • Metrics: Reduced energization timelines; improved energy-conversion efficiency; reduced service footprint. (A39-A40)	• Build upon prior SCE EPIC 2 and EPIC 3 work involving DC technologies, power electronics, EV charging, storage integration, and utility modernization, extending prior technology-readiness efforts through utility distribution demonstrations. (A39) • Develop the technical, operational, and regulatory foundations needed for utility-scale DC deployment, including service configurations, protection approaches, interconnection requirements, tariffs, and standards. (A40) • Coordinate with other EPIC Administrators and the CEC to align future project development, leverage complementary demonstrations, and avoid duplication. (A39)

Next Generation Conductors

12. Optimizing Feeder / Circuit Operations

WHAT PROBLEM ARE WE SOLVING? A44

Transportation electrification, building electrification, DER growth, and increasing power density are driving capacity needs that may outpace traditional upgrades. High-temperature superconducting conductors could provide substantial capacity increases within existing utility corridors, but utilities lack validated evidence on operational performance, cooling requirements, constructability, protection impacts, lifecycle value, and long-term utility integration under real operating conditions. This RTA addresses that gap by demonstrating whether superconducting conductors can provide a practical and cost-effective pathway for high-capacity expansion with less disruption than traditional approaches.

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WHAT IS THE DISTINCT RESEARCH APPROACH?	HOW WILL YOU KNOW YOU ARE SUCCESSFUL?	HOW WILL YOU COORDINATE?
• Evaluate high-temperature superconducting conductors and supporting systems under utility operating conditions to determine their capacity, reliability, constructability, and deployment potential for high-density load applications. (A44, A46) • Validate real-world superconducting-conductor performance, cooling requirements, protection integration, safety considerations, and lifecycle value to address deployment questions that cannot be resolved through laboratory testing alone. (A44, A46) • Develop engineering guidance and decision frameworks that compare superconducting conductors against conventional reconductoring, rebuilding, and alternative capacity-expansion approaches. (A46)	• Produce utility-grade evidence on conductor performance, cooling requirements, protection impacts, operating limits, and deployment constraints. (A46) • Demonstrate increased feeder and circuit capacity with reduced construction impacts, infrastructure replacement, and major rebuild activities. (A45, A46) • Establish engineering guidance and decision frameworks for identifying when superconducting conductors are a practical alternative to conventional capacity expansion. (A45, A46) • Primary result: Validated high-temperature superconductor selection framework. (A45-A46) • Metrics: Avoided or deferred grid-upgrade costs; incremental MW enabled; avoided pole replacements or major rebuild activities. (A45)	• Build on prior EPIC grid-modernization, dynamic-rating, advanced-sensing, grid-utilization, and grid-enhancing technology work. (A45) • Advance utility readiness for conductors through field validation, constructability assessment, protection integration, resilience evaluation, and deployment frameworks. (A45) • Coordinate with the CEC and other EPIC Administrators to align complementary activities and avoid duplicative demonstrations. (A45)

WHAT PROBLEM ARE WE SOLVING? A47

Utilities lack scalable, real-time visibility into the electrical conditions that determine feeder and circuit capacity, operating limits, and utilization. Existing sensing and data systems do not consistently provide the integrated operational information needed to safely operate infrastructure closer to actual system limits rather than relying on conservative assumptions. This RTA addresses that gap by providing decision-grade visibility that supports targeted upgrades, increased hosting capacity, improved feeder utilization, and more effective use of existing infrastructure.

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• Demonstrate an interoperable sensing architecture that measures the electrical conditions governing feeder capacity, operating limits, stability, and utilization. (A47) • Connect sensors, communications, centralized data, analytics, enterprise systems, and operational workflows to produce actionable capacity, hosting-capacity, and feeder-upgrade decisions. (A47, A48) • Evaluate sensor, communications, and analytics approaches against common performance, cost, data-quality, and interoperability requirements to establish scalable grid-visibility frameworks for planning and operations. (A49)	• Validate sensor packages, data-quality requirements, and high-value use cases for feeder-capacity, utilization, and grid-visibility applications. (A48) • Demonstrate improved observability, fault detection, hosting capacity, feeder utilization, and accommodation of additional load or DERs without traditional upgrades. (A48) • Integrate sensor outputs into planning and operations and establish scalable design standards and deployment criteria for broader adoption. (A48, A49) • Primary result: Validated grid-utilization sensing architecture. (A49) • Metrics: MW of load or DER accommodated without traditional upgrades; improved feeder utilization; avoided or deferred infrastructure upgrades; reduced overloads and voltage violations. (A48)	• Build on the EPIC 4 Stability Improvement with DERs project and prior DER-integration research. (A47-A48) • Expand prior work into a grid-utilization sensing architecture without duplicating asset-health or digital-substation research. (A47-A48) • Coordinate with the CEC and other EPIC Administrators to align complementary demonstrations and avoid duplication. (A48)