Project Title	Project Description	Year 1 Budget ($M)	Duration, Total Budget ($M)	Benefit Categories	Benefit Statement
1. Electric Resource Planning	Integrated high resolution weather models, electric resource models and HPC services will be used to quanitify uncertainly and optimize planning and investment decisions for 33%RPS to ensure system performance, reliability, and effeciency.	**$10.4**			
1.1 Flexibility Metrics and Standards	Develops a probabalistic measure of and requirements for a system's ability to flexibly address the intermittency introduced by renewables	$2.2	3 years/$5.8	Renewable Integration, system reliability, portfolio cost	Improving the accuracy of flexible resource need determination could result in substantial benefit to California ratepayers. Informing investment and policy decisions about flexibility-enhancing options, will reduce cost while preserving system reliability.
1.2 Planning Engine	Develop improved scalable models of renewable generation, demand response, grid-scale storage, and other factors that are playing an increasing role in grid planning.	$4.6	4 years/$21.3M	Renewable Integration, portfolio cost	Improved forecasting of renewable generation and its variability coupled with day-ahead unit commitment models and algorithms could lead to more efficient capital utilization. Improved economic dispatch under uncertainty could reduce operating costs and emissions.
1.3 Cyber-Physical Support of Hydropower Generation	Develop a hydrographic data network and predictive modeling toolbox to support hydropower planning and operations activities	$1.1	5 years/$8.6M	portfolio cost, environmentally sound	Support management of limited hydropower resources and design of impoved monitoring networks. Ultimately reduces cost to ratepayer and conserves natural resources.
1.4 Ensemble Weather Forecasting for Wind and Solar Generation	Determines optimal forecasting methodology for wind and solar resources using high performance physics simulations and quantifies tradeoffs between benefits of improved forecasting and computing requirements	$2.5	3 years/$8.0M	Renewable integration, portfolio cost	Supports optimal daily bidding, transmission scheduling, unit commitment, and reserve purchase-- all which will become more challengeing under 33% RPS-- to pass on savings to the ratepayers.

Project Title	Project Description	Year 1 Budget ($M)	Duration, Total Budget ($M)	Benefit Categories	Benefit Statement
2. Gas Pipeline Operations	Collection, extraction, fusion and analysis of multiple data sources that characterize the gas pipeline and its operation will inform advanced probabalistic risk analysis processes to ensure the safety and reliability of the gas pipeline system.	**$6.2**			
2.1 Sensor Fusion	Multi-source sensor fusion and visualization interface to gain a comprehensive understanding of pipeline health and integrity	$2.3	3 years/$7.3M	Safety, system operations, system cost, compliance	Provides cost effective systems and tools to prioritize system upgrades and to rapidly detect defects, reduce risk, and improve safety. Also provisions for tech transfer to ILI vendors.
2.2 Advanced Modeling and Simulation Environment for Gas System Planning and Operation	High fidelity pipeline modeling advancements including uncertainty quantification, supports pipeline management, planning, and leak/failure detection.	$2.2	5 years/$11.8M	Safety, system operations, system cost, compliance	Reduces risk in a cost effective manner by quickly identifying issues and analyizing multiple cause and response scenarios. Also prioritizes physical testing and upgrades, enables more informed sensor placement, enhances contingency planning exercises, and evaluatse a broad range of renewable deployment scenarios.
2.3 Geographic Data Integration for Enhanced Gas System Risk Management	Digitize, extract, and fuse information and apply advanced analytics to quantify and assess risk to pipeline integrity and public safety, including time-dependent impacts	$1.7	3 years/$4.7M	Safety, system operations, system cost, compliance	Cost effectively reduces risk by informing decisions about system improvement schedules, long term investments, and emergency repsonse.

Project Title	Project Description	Year 1 Budget ($M)	Duration, Total Budget ($M)	Benefit Categories	Benefit Statement
3. Electric Operations	High fidelity models of multiple grid components will be developed, and then integrated to inform system-based simulations of grid operations. These simulations will inform operational decision processes that are fully contextualized and optimized for efficiency and performance.	**$12.9**			Improved safety and reliability as well as cost reduction by supporting data-driven operations and maintenance decisions. Accelerates the development of quantitative and comprehensive risk-based integrity management plans.
3.1 Real Time Electromagnetic and Electromechanical Hybrid Transient Simulation	Integrated electromechanical and electromagnetic transient simulation utilizing high-performance computing services	$3.8	4 years/$15.5M	Reliability, System Operations and Cost	Support real-time analysis that will reduce black-out frequency and duration. Enables operators to make efficient, rather than worst-case, plans. Both improve system reliability and reduce cost to ratepayers.
3.2 Distribution Modeling and Optimization	Distribution network model that optimizes the introduction of renewable distributed generation	$3.0	2 years/$6.1M	Renewable Development	Supports the analysis of market and control concepts to optimize the operation of resources and demand within a region. Results in more efficient system.
3.3 Electric System Modeling and Control	Develops models of and control techniques for the bulk power system using high performance streaming data analytics	$3.3	4 years/$13.9M	Reliability, System Operations and Cost	Reduces system outages, and generation and load dropping, while increasing transmission capacity and stabiility with intermittents. Ratepayers realize cost savings and improved system performance.
3.4 Integrated Transmission and Distribution Model to Analyze the Impact of Distributed Generation on Transmission Reliability and	Model and analyze the impact of distributed generation on transmission reliability and restoration capabilities in extreme scenarios	$2.8	3 years/$8.8M	Renewable Integration, Operational Efficiency	Full utilization of already purchased and deployed technology. Assess the impact of renewable generation penetration into the distrubtion network on reliability and system restoration under critical load scenarios.
4. Cybersecurity for Grid Critical Infrastructure	Collection, extraction, fusion and analysis of grid network and device data will be used to develop models and simulations of cyber event impact to grid operations. These simulations, coupled with advanced analytics of actual cyber-industrial control systems data, will provide the IOUs with the situational awareness and system impact information needed to mitigate, contain, and respond to cyber attacks that may compromise grid performance or ratepayer privacy.	**$12.3**			
4.1 Modeling and Simulation to Identify Cyber Security Vulnerabilities	Detailed models of the distribution and communications networks, at statewide scale, and a simulation enviroment to identify vulnerabilities, develop mitigation strategies, and test/validate proposed security architectures to enable suport improved cybersecurity plannign and operations.	$5.1	5 years/$27.4M	Safety, Reliability	Reduces disruption or damage. Improves efficacy of system recovery plans. Optimizes expenses associated with vulnerability mitigation. This all impacts both public safety and the business environment in CA.
4.2 Advanced Threat Analysis Capability	This project includes building a coordination capability, developing tools to assess hardware, firmware, and software for vulnerabilities, mining of operational data for indicators of compromise, and providing situational awareness of threats to the California Investor-Owned Utilities' (IOU) cyber infrastructures.	$7.2	5 years/$36.5M	Safety, Reliability	Reduces disruption to critical infrastructure that support health and human services, businesses in CA. Reduces potential for system damage that could negatively impact rates in CA.
	Total	**$41.8**			