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2018 – 2020 EPIC Investment Plan
Draft Funding Initiatives

Theme 1: Advance Technology Solutions for Deep Energy Savings in Buildings and Facilities

S1.1 Accelerate Product Development and Market Acceptance of Solid-state Lighting Technologies and Designs

S1.2 Develop Advanced Building Envelope Materials and Designs for Healthy, Comfortable and Highly Efficient Buildings

S1.3 Drive Technical- and Cost-Performance Improvements in High-Efficiency Heating, Ventilation and Air Conditioning Systems

S1.4 Enable Integration of Building and Equipment Controls and Automation

S1.5 Increase the Energy Efficiency of Plug Loads and Consumer Electronics Devices

S1.6 Accelerate the Transition to Direct Current Powered Buildings and Facilities

S1.7 Develop Technologies that can Assist in Decarbonizing Key California Industries

S1.1 Accelerate Product Development and Market Acceptance of Solid-state Lighting Technologies and Designs

Initiative 1.1.1

Pilot and Test New Solid-State Lighting Features and Applications That Add Functionality in Addition to Energy Savings

Description

In addition to energy efficiency, solid state lighting (SSL) provides the opportunity to increase the functionality of lighting systems and to design spaces that are attuned and customized to the needs of a particular space or use. This initiative will evaluate what value-added features would increase adoption of energy-efficient SSL technology. Information and data will be collected to determine the value added features that would result in increased adoption of SSL technology, along with the estimated cost for the feature, the total energy use of the increased functionality and impact on the lighting system, and overall resulting benefits. Pilot tests of the best value added features will be conducted in various residential, commercial and industrial settings to determine whether the value added functionality would increase uptake of SSL technology. The value added features to be analyzed could include color tuning, circadian sensitive lighting, daylighting coupling, internal energy metering, voice recognition controls, integration with other smart controls, egress lighting illumination, and internet connectivity for remote control.

Impact if Successful

Inclusion of value added features into SSL technologies could lead to greater adoption in harder to reach market segments such as hospitals and healthcare facilities and result in other benefits in addition to energy savings to California ratepayers, such as safety, alertness, and customizing the light use to the particular task.

Primary Users and/or Beneficiaries

In key market segments such as hospitals, healthcare facilities, residential buildings, and retail establishments, the color tuning and circadian sensitive lighting can improve the occupant experience, such as safety and alertness. Also, intuitive user interfaces are needed to facilitate the use of the added features when coupled with traditional lamps and luminaires.

Metrics and Performance Indicators

Increased adoption of SSL lighting, reduced operation and maintenance costs, reduction in energy use for lighting.

Topic(s) addressed	Value Chain	Program Area(s)
Novel LED Applications	Demand-side Management	Applied Research and Development

S1.1 Accelerate Product Development and Market Acceptance of Solid-state Lighting Technologies and Designs

Initiative 1.1.2

Test Novel Luminaire Systems Architecture And Form Factors That Leverage The Unique Properties Of LEDS

Description

New solid state lighting technology offers opportunities for novel fixture geometries and integration to significantly accelerate their adoption in applications such as hospitality, retail, health care, outdoor lighting and signage. This includes ultra-thin fixture designs, novel form factors, and unique physical characteristics that cannot be obtained with incumbent fluorescent, incandescent or high intensity discharge lamp technology. This initiative will develop, design, and test new fixture geometries with the following characteristics: easy installation in new construction or existing buildings in selected industries; high potential for energy saving; reduced interruption of circadian patterns in humans and wildlife; and reduced light trespass and night sky pollution for outdoor fixtures.

Impact if Successful

Novel designs for outdoor lighting could redefine form factors for pole and street lighting into entirely new concepts. In California, non-LED streetlights represent about 70 percent of all fixtures and represent a large potential of untapped savings. Once demonstrated and validated, these energy saving technologies could be in the California's lighting code to achieve potential savings.

Primary Users and Beneficiaries

Commercial, Institutional and Industrial facilities are all potential users and beneficiaries of the initiative.

Metrics and Performance Indicators

Increased adoption of SSL lighting, reduce operation and maintenance costs, reduction in energy use for lighting.

Topic(s) addressed	Value Chain	Program Area(s)
Novel LED Applications	Demand-side Management	Applied Research and Development

S1.1 Accelerate Product Development and Market Acceptance of Solid-state Lighting Technologies and Designs.

Initiative 1.1.3

$1 LED A-19 Lamp Prize

Description

Despite the wide range of added value presented by SSL technology, the higher initial cost of LEDs when compared to traditional lighting technology remains a barrier. The added features of LEDs such as spectrum controllability and internet connectivity also add cost. Further research is needed to continue to drive SSL cost down while maintaining product quality and feature richness. This initiative would provide a cash prize to manufacturers of LED A19 lamps that do all of the following:

- Provide the same light output as a 100 watt incandescent light bulb
- Meet the Energy Commission specifications for color rendering and durability and performance
- Demonstrate and install the lamp in a minimum number of buildings in disadvantaged communities in residential, multifamily, small commercial and industrial
- Market the lamp at a cost of $1 (or no more than twice the cost of competing incandescent bulbs)

Impact if Successful

Lowering the cost of a quality 60 and 100 watt equivalent A-19 LED lamp could have the potential of eliminating incandescent and CFL lamps in homes and businesses in California resulting in energy savings from their replacement.

Primary Users and/or Beneficiaries

Residential, small commercial and industrial sectors.

Metrics and Performance Indicators

Sales figures of 60 and 100 watt incandescent lamps and 60 and 100 watt equivalent CFL lamps compared to sales of the same products in previous years.

Topic(s) addressed:	**Value Chain:**	**Program Area(s):**
Technical and Cost Advancements	Demand-side Management	Applied Research and Development

S1.2 Develop Advanced Building Envelope Materials and Designs for Healthy, Comfortable and Highly-Efficient Buildings

Initiative 1.2.1

Deploy Next Generation Window and Building Envelope Systems in Existing Residential and Commercial Buildings

Description

Envelope systems shape the heating, cooling, ventilation and lighting requirements of buildings, which together account for about half to total energy use in buildings. Tightening the envelope allows for sizing smaller HVAC units while also providing opportunities for non-compressor type cooling and ventilation systems. This initiative will fund a large scale deployment of pre-commercial window and envelope measures that have proven on a limited scale the potential for cost effective energy savings. The deployment will occur in existing residential, multifamily and commercial buildings built before 1980. A portion of the deployment activities must occur in disadvantaged communities. The demonstrated technologies must have been independently tested and demonstrated to have the potential for cost effectiveness (<10 year simple payback) in Northern, Central and Southern California. Potential technologies include:

1. Building envelope material
2. Air-and liquid sealing technologies
3. Dynamic windows and window films
4. Highly insulating roofs

Impact if Successful

This initiative aims to help accelerate the commercialization and large scale deployment of window and building envelope technologies that have shown promise to significantly reduce HVAC energy use in buildings, while also increasing occupant comfort and infrastructure value to building owners. Data from demonstrations could be used to advance future codes and standards efforts.

Primary Users and/or Beneficiaries

Ratepayers, building owners, building occupants, building renovators, regulatory agencies, construction industry, architects and engineers, manufacturers, innovators/entrepreneurs, research community, technology investors

Metrics and/or Performance Indicators

Projects will include performance and benefits analysis. Potential metrics include energy and cost savings, customer/occupant satisfaction, environmental benefits, number of post installation deployments after the conclusion of the project.

Topic(s) addressed	Value Chain	Program Area(s)
Advanced Window and Building Envelope Systems	Demand-side Management	Technology Demonstration and Deployment

S1.2 Develop Advanced Building Envelope Materials and Designs for Healthy, Comfortable and Highly-Efficient Buildings

Initiative 1.2.2

Builder Competition for Best Residential Envelopes

Description

This initiative will conduct a contest for the most efficient residential building envelope. A limited number of production home builders (single and multifamily) will be selected to compete for prizes for the most efficient envelopes that can be produced at a certain price point to allow for future replication by others. Each selected builder will be required to build X homes/multifamily buildings. A third party firm will be selected to conduct test on a random selection of houses and multifamily buildings, out of a larger number required to be entered in the contest. The third party will develop a metric and method of test for a quick assessment of as-built residential buildings and for multifamily buildings. This test will include such metrics as air leakage, conduction losses, solar heat gain, daylighting efficacy, and possibly include subjective measures. Prize winners will receive cash prizes and recognition.

Impact if Successful

The expected outcome will benefit residential and multifamily building occupants and will result in more comfortable and energy efficient compared to current construction. The initiative will have persistent benefits, because participant builders will adopt methods of construction which produce more efficient and valuable buildings which they will continue to use beyond the scope of the program. These improved methods will diffuse into the building industry at large. The energy system will benefit from residential buildings with lower heating, cooling, and lighting energy demand. Another benefit will be the development of a residential method of test which may be adaptable to building inspection and quantitative performance testing by building officials, HERS raters, and others.

Primary Users and/or Beneficiaries

Ratepayers, building owners, building occupants, regulatory agencies, construction industry, architects and engineers, manufacturers, innovators/entrepreneurs, research community, technology investors

Metrics and/or Performance Indicators

The metric for success will be successful development of a practical method of test for residential and multifamily envelope efficiency, the participation of many production homebuilders, and the successful production and sustainability of many highly efficient single and multifamily buildings after the project has completed.

Topic(s) addressed	Value Chain	Program Area(s)
Advanced Window and Building Envelope Systems	Demand-side Management	Technology Demonstration and Deployment

S1.2 Develop Advanced Building Envelope Materials and Designs for Healthy, Comfortable and Highly-Efficient Buildings

Initiative 1.2.3

Multifamily Factory Built Homes Competition for Highly Efficient Building Envelopes

Description

With increasing housing prices, modular construction including mobile homes can offer housing that is cheaper and faster. Modular construction residential homes are put together in a factory setting. However, all manufactured homes produced in the nation conform to one set of preemptive standards, the Manufactured Housing Construction Safety Standards, enforced and maintained by the US Department of Housing and Urban Development. The standards contain thermal requirements that were last updated in 1994 and the requirements are far less stringent than California's Title 24. As past research focused on single family factory built homes, this initiative will focus on multifamily units that could be installed in disadvantaged communities. This initiative will conduct a contest for the most efficient building envelope for multifamily factory built homes. A limited number of manufactured home builders will be selected to compete for the design and construction of the most efficient envelopes. A third party firm will be selected to conduct a test on a random selection of factory built homes, out of a larger number required to be entered in the contest. The third party will develop a metric and method of test for a quick assessment of the factory built multifamily buildings. This test will include such metrics as air leakage, conduction losses, solar heat gain, daylighting efficacy, and possibly include subjective measures. Prize winners will receive cash prizes and recognition.

S1.2 Develop Advanced Building Envelope Materials and Designs for Healthy, Comfortable and Highly-Efficient Buildings

Initiative 1.2.3

Multifamily Factory Built Homes Competition for Highly Efficient Building Envelopes

Impact if Successful

The expected outcome will ultimately benefit occupants of multifamily buildings, who will be more comfortable while also reducing energy costs compared to a typically built at present. The initiative will have persistent benefits, because participant builders will adopt methods of construction which produce more efficient and valuable buildings which they will continue to use beyond the scope of the program. These improved methods will tend to diffuse into the building industry at large. The energy system will benefit from residential buildings with lower heating, cooling, and lighting energy demand. Another benefit will be the development of a method of test for factory built homes which may be adaptable to building inspection and quantitative performance testing by building officials, HUD, and others.

Primary Users and/or Beneficiaries

Ratepayers, building owners, building occupants, regulatory agencies, construction industry, architects and engineers, factory built home manufacturers, innovators/entrepreneurs, research community, technology investors

Metrics and/or Performance Indicators

The metric for success will be successful development of a practical method of test for factory built homes, participation of by factory home manufacturers, adoption of the advanced envelope measures by factory homebuilders are part of their standard practice.

Topic(s) addressed	Value Chain	Program Area(s)
Advanced Window and Building Envelope Systems	Demand-side Management	Technology Demonstration and Deployment

S1.3 Drive Technical- and Cost-Performance Improvements in High-Efficiency Heating, Ventilation and Air Conditioning Systems

Initiative 1.3.1

Develop and Test Cold Climate Electric Heat Pump Space and Water Heaters

Description

Current air source heat pumps lose about 60% of their capacity and operate at half the efficiency when operating at -13 degrees F. In recent years, manufacturers have designed electrically-driven heat pumps for cold-climate operation through the use of multi-stage, variable-speed, or booster compressors, advanced refrigerant management, improved defrost control, alternative refrigerants, and other features.

This initiative will develop and test advanced electric cold climate heat pumps for space and/or water heating that are capable of performing at low-ambient temperature without impacting performance, energy efficiency or operating costs. Potential areas of consideration include elimination of defrost (or frost buildup) and backup heat sources to improve the performance and energy efficiency of cold climate heat pumps. The prototype heat pump to be developed for space conditioning must have an HSPF ≥ 10.5/≥ 23.5 SEER and for water heating the average Coefficient of Performance (COP) must be greater than 4 as measured in the laboratory and in actual installations. The prototype would be tested in a mix of building types, such as single family, multifamily, small commercial across various climate zones (hot and cold climates) and IOU service areas.

Impact if Successful

Incorporating advanced compressor designs, defrost techniques, and other features improves the performance of cold climate heat pumps beyond previous products. This could result in reducing operating costs and increase consumer interest in purchasing and using electric heat pumps for space and water heating.

Primary Users and/or Beneficiaries

Residential & Commercial Building owners, equipment manufacturers, HVAC contractors

Metrics and Performance Indicators

Efficiency (energy savings compared to standard heat pumps), satisfactory Performance based on occupant surveys.

Topic(s) addressed	Value Chain	Program Area(s)
Technical and Cost Advancements	Demand-side Management	Applied Research and Development

S1.3 Drive Technical- and Cost-Performance Improvements in High-Efficiency Heating, Ventilation and Air Conditioning Systems

Initiative 1.3.2

Develop and Test Electrochemical Compression Systems

Description

Mechanical compressors in cooling equipment are very energy intensive and have an efficiency of around 65%.. In place of a noisy motor-driven compressor, electrochemical compressors can improve the efficiency by about 30%. Hydrogen gas combines with water, ammonia, or another refrigerant, and drives the combined working fluid through a standard Rankine vapor-compression cycle.

The research would develop and test a working prototype in a California light commercial application and document the energy savings over a year of monitoring. Data will be collected on performance, savings and operations over various load conditions.

Eventual use could be residential and light commercial HVAC (including split systems, heat pumps and packaged systems) and refrigerators and could be expanded to larger systems.

Impact if Successful

If successful, lightly pressurized hydrogen can be produced from electricity driving an HVAC cycle with water, leveraging hydrogen's excellent thermodynamic characteristics, as well as existing proton-exchange-membrane (PEM) technology.

If successful, this initiative would introduce HVAC products using electrochemical compressors. Electrochemical compressors have no moving mechanical parts, are solid state, silent, use hydrogen as the refrigerant, use about 30% less electricity than mechanical compressors, and compresses hydrogen without significantly heating it during compression (isothermic).

Primary Users and/or Beneficiaries

Residential & Commercial Buildings, refrigerated ware houses, refrigeration and HVAC manufacturers

Metrics and Performance Indicators

The COP of a Electrochemical Compression Systems ≥ to 4.5

Topic(s) addressed	Value Chain	Program Area(s)
HVAC Designs	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment

S1.3 Drive Technical- and Cost-Performance Improvements in High-Efficiency Heating, Ventilation and Air Conditioning Systems

Initiative 1.3.3

Manufacturing and Designing Improved Heat Exchangers

Description

Heating and cooling systems depend on heat exchangers to transfer heat from the surfaces of the equipment to air. Efficient heat exchangers are typically large and expensive. It may be possible to greatly improve heat exchange efficiency through improved designs such as use of microchannel devices. New manufacturing methods including additive manufacturing, may allow production of heat exchange designs not possible with traditional approaches, which could increase the efficiency of commercial air conditioners by as much as 20%.

Additive manufacturing may also contribute to energy efficiency across sectors, whether through the rapid development and fabrication of prototypes to reduce the cost and lead time of new products or more directly through the production of energy-saving products, such as compact, high-surface area heat exchangers, that are more efficient than heat exchangers made by conventional methods. Additional HVAC products could include: enclosures, fan shrouds, heat pipes and even fan blades. 3D printing will allow for customization of air conditioning systems, which is not cost-effective using traditional manufacturing

This initiative proposes a design competition for developing heat exchangers for various applications (condensers and evaporators) and must include the following requirements:

- New design heat exchanger must have an efficiency greater than 20% compared to current “best available” heat exchangers. When installed into an electric heat pump, the resulting SEER must be ≥ 23.5
- New design must meet required performance, durability requirements
- Designer must have a manufacturing partner—such as an HVAC manufacturer. Researchers can use various additive manufacturing technologies to include: 3D Printing, Rapid Prototyping (RP), Direct Digital Manufacturing (DDM), layered manufacturing and additive fabrication to develop prototype heat exchanger units.

Selected design winner will receive funds to build a prototype and incorporate it into an electric heat pump. The heat exchanger will be evaluated for efficiency, performance and durability for a minimum of 12 months.

S1.3 Drive Technical- and Cost-Performance Improvements in High-Efficiency Heating, Ventilation and Air Conditioning Systems

Initiative 1.3.3

Manufacturing and Designing Improved Heat Exchangers

Impact if Successful.

If successful, innovative heat exchanger designs for HVAC systems may reduce the volume and weight of heat exchangers and improve performance up to 20 percent.

Primary Users and/or Beneficiaries

HVAC manufacturers

Metrics and Performance Indicators

Efficiency—energy savings and efficiency and performance improvements, High level of acceptance by other manufacturers, Reduction in weight

Topic(s) addressed	Value Chain	Program Area(s)
HVAC Designs	Demand-side Management	Applied Research and Development

S1.4 Enable Integration of Building and Equipment Controls and Automation

Initiative 1.4.1

Research and/or Demonstrate Open Source Platforms, Protocols, and Interoperability of Technologies

Description

This initiative will investigate the feasibility of new open source platforms capable of creating affordable, flexible building automation solutions across small and medium scale building types (e.g. small commercial, residential). Research may range from advancements in open source controller technologies (such as an HVAC controller), demonstration of open source communication protocols, or the development of protocols for smart phone, tablets, or other granular data source communication to building systems.

Impact if Successful

By providing open standards vendors will not have to build their own communication and control systems, significantly reducing the development costs and time needed to incorporate automated control functionality into their products. The open standard would also enabled interoperability, meaning equipment from multiple vendors could communicate with little to no additional setup costs or specialized installation needed. This not only lowers the installation costs of automated technologies in buildings, it gave customers the flexibility to change equipment providers at will. Because of the advantages of the open standard, building automation in small and medium scale buildings will be able to scale much quicker and cheaper than if individual private companies had developed their own proprietary automation controller and systems.

Primary Users and/or Beneficiaries

Building owners, building developers, building occupants

Metrics and/or Performance Indicators

Consolidation of existing and new standards by the building energy management system controls companies, market penetration rate of new technologies into various building sectors, energy savings

Topic(s) addressed	Value Chain	Program Area(s)
Integration of Building Automation and Control Technologies	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment

S1.4 Enable Integration of Building and Equipment Controls and Automation

Initiative 1.4.2

Human Centered Design Thinking for Next Generation Building Controls

Description

Building automation has underperformed due to a lack of human centered design thinking in the engineering and implementation phases of automation technologies within a building. Technologies such as dynamic, simulated environments that enable building designers to interact with representative occupants early in the design process. This will help to ensure the occupant's needs are met in an intuitive and appealing way. Additionally, the use of smartphones and other solutions with machine learning can connect human and building needs to evolving building automation capabilities but requires further investigation.

Impact if Successful.

Building automation systems will perform better and stakeholders such as building owners and occupants will gain more value from a well-designed, smart building automation system. Additionally there will be benefits such as increased occupant comfort, reduced maintenance and energy savings.

Primary Users and/or Beneficiaries

Building owners, building developers, building occupants

Metrics and Performance Indicators

Return-on-investment for building automation technologies, energy savings

Topic(s) addressed	Value Chain	Program Area(s)
Machine Learning and Human centered design	Demand-side Management	Technology Demonstration and Deployment Market Facilitation

S1.4 Enable Integration of Building and Equipment Controls and Automation

Initiative 1.4.3

Demonstrate Innovative Security and Cyber Security Methods

Description

Despite the added value presented by building automation technology and cloud computing, there are real risks associated with security threats to buildings. This initiative aims to research existing or novel approaches to securing technologies that facilitate the interactions between users, buildings, and the grid. Research can range from demonstration of building transactive energy models and tokenization of energy, to demonstration of blockchain security, or digital privacy and security standards such as The Digital Standard.

Impact if Successful

By promoting novel security and energy transaction approaches such as blockchain this initiative will help demonstrate how buildings and grid can interact in a highly secure manner while providing privacy for its users and promoting a prosumer approach to grid interactions from a building perspective.

Primary Users and/or Beneficiaries

Building owners, building developers, building occupants, building energy management system control companies, utilities

Metrics and Performance Indicators

Grid and building flexibility and reliability, energy savings

Topic(s) addressed	Value Chain	Program Area(s)
Privacy and Security Standards	Demand-side Management	Applied Research and Development

S1.5 Increase the Energy Efficiency of Plug Loads and Consumer Electronics Devices

Initiative 1.5.1

Develop and Test New Strategies for Low Power and Idle Mode Devices

Description

This initiative will address devices, including networks, that are always on but have low power/idle mode or no power management capabilities. These modes consume electricity even when the owners are not using them or think they have been turned off. This research will include:

- Identify and rank products with the highest potential of energy savings and create a database of device ownership, usage patterns (duty cycles) and energy consumption
- Develop and test devices that have zero to near zero idle modes that do not impact the quality of the device or its main functionality and that could be added to the high ranking devices at little or no additional cost. The test could involve various end user groups and collecting data on pre- and post practices.
- Develop effective strategies that will motivate manufacturers to include in the design methodology
- Develop test procedures for measuring idle mode and active mode that could help inform future codes and standards.
- Develop a comprehensive database of device ownership, usage patterns (duty cycles)

Impact if Successful

Could lead to more energy efficient and reliable devices out in the marketplace. These types of devices can influence future building codes and standards. If implanted through manufacturers this has the ability to lower energy bills for consumers.

Primary Users and/or Beneficiaries

Electronic manufactures, consumers, building owners, IOUs, governmental codes and standards setting agencies

Metrics and/or Performance Indicators

Energy savings, greater reliability, number of manufacturers adopting technology.

Topic(s) addressed	Value Chain	Program Area(s)
Plug load devices	Demand-side Management	Applied Research and Development

S1.5 Increase the Energy Efficiency of Plug Loads and Consumer Electronics Devices

Initiative 1.5.2

Develop and Test Energy Saving Opportunities for Electronic Medical Equipment with Potential to Reduce Standby or Idle Energy Use

Description

This initiative will address energy saving opportunities for medical equipment in the healthcare sector. Hospital facility managers often lack measured energy use data on their facilities and most decisions on energy efficiencies is often based on building simulation modeling. The National Renewable Energy Laboratory (NREL) completed a study of the some of the plug load usage in hospitals. In particular, one of the areas studied was hard-wired, medical imaging devices, such as MRIs, and CAT Scans. These devices are all 24/7 and even when they are not used, the idle modes show that these devices could use up to 10 kW. This research will examine medical equipment plug load operational modes to determine control technologies/strategies to power down devices when not in use, and reduce idle power while ensuring fast response and emergency readiness. This research will:

- Identify and rank hospital/home/office medical equipment with the highest potential of energy savings. Examples of equipment could include heart monitors, x-rays, and MRI scanners, CT Scans, X-Rays, and other lab equipment create a database of device ownership, usage patterns (duty cycles) and energy consumption
- Work with a manufacturing partner and other stakeholders (e.g., hospital, and the California Office of Statewide Health Planning and Development) to develop and test devices that have control strategies to reduce idle power or power down devices when not in use, such as on weekends in a medical office, but main functionality and fast response for emergency readiness.
- Develop effective strategies that will motivate manufacturers and the healthcare industry to include in the design methodology

Impact if Successful

This initiative if implemented can save money and energy to California residents and the healthcare industry.

Primary Users and/or Beneficiaries

Hospitals, healthcare industry, equipment manufacturers, government, IOUs

Metrics and Performance Indicators

Lower energy bills, adoption of features by manufacturers, acceptance of new devices by healthcare professionals, approval by medical care regulators

Topic(s) addressed	Value Chain	Program Area(s)
Plug load devices	Demand-side Management	Applied Research and Development

S1.5 Increase the Energy Efficiency of Plug Loads and Consumer Electronics Devices

Initiative 1.5.3

Large-scale Demonstrations of Low Energy Consuming Plug-in Devices with the Greatest Potential of Market Adoption and Penetration

Description

This initiative will demonstrate new emerging plug load technologies with at least 10 percent lower energy consumption than devices currently on the market, have high technical potential, add minimally to equipment cost and with near term applicability. The demonstrations can provide a foundation for both scaling up production and providing the energy data to justify savings and benefits.

Impact if Successful.

The potential to influence future Title 20 codes and standards. Potential for substantial savings in both the commercial and residential sectors.

Primary Users and/or Beneficiaries

Building owners and operators, end-users, and IOUs

Metrics and Performance Indicators

Lower energy bills

Topic(s) addressed	Value Chain	Program Area(s)
Plug Load Devices and Strategies	Demand-side Management	Technology Demonstration and Deployment

S1.6 Accelerate the Transition to Direct Current Powered Buildings and Facilities

Initiative 1.6.1

DC Building Distribution Systems to Enable New ZNE Commercial Buildings by 2030

Description

This initiative will support the development of DC buildings, and hybrid AC/DC buildings, test bed that can be used to test and demonstrate electrical components and configurations, system voltages, communication protocols, installation procedures, and safety protections necessary for standards and to inform Title 24 buildings standards for DC and hybrid buildings. The test bed will determine the optimal combinations of AC and DC electrical systems in different building types to maximize the energy efficiency, power quality, resiliency, cost, occupant control, and other non-energy benefits in both the residential and commercial sectors, while comparing the benefits of DC and hybrid buildings to traditional AC buildings. The test bed will also explore the technical feasibility, cost, and safety of repurposing existing AC systems into DC systems. Testing and demonstration will include evaluating operations of DC systems that incorporate roof top solar, electric vehicle charging, customer side energy storage, and building control systems and integration with USB and Power over Ethernet (PoE) devices.

This test bed will provide DC appliance manufacturers with opportunities to test their products in a DC building environment. This will provide valuable, practical information to appliance manufacturers on how their appliances will function in actual DC buildings, and inform engineers on the impacts the operation of different appliance will have on DC building systems. Work done in this test bed will help establish best practices for DC systems and feed into training materials on how to design, install, and maintain effective DC electrical systems in buildings.

S1.6 Accelerate the Transition to Direct Current Powered Buildings and Facilities

Initiative 1.6.1

DC Building Distribution Systems to Enable New ZNE Commercial Buildings by 2030

Impact if Successful

A successful DC and hybrid building test bed will help inform future Title 24 building standards and California's progress towards ZNE goals. Developing standards for DC buildings will provide consumer protection and facilitate the stronger market for DC technologies necessary for mass adoption.

Successfully quantifying the cost, operational, energy and non-energy benefits of DC buildings through demonstration will provide the building industry, and individual consumers, with valuable information on DC and hybrid buildings and could influence motivate businesses and other organizations to accept potentially longer payback periods, accelerating adoption of these advanced technologies. As the market for PV and battery storage systems grow with the anticipation of NEM 2.0, the benefits of DC and hybrid buildings could facilitate greater adoption of PV, battery storage systems, and electric vehicles.

Primary Users and/or Beneficiaries

Electric ratepayers who own and operate buildings, construction industry, electrical contractors, appliance manufacturers, energy regulators, HVAC equipment manufacturers and installers, building designers, academia, researchers, utilities, solar installers, inverter manufacturers, battery energy storage industry, building retrofitters.

Metrics and/or Performance Indicators

Development of cost comparisons for DC buildings, AC buildings, and hybrid buildings, data to inform future Title 24 development, best practices and training materials that for installing DC and hybrid electrical systems in buildings.

Topic(s) addressed	Value Chain	Program Area(s)
DC Buildings, Industry Standards, DC appliances, Workforce Training	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment

S1.6 Accelerate the Transition to Direct Current Powered Buildings and Facilities

Initiative 1.6.2

Cost Competitive, Efficient DC Appliances

Description

This initiative will accelerate development and cost reduction of DC appliances by focusing on key components, such as DC motors, variable frequency drives, solid state heating and cooling, and other core components of standard appliances. The optimization of these key components will provided benefits to numerous appliance types, and bring efficiency gains and/or cost reductions to appliances used in California's buildings.

Impact if Successful

Could lead to greater adoption of DC appliances and DC buildings by decreasing the initial purchase price and lowering the lifetime energy costs.

Primary Users and/or Beneficiaries

Electric ratepayers with DC systems in their buildings, appliance manufacturers, energy regulators, HVAC equipment manufacturers and installers, academia, researchers, utilities.

Metrics and/or Performance Indicators

Lower cost primary components for DC appliances, number of manufacturers producing DC appliances, number of new DC appliances being offered in the marketplace.

Topic(s) addressed	Value Chain	Program Area(s)
DC appliances	Demand-side Management	Applied Research and Development

S1.7 Develop Technologies that can Assist in Decarbonizing Key California Industries

Initiative 1.7.1

Develop and Deploy Sensors and Software to Optimize Refrigeration Compressor Efficiency by Automatically Floating Compressor Head Pressure

Description

California has a large population of refrigeration compressors of all sizes operating in virtually every climate zone within the state. Refrigeration compressors generally are designed, and their head pressures set to serve peak cooling loads during the hottest summer months. Unfortunately, the same head pressure is typically maintained all year around. Without a provision for automatically adjusting head pressure, the refrigeration compressor consumes the same amount of electrical power year-round.

Automatic control based on outdoor temperature conditions is the most desirable approach but requires the development of effective sensors and a dashboard-based operator system to make it effective. This initiative will develop and deploy improvements in refrigeration compressor control through the use of sensors and software. The improvements will be deployed in a minimum of 50 industries in California. This initiative will prove the viability of the concept and document the savings and benefits. These sensors and software applications will provide information to plant operators of areas of potential waste and has the potential of reducing industrial plant energy by 15 percent.

Impact if Successful

Could lead to greater adoption of optimization sensors and software suites that could improve energy efficiency in medium scale industries who are not aware of efficiency gains to be made. This may help businesses and other organizations more acceptable of the longer payback period.

Primary Users and/or Beneficiaries

Initially, industries that utilize large amounts of refrigeration compressors. The Industry targeted by this initiative are primarily refrigerated warehouses but could be expanded to include breweries, print shops, mechanics, and agricultural operations among others.

Metrics and/or Performance Indicators

The nature of optimization software will provide a before and after snapshot of efficiency which will prove the value of the underlying concept.

Topic(s) addressed	Value Chain	Program Area(s)
Optimization Software in refrigeration compressors	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment

S1.7 Develop Technologies that can Assist in Decarbonizing Key California Industries

Initiative 1.7.2

Develop and Deploy Sensors and Software to Optimize Compressed Air and Other Related Systems to Minimize Energy Losses and Maximize Efficiency

Description

Nearly all manufacturing and food processing plants employ compressed air systems to drive various parts of their operations. Compressed air is generally the most expensive utility in a plant. To begin with, most of the electrical energy input is wasted because of compressor inefficiency. Added to that are distribution system air leaks. Nearly 80% of the electrical power input to a typical compressor is lost as heat due to inefficiency. Most plants have air leakage rates of approximately 33%. Compounding this is the fact that compressed air systems in the majority of plants have deviated from its original design and are no longer operating optimally because of system modifications and additions. Additionally the compressed air systems often run uncontrolled and it is possible that these compressors continue to run even when the plant itself is not operating.

This initiative will develop and deploy sensor and software optimization controls for compressed air systems that can help operators compare current operations to industry standards, determine leaks in their systems and potential energy and cost savings of fixing the leaks. Currently, plant operators do not have access to metadata level comparisons of compressed air leaks with other similar industries. Large scale deployment is needed in order to show the viability and benefits of the concept. This initiative involves a program to deploy sensors and software in up to 500 industries in California. These sensors and software applications will provide information to plant operators of areas of potential waste and has the potential of reducing industrial plant energy by 15 percent.

Impact if Successful

Could lead to greater adoption of optimization sensors and software suites that could improve energy efficiency in medium scale industries who are not aware of efficiency gains to be made. This may help businesses and other organizations more acceptable of the longer payback period.

Primary Users and/or Beneficiaries

Initially, industries that utilize large amounts of compressed air. Industries include breweries, print shops, mechanics, and agricultural operations among others.

Metrics and/or Performance Indicators

The nature of optimization software will provide a before and after snapshot of efficiency which will prove the value of the underlying concept.

Topic(s) addressed	Value Chain	Program Area(s)
Optimization Software in compressed air	Demand-side Management	Technology Demonstration and Deployment

S1.7 Develop Technologies that can Assist in Decarbonizing Key California Industries

Initiative 1.7.3

Develop Strategies and Tools for Maximizing Cost Effective Energy Efficiency Strategies for Decarbonization the Industrial Sector

Description

This initiative will develop strategies that offer highest potential for cost-effective greenhouse gas reduction for major industries in California. The strategies will identify opportunities, best approaches and technologies for implementation in the near (within 5 years) and mid-term (5-10 years), cost effectiveness, potential energy savings and greenhouse gas emission reductions, presence in California, and regulatory constraints. Major industrial sectors to be considered include petroleum refining, food products, electronics, oil and gas extraction, chemical and allied products, glass and cement. The resulting strategies will provide information on the potential carbon reductions technically and economically possible for California.

Impact if Successful

Will provide industries and governmental agencies with a tool to identify approaches and strategies for cost effective decarbonization.

Primary Users and/or Beneficiaries

Industry, government agencies

Metrics and Performance Indicators

Implementation or use of recommendations by those who download publication.

Topic(s) addressed	Value Chain	Program Area(s)
Technical and Cost Advancements	Demand-side Management	Applied Research and Development

S1.7 Develop Technologies that can Assist in Decarbonizing Key California Industries

Initiative 1.7.4

Large Scale Deployment of Pre-commercial Technologies with Demonstrated Potential

Description

This initiative involves large scale deployment of previously funded research projects that have the capability of reducing industrial energy use by at least 10 percent and be scalable and be replicated at multiple facilities. The targeted technologies must be proven at the pilot stage or have had low market penetration due to high costs. This initiative is designed to have technologies deployed at large scale to demonstrate savings and benefits so that manufacturers can develop a sustainable program to help secure future private funding or participate in pay for performance programs with utilities and others.

Impact if Successful.

Will spur market adoption in a broad spectrum of industries using proven, but not yet adopted, CEC funded technologies.

Primary Users and/or Beneficiaries

Light and medium industrial facilities without in house efficiency expertise.

Metrics and Performance Indicators

Sales figures from equipment manufacturers.

Topic(s) addressed	Value Chain	Program Area(s)
Technical and Cost Advancements	Demand-side Management	Technology Demonstration and Deployment

Theme 2: Accelerate Widespread Customer Adoption of Distributed Energy Resources

S2.1 Increase the Cost-effectiveness of Highly Energy Efficient Buildings and Communities

S2.2 Push Low-Carbon Microgrids Closer to Commercial Viability

S2.3 Improve the Business Proposition of Integrated Distributed Storage

S2.4 Incentivize DER Adoption through Innovative Strategies at the Local Level

S2.1 Increase the Cost-effectiveness of Highly Efficient Buildings and Communities

Initiative 2.1.1

Develop and Test Plans for Enhanced New Construction of Highly Efficient Communities that Includes Distributed Energy Resources

Description

This initiative will fund the development of several enhanced plans for community-scale, highly efficient new construction projects. This initiative aims to have builders and developers who are already in the planning stages for subdivisions, business parks, office campuses and other -like projects to add advanced energy efficiency (e.g., envelope, lighting, HVAC, controls) and distributed energy resources into their projects. The goal is to have plans that can be implemented during the build-out phase that will include advanced energy efficiency beyond current requirements, to minimize energy use and electrical load, and use of distributed energy resources to provide grid flexibility.

Phase 1 could focus on plan development. The applicants must already be in the planning stages of a building development and have prepared and completed all environmental documents (e.g., CEQA) and secured local agency approval to build. Proposals could be evaluated based on community energy profiles, potential for load flexibility, ability to scale and be duplicated in other communities, team qualifications, quality of commitments, financial arrangements, and overall sustainability including transportation impacts. The selected projects will then develop the enhanced plans which will include community layouts, building plans, energy and load simulation at building and community levels, advanced energy efficiency measures and DER measures to be installed, cost relative to conventional construction ($/sf and $/kWh), customer/occupant appeal, financing arrangements including subsidies required, construction partners, and municipal and utility planning approvals. Projects may include building-integrated or community scale renewable energy and energy storage elements.

Phase 2 could focus on funding a portion of the incremental cost for the build-out of selected projects from Phase 1. The incremental cost is the difference between the original costs as designed versus the building cost of the enhanced plan. Selection factors for Phase 2 could include affordability ($/square feet), benefits to disadvantaged communities, ability to provide grid flexibility, ability to address local and regional energy issues, and sustainable and likelihood of business model replicability.

S2.1 Increase the Cost-effectiveness of Highly Efficient Buildings and Communities

Initiative 2.1.1

Develop and Test Plans for Enhanced New Construction of Highly Efficient Communities that Includes Distributed Energy Resources

Impact if Successful

The primary impact will be to stimulate construction of highly efficient communities in support of California goals to reduce greenhouse gas emissions. It is hoped that some of the communities that are not funded in Phase 2 will still be constructed because the applicants have already developed a plan. In this case, the initiative will be an efficient method of catalyzing highly efficient communities, simply by sponsoring the early planning stage. Costs and benefits to customers and the grid will be better understood and this can help assist future development and construction of highly energy efficient buildings and communities.

Primary Users and/or Beneficiaries

Home and business owners, builders, developers, contractors, utilities

Metrics and/or Performance Indicators

- Successful development of new highly energy efficient single family, multi-family communities and commercial developments.
- Increased cost-effectiveness of highly efficient, grid-friendly buildings and communities.
- Replicable and cost-effective demonstrations of community-scale renewable resources
- Information resources to assist the replication of similar efforts elsewhere
- Improved value, livability, and environmental sustainability of components, individual buildings, and whole communities

Topic(s) addressed	Value Chain	Program Area(s)
Zero Net Energy Communities	Demand-side Management	Applied Research and Development

S2.1 Increase the Cost-effectiveness of Highly Efficient Buildings and Communities

Initiative 2.1.2

Assess, Plan and Test Innovative Strategies to Employ Cost-effective Combinations of Advanced Energy Efficiency Technologies, Distributed Generation and Electricity Storage to Provide Grid Benefits

Description

This initiative will evaluate the potential for existing communities—defined at a level of the distribution system (such as a circuit or sub-station or some other aggregation point)—to develop and pilot test innovative strategies for investing in efficiency renovations, distributed generation and storage resources.

In the first phase, successful applicants would identify a community, analyze current community consumption patterns and estimate impacts for efficiency, distributed generation and storage investments that could impact grid operations. It is envisioned that funded projects will evaluate the potential in multiple communities. In addition, the projects would assess community interest in participation, develop a community engagement and investment strategy and identify a coalition of contractors, community leaders, local government and utility representatives willing to support a pilot test of the strategy. The results from the evaluation will be fully-developed proposals for the second phase.

In the second phase, participants from the first phase could compete for funding to pilot test the innovative approaches to achieving highly efficient and sustainable existing buildings at community scale as identified in the first phase. The pilots should reflect real-world conditions for investment, with building owners and local government entities leveraging their own investments with existing utility and government subsidies, reserving research funds for collecting data and supporting pilot implementation. The measure of a successful strategy should be that the program becomes largely self-sustaining and can be replicable in other, similar communities.

S2.1 Increase the Cost-effectiveness of Highly Efficient Buildings and Communities

Initiative 2.1.2

Assess, Plan and Test Innovative Strategies to Employ Cost-effective Combinations of Advanced Energy Efficiency Technologies, Distributed Generation and Electricity Storage to Provide Grid Benefits

Impact if Successful

As a laboratory for innovation, it creates a replicable business model and advances California's goals of dramatically reducing the environmental impact of existing and new buildings.

Primary Users and/or Beneficiaries

Home and business owners, builders and contractors, local governments, utilities and the people of California.

Metrics and/or Performance Indicators

- Successful redevelopment of existing communities towards optimizing investments in Energy Efficiency and Distributed Energy Resources
- Explicit optimization of energy efficiency and distributed energy resource investments from the perspective of participating community members
- Increased cost-effectiveness of highly efficient buildings and building components
- Replicable and cost-effective demonstrations of community-scale distributed energy resources
- Information resources to assist the replication of similar efforts elsewhere
- Improved value, livability, and environmental sustainability of components, individual buildings, and whole communities

Topic(s) addressed	Value Chain	Program Area(s)
Zero Net Energy Communities	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment

S2.2 Push Low-Carbon Microgrids Closer to Commercial Viability

Initiative 2.2.1

Advance Microgrids to the Tipping Point of Broad Commercial Adoption

Description

This initiative will bring together key stakeholders in the microgrid market and develop clear pathways to resolve the identified obstacles to transitioning microgrids closer to the commercial market using the actions defined in the published *Roadmap for the Commercialization of Microgrids in California* and from public workshops held to develop the Grant Funding Opportunity under this initiative. This initiative will develop documents that provide clear directions to the CPUC, CA ISO, other state agencies and Legislature on what issues remain to be resolved and what are the recommended resolutions to these issues.

Impact if Successful

This effort will provide the key decision makers in the State of California a clear understanding of the issues facing microgrids, options on how to address those issues and definitive recommendation on next steps to move microgrids closer to commercialization. This will provide the vehicle for California to be the leader in the nation and the world in using microgrids to address climate change issues, key state energy policies; provide end customer better energy services; and perform these actions in the most cost effective manner possible by addressing how microgrid solutions compare to other non-microgrid solutions.

Primary Users and/or Beneficiaries

CPUC, CAISO, CEC, utilities, independent power producers, energy storage developers, vendors, and service providers, U.S. DOE, national labs, CESA, ESA, researchers, and policy makers.

Metrics and/or Performance Indicators

- Microgrid policies and procedure that are defined and published
- Number of commercial standards that were updated to include microgrids
- Status of specific recommendations and actions in the *Roadmap for the Commercialization of Microgrids in California* that is addressed and resolved.

Topic(s) addressed	Value Chain	Program Area(s)
Microgrid Commercialization	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment

S2.3 Improve the Business Proposition of Integrated Distributed Storage

Initiative 2.3.1

Development of Customer's Business Proposition to Accelerate Integrated Distributed Storage Market

Description

This initiative will address the key commercial business case actions defined in the State's Energy Storage Roadmap, *Advancing and Maximizing the Value of Energy Storage technology, A California Roadmap*. The Roadmap identifies three key categories of challenges: (1) Expanding revenue opportunities, (2) reducing costs of integrating and connecting to the grid, and (3) Streamlining and spelling out policies and processes to increase certainty.

This initiative will establish key stakeholder working groups and conduct workshops to assess the issues holding back the commercial progress of distributed ES as a DER resource, develop specific action plans to address three categories of challenges identified by the State's Energy Roadmap, and verify the priority of these action plans based on the need of ES procurement target implementation of AB 2514 and AB 2868. Then, the grant funding initiatives will be developed to assess, evaluate and demonstrate solutions to these priority actions. These efforts will be combined into a publicly available customer's business proposition of integrated distributed ES to accelerate the commercial adoption of ES as a DER.

Impact if Successful

This effort will provide the key decision makers in the State of California and the ES industry a clearer understanding of the issues holding back the commercial progress of distributed ES as a DER resource, options on how to address those issues and definitive recommendations on next steps to make ES a more commercially viable DER to meet the future DER demands for California's Grid. These efforts will assist the CPUC and the California's IOUs and POUs as they implement AB 2514 and AB 2868 by ensuring the most cost effective decisions are made on applying energy storage as a DER service on the grid and that the values provided by these energy storage DER services are better understood, more easily monetized and more effectively implemented.

Primary Users and/or Beneficiaries

CPUC, CAISO, California Energy Commission, utilities, independent power producers, energy storage developers, energy storage vendors, and DER service providers, U.S. DOE, national labs, CESA, ESA, researchers, and policy makers.

Metrics and/or Performance Indicators

- Clearly defined revenue opportunities for ES in California and a better understanding on how these opportunities illustrate the commercial viability of ES as a DER.
- Overall industry acceptance of the valuations and benefits defined in the documents and tools provided by this initiative

Topic(s) addressed	Value Chain	Program Area(s)
Commercialization of ES as DER service	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment Market Facilitation

S2.4 Incentivize DER Adoption through Innovative Strategies at the Local Level

Initiative 2.4.1

EPIC Challenge II

Description

The scale and scope of California's energy and climate goals will require action and support at all levels and from all parts of the state. California's local governments and communities will play a crucial role in achieving these goals, developing new solutions and innovations at the local levels that can help catapult clean energy investment at unprecedented levels.

In line with the state's clean energy goals, several cities across the state have adopted goals for achieving 100% renewable energy, Zero-Net Energy (ZNE), or carbon neutrality; and several more are exploring ways to adopt similar goals. However, most local governments lack the financial means to pursue and pilot creative new approaches for reimaging energy in their communities.

In 2016, the Energy Commission launched the EPIC Challenge, a two-phased competition that challenges multi-disciplinary teams to conceptualize and build an Advanced Energy Community (AEC) that can serve as a model for other communities.

This initiative continues the EPIC Challenge to further advance the comprehensive clean energy plans, regulations, and codes of cities and communities across California. This initiative will fund competition(s) that will challenge project teams to develop innovative and replicable approaches for accelerating the deployment of Advanced Energy Communities and explore the potential for Energy Districts, aggregated energy metering (especially in the agricultural sector), and curbing soft costs for customer-side energy storage deployment.

S2.4 Incentivize DER Adoption through Innovative Strategies at the Local Level

Initiative 2.4.1

EPIC Challenge II

Impact if Successful

Could demonstrate the feasibility of innovative planning, permitting and financing approaches at the local and regional levels, and incentivize the development of Advanced Energy Communities and increased adoption of DER. By pre-establishing energy storage and other DER siting requirements and regulatory pathways, this initiative could help ensure that California cities and communities are equipped to adopt innovative DER technologies.

Could facilitate the identification, collection, and distribution of California builders, small businesses, and vendors who can provide, install, and/or maintain clean energy technologies, including DER.

Could help establish best practices for engaging community organizations in the planning, design, and deployment of clean energy communities and advance best practices for collaboration between planners of Advanced Energy Communities and the residents and leaders of low-income and disadvantaged communities.

Primary Users and/or Beneficiaries

Ratepayers who will be purchasing clean energy technologies, local governments, environmental organizations, agricultural organizations, and developers of clean energy technologies.

Metrics and Performance Indicators

Increase in community-scale DER adoption in cities and communities across California.

Topic(s) addressed	Value Chain	Program Area(s)
Distributed Energy Resources Community-Scale Developments Planning and Permitting	Demand Side Management	Market Facilitation

Theme 3: Increase System Flexibility from Low-Carbon Resources

S3.1 Accelerate Broad Adoption of Automated Demand Response Capabilities that Provide the Grid Flexible Response Services

S3.2 Enable Electric Vehicle-based Grid Services

S3.3 Increase the Value of Distributed Energy Resources and Renewables to the Transmission and Distribution System

S3.4 Define and Demonstrate the Locational Benefits and Optimal Configurations of Grid-level Storage as the California Grid Transitions to More Distributed Energy Resources

S3.1 Accelerate Broad Adoption of Automated Demand Response Capabilities that Provide the Grid Flexible Response Services

Initiative 3.1.1

Market Design and Performance Assessment for the Next-Generation Demand Response Landscape

Description

This initiative will develop and pilot test new market designs and concepts (wholesale and retail rates and tariffs), end use customer incentive structures and demonstration programs that address specific system needs of the California grid where demand response (DR) can provide cost effective services. The effort will complete both customer behavioral studies to better understand how to encourage end-use customers to respond to DR opportunities and then develop pilot projects to assess the value of these concepts with actual field demonstrations. The research will identify specific subsets of end-use loads (by technology and/or customer type) that have (or could develop) the technical ability to respond to DR signals and explore opportunities for these resources to meet the variable flexible response needs of the California Independent System Operator (CAISO) and the utilities. This effort will assess and demonstrate how DR can provide both rapid load reductions when the grid is short of energy and load increases when the grid is in an over generation situation. Research conducted under this initiative will assess the load shapes and potential load control performance of both traditional end-use load management systems and systems that combine load control with distributed generation and electricity storage. Based on historical data and the projections of the CPUC funded DR Load Potential Study these DR services are expected to be least-cost to the customer and provide the best value to the grid. The retail elements of these market designs, incentive structures and programs could be implemented by either utilities or 3rd party aggregators. These pilot tests would necessarily include both load management alone and different combinations of DERs, including onsite generation and storage to provide a better understanding of effective investment strategies for different types of customers with different consumption needs.

S3.1 Accelerate Broad Adoption of Automated Demand Response Capabilities that Provide the Grid Flexible Response Services

Initiative 3.1.1

Market Design and Performance Assessment for the Next-Generation Demand Response Landscape

Impact if Successful

Demand response can be demonstrated as the most cost effective DER service available to grid operators. The behavioral studies can provide information that will make DR more widely adopted, because it would entail more desirable (less costly) customer actions, would better incent the participating end use customer, and provide the rapid load changes the grid operators will need as the concentration of renewables continues to grow.

Primary Users and/or Beneficiaries

- Electricity customers in all sectors could participate. Nonparticipant ratepayers benefit by having a smoother functioning, more reliable, less costly electricity grid.
- DR providers, LSEs and system operators who would use data generated to more precisely estimate load impacts under different conditions and at different times.
- Industrial and commercial customers with flexible loads and/or some combination of PVs, storage and load management technology.
- Small and medium-size customers – residential, commercial, industrial and agricultural with "typical" consumption needs – who are more likely to implement DR/DER approaches that are based on industry best practices and marketed in volume to reduce costs.

Metrics and/or Performance Indicators

- Customer participation levels, level of incentive needed to ensure participation
- Participant satisfaction and retention rates
- Load shaping (reducing the steep afternoon ramp) and other changes to the duck curve
- Value, amounts, and types, of ancillary services provided to the grid
- Participation rates
- System impacts
- Adoption rates
- Cost-effectiveness (customer)

Topic(s) addressed	Value Chain	Program Area(s)
Demand Response Market Design	Demand Response	Applied Research and Development Technology Demonstration and Deployment

S3.2 Enable Electric Vehicle-based Grid Services

Initiative 3.2.1

Grid-Friendly PEV Mobility

Description

This initiative will demonstrate advanced VGI functions to better characterize the business cases for emerging applications. It will advance communication and control functionalities between PEVs and grid infrastructure, thereby expanding aggregation capabilities and associated market opportunities. It will demonstrate the value of advancing technological platforms to incorporate traffic flow awareness and automated trip planning with VGI capabilities. It will also seek to reduce the marginal costs for bi-directional functionality for PEVs and charging stations so automakers will have increased confidence in the business case for producing and warranting bi-directional capable PEVs.

Impact if Successful

The most cost-effective smart charging and bi-directional VGI applications will accelerate PEV adoption. A robust ecosystem of third-party aggregators will maximize access of PEVs to electricity market revenue. Integration of charge scheduling with traffic flow awareness will improve utilization of existing transportation and grid infrastructure, expanding PEV benefits and optimizing the grid integration of ACES vehicles. Bi-directional capable PEVs and charging stations will be widely available and deployed to fulfill grid service and energy security needs through V2G and V2B.

Primary Users and/or Beneficiaries

PEV owners and fleet operators, Charging companies and third-party aggregators, Electric utilities and the CAISO, Regulators, Facilities using PEVs as energy storage

Metrics and/or Performance Indicators

PEV services as a proportion of DER grid services, Driver and owner acceptance of smart / bi-directional VGI, number of participants, Revenue and market penetration of PEV / DER aggregators, including for bi-directional charging capabilities, Bi-directional cost differential for automakers and charging station manufacturers

Topic(s) addressed	Value Chain	Program Area(s)
Smart Charging	Demand-side Management	Applied Research and Development
Bi-Directional Power Flow	Grid Operations / Market Design	Technology Demonstration and Deployment
		Market Facilitation

S3.2 Enable Electric Vehicle-based Grid Services

Initiative 3.2.2

Battery Second Use

Description

This initiative will develop technologies or test methods to better characterize, assess, and/or monitor PEV battery cell condition to better enable battery second-use grid storage applications such as reducing peak loads from DC fast charging. This proposed research will also develop and demonstrate viable and beneficial technologies to optimize second-life PEV battery packs for maximum performance and capacity in second-life applications used to enhance grid reliability.

Impact if Successful

This initiative could improve the value proposition for repurposing batteries that have reached their end-of-useful life in PEV applications. The useful battery cells could be packaged into larger energy storage systems for grid-level or localized energy storage to provide grid stabilizing services.

Primary Users and/or Beneficiaries

Residential PEV owners, Electric Utilities

Metrics and/or Performance Indicators

- cost effectiveness of second use battery, or other best use of components
- potential lifetime carbon footprint reduction
- reduced cost of PEV ownership
- resulting accelerated PEV market adoption
- battery waste diverted from landfills
- number or batteries repurposed

Topic(s) addressed	Value Chain	Program Area(s)
Battery Second Use (B2U)	Demand-side Management Transmission and Distribution	Applied Research and Development

S3.3 Increase the Value of Distributed Energy Resources and Renewables to the Transmission and Distribution System

Initiative 3.3.1

Optimize and Coordinate Smart Inverters Using Advanced Communication and Control Capabilities

Description

This initiative will improve the ability of solar PV to benefit the grid and ratepayers by optimizing the functionality of smart inverters. Advanced smart inverter functionality will enable rooftop PV to respond to signals from a utility or other grid operator to improve power quality and reduce the chance of electricity outages. Smart inverters also increase the amount of solar PV that can be installed on the distribution grid without upgrades to grid equipment. However, the use of advanced smart inverter functions will reduce the real power provided to the grid by rooftop PV. This initiative will develop DERMS algorithms to optimize the settings and coordination of advanced smart inverters to maximize the output of solar generation on the grid while maintaining reliability and power quality.

Impact if Successful

This initiative will enable smart inverters to provide grid services without excessively reducing the amount of renewable generation from rooftop PV that is exported to the grid. This reduces GHG emissions from California's power mix and maintains revenues for DER owners for providing renewable generation.

Primary Users and/or Beneficiaries

Utilities, smart inverter manufacturers, DER owners and service providers, researchers, and third-party aggregators.

Metrics and/or Performance Indicators

1. Maintenance of power quality.
2. Maintenance of grid reliability.
3. Increase in output of rooftop PV generation over business as usual.
4. Quantify the value streams for ancillary services.

Topic(s) addressed	Value Chain	Program Area(s)
Smart Inverters	Transmission Distribution	Applied Research and Development Technology Demonstration and Deployment

S3.3 Increase the Value of Distributed Energy Resources and Renewables to the Transmission and Distribution System

Initiative 3.3.2

Reduce the Cost and Time Needed for Interconnection to the Grid and Improve Interoperability

Description

Build on the outcomes of modeling funded under the second investment plant to improve distribution modeling to show the optimal locations for DERs, including smart inverters, and facilitate interconnection.

Impact if Successful

Improving distribution modeling will reduce the need for individual interconnection studies, thus streamlining utility interconnection applications and lowering costs.

Primary Users and/or Beneficiaries

CPUC, Utilities, DER owners and aggregators.

Metrics and Performance Indicators

1. Reduction of individual interconnection studies by the utilities.
2. Faster utility interconnection applications.
3. Lower interconnection fees.

Topic(s) addressed	Value Chain	Program Area(s)
Modeling	Distribution	Applied Research and Development

S3.3 Increase the Value of Distributed Energy Resources and Renewables to the Transmission and Distribution System

Initiative 3.3.3

Advance Distribution Planning Tools

Description

Improve distribution-planning tools to coordinate and optimize DERs on the grid, and maximize the benefits for ratepayers and those in disadvantaged communities, within a framework that includes Distributed Energy Resource Management Systems and improves and speeds up Integrated Capacity Analysis calculations.

Impact if Successful

Increased DER deployment and lower costs, both statewide and within disadvantaged communities.

Primary Users and/or Beneficiaries

Utilities, Regulators, Policymakers, DER owners and aggregators.

Metrics and Performance Indicators

1. Improved reliability and operational efficiency of the distribution grid.
2. Reduced GHG emissions in disadvantaged communities.

Topic(s) addressed	Value Chain	Program Area(s)
Distribution Planning	Distribution	Applied Research and Development

S3.3 Increase the Value of Distributed Energy Resources and Renewables to the Transmission and Distribution System

Initiative 3.3.4

Provide Visibility into DER Responses to Weather and Other Variables and into the Effects of DER on Gross Load

Description

This initiative will allow grid operators to understand the effects of weather patterns and other events on rooftop solar production, electric vehicle charging, and other DER usage. The collection and analysis of this information will enable forecasters to better predict the net load that will need to be met through geothermal, natural gas, and other utility-scale generation.

Impact if Successful.

An improvement in the ability of the CAISO and other grid operators to forecast the net load and determine reserves that will need to be scheduled to meet the predicted demand, particularly in cases of heat waves and other atypical events.

Primary Users and/or Beneficiaries

CAISO, CPUC, Utilities, DER owners and aggregators.

Metrics and Performance Indicators

1. Improvement in net load forecasting accuracy.
2. Reduction in large errors in net load forecasts.
3. Database of DER production and consumption data, with regional granularity and time, weather, and other variables.

Topic(s) addressed	Value Chain	Program Area(s)
Renewables Forecasting	Generation Demand-Side Management	Applied Research and Development Technology Demonstration and Deployment

S3.3 Increase the Value of Distributed Energy Resources and Renewables to the Transmission and Distribution System

Initiative 3.3.5

Facilitate Adoption of the Communication Standards and Protocols for the Electricity System

Description

This initiative will develop a standard framework to evaluate and compare competing communication standards and protocols currently being developed and proposed for grid-connected devices including storage, electric vehicle and smart inverters. As part of the framework, the recipient will develop a set of criteria - such as minimum functionality requirements, ease of adoption, security and backward compatibility - for specific grid-service applications and test the different communication standards against the criteria.

Impact if Successful

OEMs currently have one of three options: select one of the competing standards to support in their devices and hope another isn't selected as the industry standard; support all or most of the communication standards which can add significant cost and complexities to their products; or not build in any communication functionality into their devices at all. Clear guidance and direction from the state can help increase the uptake of device-level communication and control functions for grid services.

This initiative will help state policymakers determine which communication standards should be adopted for consumer-level and grid-level devices. In addition, this initiative will help lead to greater interoperability among consumer-level and grid-level devices which can further lower setup and installation costs.

Primary Users and/or Beneficiaries

State-level policymakers, original equipment manufacturers.

Metrics and Performance Indicators

Communication standards adopted by state-level policymakers

Topic(s) addressed	Value Chain	Program Area(s)
Standards and Protocols	Grid Operations Demand-side Management Distribution	Market Facilitation

S3.4 Define and Demonstrate the Locational Benefits and Optimal Configurations of Grid-level Storage as the California Grid Transitions to More Distributed Energy Resources

Initiative 3.4.1

Assessment and Simulation Study of California Grid with Optimized Grid-Level Energy Storage

Description

This initiative will focus on analysis and detailed studies that provide insights into the future needs for grid-level ES connected to the distribution or transmission grid and managed or controlled by utilities, the CAISO or the third-party owners executed power purchase agreement with IOUs or CAISO.

First, the effort will establish a baseline assessment of the grid-level ES systems available on the California grid. It will create a database and informational materials on grid-level ES systems for use cases laid out by AB 2514, AB 2868, IOUs' procurement plans, and any later legislation or CPUC rulings. The analysis will include the collection of available data on the field performance of different installed grid-level ES technologies to: 1) determine how the varied technologies are performing, 2) assess the value or need for different durations of grid-level ES capabilities to support the key functions of the grid, and 3) evaluate how the power grid is benefitting from the integration of grid-level ES systems. The effectiveness and value of using grid-level ES systems will be assessed for meeting wholesale and distribution system needs as defined by the CPUC, IOUs, and CAISO perspective.

Second, this initiative will fund a comprehensive and complex simulation study that can model, simulate, analyze, and validate the impact of grid-level ES installations on California's power grid. It will identify where grid-level ES could provide the greatest benefits, and what optimum capacity targets are to be set for procurement. The simulation study will provide valuable information on which combinations of different ES technologies provide the best value in relationship to the grid's stability while assessing performance and duration of the ES in stochastic and dynamic modes. It will also assess operational characteristics of the grid given existing and proposed procurement targets and evaluate locational values, operational values, and capacity values of ES. Further, it will consider the impacts of grid congestion, and will address the amount of GHG emission reductions produced under different grid-level ES configurations, taking into account other flexibility options such as automated demand response, classical peaker plant operations, aggregated DER services and other grid-level energy services that become available to the utilities and CAISO.

S3.4 Define and Demonstrate the Locational Benefits and Optimal Configurations of Grid-level Storage as the California Grid Transitions to More Distributed Energy Resources

Initiative 3.4.1

Assessment and Simulation Study of California Grid with Optimized Grid-Level Energy Storage

Impact if Successful

This simulation study will provide valuable information on which combinations and locations of grid-level ES provide the best value in relationship to grid stability and operation, while assessing the performance and duration of the grid-level ES in stochastic and dynamic modes. It will provide new insights into the implementation of the ES policies, and allow for the most cost-effective choices for ratepayers. Furthermore, this initiative will provide ES stakeholders institutional knowledge, field experience, and special insight into where and how much storage expansion is justified based on California grid needs and the performance and costs of grid-level ES systems. Simulation study will create a robust analysis tool that characterizes grid benefits, including the value of different grid-level ES technologies for multiple grid services. This will facilitate industry acceptance and help policy makers understand ES as a viable solution for higher penetration of renewable energy, multiple ES grid services, flexible grid operation, and GHG emission reductions.

Primary Users and/or Beneficiaries

CPUC, CAISO, California Energy Commission, utilities, independent power producers, energy storage developers, vendors, service providers, U.S. DOE, national labs, industry associations, researchers, and policy makers

Metrics and/or Performance Indicators

Use and adoption of analysis and framework produced by the simulation study by stakeholders in CA, other states, and worldwide.

Wider integration of grid-level ES systems in resource planning at the grid level.

Broad deployment of grid-level ES to enhance renewable energy penetration and contribute to the grid flexibility, resiliency, and reliability.

Topic(s) addressed	Value Chain	Program Area(s)
Energy Storage Simulation Study	Grid Operations/Market Design	Applied Research and Development

Theme 4: Increase the Cost-Competiveness of Renewable Generation

S4.1 Advance Emerging Thin-film PV Technologies for High Value Applications

S4.2 Develop Technologies that Enable Increased Wind Capacity in California

S4.3 Increase the Strategic Value of Flexible CSP and Geothermal to the Electricity System

S4.4 Improve the Value Proposition of Bioenergy

S4.1 Advance Emerging Thin-film PV Technologies for High Value Applications

Initiative 4.1.1

Advance the Material Science, Manufacturing Process, and In-Situ Maintenance of Thin-film PV Technologies

Description

This initiative will advance the material science associated with emerging thin-film PV technologies by exploring advantages of changes in materials composition substituting toxic and/or rare elements with non-toxic and abundant alternatives. Moreover, this initiative will support development of novel encapsulating materials and techniques that will prevent module failures and pave the pathway for large-scale application.

Recent R&D efforts have demonstrated that some of the thin-film PV materials have efficiencies above 20%, but still have toxicity and stability issues. Efforts to replace toxic rare elements and/or optimize the materials composition have proven that cheap, environmentally-friendly thin-film PV modules with acceptable degradation rates can be developed. However, their efficiency must be improved to make these technologies competitive.

As thin film PV technology matures, the need for large scale manufacturing will arise. If all-new custom equipment is needed for all parts of the supply chain, the market will be disincentivized to invest in this technology. However, if existing manufacturing equipment and processes can be used to manufacture thin film PV, the capital costs associated with mass manufacturing will be lower.

Emerging thin-film PV technologies possess numerous unique qualities such as flexibility, ability to take different shapes, wide range of possible transparencies and colors, and low weight and provide a variety of interesting possibilities in terms of their use in product integrated applications (e.g. integration into buildings, electronic devices, vehicles). However, currently the lifetimes of solar flexible modules are considerably shorter than targeted lifetimes of the targeted product carriers. Full integration into buildings and consumer goods would require a development of cost-effective in-situ refurbishment and upgrade processes where degraded materials can be flushed out and refilled with fresh PV materials.

S4.1 Advance Emerging Thin-film PV Technologies for High Value Applications

Initiative 4.1.1

Advance the Material Science, Manufacturing Process, and In-Situ Maintenance of Thin-film PV Technologies

Impact if Successful

Combining advancements in materials science of thin-film photovoltaic materials, demonstration of high efficiencies, utilization of abundant and non-toxic materials with effective low-cost encapsulating strategies to increase module life time could lead to a greater acceptance and large-scale adoption of thin film PVs. Additionally, new market niches that aren't feasible to traditional silicon PVs could become available to a lower cost, non-toxic thin film PV technology.

In-situ refurbishment would allow integration of thin-film PV technologies in products that require a lifetime currently exceeding the lifetime expectations of any PV technologies.

Primary Users and/or Beneficiaries

PV Manufacturer, Building Developers, Car Owners, Consumer Electronics Users

Metrics and/or Performance Indicators

Lower Costs, Greater Reliability, Increased Safety, GHG Emissions Mitigation and Adaptation. Production costs, TRL. Maintenance Costs, Life Cycle Length, Raw Material Savings, Job Creation

Topic(s) addressed	Value Chain	Program Area(s)
Thin film material alternatives Encapsulating materials/techniques Manufacturing Processes for Thin Film PV In Situ/Upgrade Processes	Generation, Demand-side Management Market Facilitation	Applied Research and Development

S4.2 Develop Technologies that Enable Increased Wind Capacity in California

Initiative 4.2.1

Advanced Manufacturing and Installation Approach for Utility-Scale Land-Based Wind Turbine Components

Description

This initiative will fund projects to support advanced manufacturing techniques of wind turbines components and introduce new composite material for wind towers and blades. The trend of taller tower and larger turbine blades present new challenges to the wind industry because larger turbine blades, capable of harnessing more wind energy, increase rotor costs and structural loads on the nacelle, rotor, and tower, as well as the drivetrains must be able also to endure the greater loads. This initiative could lead to new manufacturing process for blade shells and wind tower, new design and test innovative drivetrain concepts for more reliable components, and stronger materials for turbine blades and towers. The objective of projects under this funding strategy is to improve the performance of wind technology for high and low speed wind sites, while lowering the LCOE of wind energy in California. The US Department of Energy (DOE) Wind Program is concentrating efforts on improved performance, lower costs, and reduced market barriers of wind power. This Energy Commission's initiative will leverage DOE's efforts applied to advanced manufacturing techniques to wind turbine components.

Impact if Successful

This initiative could support the achievement of the state's energy and GHG reduction goals by improving the performance of wind technology and exploring untapped areas with lower wind speed. The advancement in manufacturing techniques for larger wind technology, both in the industry or on-site, create opportunities for further LCOE reductions and increase the share of wind energy in the electricity mix.

Primary Users and/or Beneficiaries

The primary direct beneficiaries of the research findings would be land-based wind technology developers and operators. The advanced manufacturing techniques in the wind turbine components and the introduction of stronger composite material for the wind turbine blades and towers will benefit also to ratepayer by adding more cost-competitive clean energy to the electricity mix and creating skilled people and local jobs that contribute to keep California as a leader and pioneer in wind energy.

Metrics and/or Performance Indicators

LCOE of Land-Based Wind

Capacity Factor

Downtime due to failures (days)

S4.2 Develop Technologies that Enable Increased Wind Capacity in California

Initiative 4.2.1	Advanced Manufacturing and Installation Approach for Utility-Scale Land-Based Wind Turbine Components		
	Topic(s) addressed	**Value Chain**	**Program Area(s)**
	Advanced manufacturing techniques of blade shell Advanced building process of wind towers Advanced manufacturing techniques for more reliable drivetrain components Use of stronger materials in wind blades Cost-effective techniques to build concrete or hybrid concrete/steel wind towers for high altitude wind	Generation	Applied Research and Development Technology Development and Demonstration

S4.2 Develop Technologies that Enable Increased Wind Capacity in California

Initiative 4.2.2

Reduce Costs and Technical Barriers to Facilitate Deployment of Offshore Wind

Description

This initiative will fund research to support technology advances that will lower the cost of electricity from offshore wind generation and transmission to shore. Key components that may be investigated include designs for floating platforms, rotors, drivetrains, and generators customized for the offshore wind space.

There is currently no single port in California with adequate infrastructure to support fabrication, construction, assembly, and deployment of offshore wind technology as currently envisioned. Upgrades to the ports are likely to be enormously expensive and compete with other legitimate uses of the port. In addition, the offshore wind supply chain for the West Coast is still in its infancy and there is possibly still time to shape it. Therefore the initiative may support the design of offshore wind components and logistics systems that can be accommodated by the capacity of existing ports (or with modest upgrades). This work could also be coordinated with upgrades to increase port resilience to sea level rise and electrification.

Impact if Successful

This initiative could support the achievement of the state's energy and GHG reduction goals by designing new technology that could lower capital costs of installing offshore wind. Through design of new components and logistics systems that minimize the costs of upgrading ports to support this emerging industry, the initiative could enable this high capacity, low carbon energy resource whose profile complements solar and would help flatten the duck curve.

Primary Users and/or Beneficiaries

The primary direct users of the research findings would be offshore wind technology developers. This would also benefit ratepayers by lowering LCOE. Port authorities may benefit by making upgrades that are needed to support deployment of offshore wind, which could create local jobs.

Metrics and/or Performance Indicators

LCOE of offshore wind

Topics addressed	Value Chain	Program Area(s)
Reduce Costs	Generation	Applied Research and Development
Port Readiness	Transmission	Technology Development and Demonstration

S4.2 Develop Technologies that Enable Increased Wind Capacity in California

Initiative 4.2.3

Real-Time Remote Monitoring System for Offshore and Land-Based Wind Technologies

Description

This initiative will fund projects to support the development and deployment of cost-effective real time remote monitoring and control system in off-shore and land-based wind turbines. The annual O&M expense is an important element in the estimation of LCOE, where the monitoring and diagnosis become essential to reduce maintenance costs and ensure wind power generation. The improvement in O&M practices by considering performance monitoring for operation and introducing condition-based maintenance has an opportunity of O&M cost reduction of 21 percent for offshores plants and 11 percent for land-based plants. The objective of projects under this funding strategy is to reduce the maintenance costs by introducing a proactive maintenance system (preventive approach) that avoids unexpected failures that lead to expensive repair, generation loss, and minimizes downtime and maximizes technology performance.

Impact if Successful

This initiative could support the achievement of the state's energy and GHG reduction goals by improving the performance of wind technology by continuity of wind energy generation without unexpected failures and generation loss, and that minimizes downtime and maximizes technology performance. The deployment of a proactive maintenance system will reduce the O&M costs, contributing with the LCOE reduction and increasing the share of wind energy in the electricity mix from both offshore and land-based resources. This initiative will help reduce the costs of a robust sensor network for wind energy parks.

Primary Users and/or Beneficiaries

The primary direct beneficiaries of the research findings would be offshore and land-based wind operators. Have a proactive maintenance system will benefit also to ratepayer by adding more cost-competitive and reliable clean energy to the electricity mix and creating local jobs that contribute to keep California as a leader and pioneer in wind energy.

Metrics and Performance Indicators

LCOE of Offshore Wind, LCOE of Land-Based Wind, Downtime due to failures (days)

Topic(s) addressed	**Value Chain**	**Program Area(s)**:
Develop real-time monitoring and control systems for off-shore and land-based wind turbines Develop low-cost sensor network for different wind turbine components Improve SCADA data quality	Generation	Applied Research and Development Technology Development and Demonstration

S4.3 Increase the Strategic Value of Flexible CSP and Geothermal to the Electricity System

Initiative 4.3.1

Making Flexible-Peaking Concentrating Solar Power (CSP) with Thermal Energy Storage (TES) Cost Competitive

Description

This initiative will conduct comprehensive research, technology development and demonstration, and studies that will advance the technology readiness of CSP-TES, bring it closer to the market, and make CSP-TES cost competitive relative to comparable fossil fueled power generation and conventional (battery) energy storage system. It will support RD&D on a range of system components and integration approaches needed to increase the efficiency of CSP-TES; demonstrate and deploy emerging low cost/alternative CSP; and conduct holistic system simulation, modeling and design studies that will confirm the system performance relative to other energy storage. The initiative may be implemented under different sub-topics or project group areas as follows:

a. Improving efficiency while lowering the cost of critical components of CSP-TES system. This project group will complement the DOE Sunshot goal on CSP by targeting components needed to increase efficiency and reduce the total cost of CSP-TES. The components will include the thermal energy storage, reflectors and receivers, and power cycle systems including heat exchangers.

b. Demonstrate and deploy small scale (less than 10 MWe) CSP systems employing alternative designs and materials, to improve and verify the economics of the system, and generate information needed for scale up. This project group will build on emerging simpler and low cost CSP system –largely based on linear Fresnel or parabolic troughs – that are on advanced stage of development.

c. Holistic study such as simulation and modeling and design studies that will yield information on the implications of emerging and alternative designs; needs and economics of operating CSP as a peaker power plant; identifying deployment areas and potential environmental and permitting impacts; and technical and economic comparison to other solar plus battery energy storage.

S4.3 Increase the Strategic Value of Flexible CSP and Geothermal to the Electricity System

Initiative 4.3.1

Making Flexible-Peaking Concentrating Solar Power (CSP) with Thermal Energy Storage (TES) Cost Competitive

Impact if Successful.

More cost effective and financially viable CSP with thermal energy storage will attract investors and increase likelihood of deployment thereby making significant contribution to the RPS goal, provide flexible generation needed to support variable renewables, and generate economic and job creation opportunities.

Primary Users and/or Beneficiaries

CSP developers and investors, electric utilities and balancing authorities, and ratepayers or Everyone who buys electricity

Metrics and Performance Indicators

Capital and O&M costs, components and system costs including cost of output electricity, high temperature ability, system efficiency, quality of designs, operational requirements, impacts and implications.. Example indicators are DOE SunShot goals of:

- $0.06/kWh
- <$15/kWh$_{th}$ for thermal energy storage
- system temperature of over 700 ° C, and
- power cycle efficiency of at least 50%.

Topic(s) addressed	Value Chain	Program Area(s)
Efficient and low cost thermal energy storage and heat transfer fluid Low cost and improved receivers and absorbers Component integration and system requirements for flexible operation Low cost alternatives to conventional CSP	Generation	Applied Research and Development

S4.3 Increase the Strategic Value of Flexible CSP and Geothermal to the Electricity System

Initiative 4.3.2

Geothermal Energy Advancement for a Reliable Renewable Electricity System

Description

Based on project findings and discussions with facility owners, operators prefer to operate geothermal as a baseload because of a host of issues associated with flexible generation, among them is the buildup of hydrochloric acid, hydrogen sulfide and other corrosive and toxic materials; and from efficiency perspective, steam generation and the energy associated with distribution are generally wasted or lost during curtailment of production. This initiative will address flexible generation issues identified so far by exploring strategies such developing materials, designs and operational techniques to mitigate corrosion issues and possibly integrate energy storage, a strategy that has yet to be demonstrated. The initiative will also support activities that explore the economic values of capturing the useful elements from buildup of these condensates (such as solid sulfur for agriculture use or metals for industrial application). The initiative will also support strategies that boost geothermal from existing facilities and wells that are now declining or idle. The overall intent is to further position geothermal energy as a key player in attaining the State's RPS goal by being able to backup intermittent renewables and providing sustained and increased renewable generation to the grid.

Impact if Successful

Accelerated penetration of renewables in the electricity grid and reducing the need for non-renewable generation systems that can ramp up and down to support variable renewables. It could lead to more cost effective geothermal power plants, making them more attractive to investors.

Primary Users and/or Beneficiaries

Geothermal developers, utilities

Metrics and Performance Indicators

Rates or ability to ramp up and down, Lower costs, additional revenue

Topic(s) addressed	Value Chain	Program Area(s)
Flexible geothermal energy generation; Increasing cost effectiveness and economic opportunities of geothermal power generation	Generation	Applied Research and Development

S4.4 Improve the Value Proposition of Bioenergy

Initiative 4.4.1

Tackling Tar and Other Impurities: Addressing the Achilles Heel of Gasification

Description

This initiative will focus on research that will help to eliminate the reliability risks of gasification technologies due to system problems caused by tar and other impurities. Tars, condensable organic molecules (C_6 and greater), are a persistent problem in biomass gasification systems. The operating temperatures (typically around 700-900° C) prevent complete cracking of the tar compounds which when condensed, could result in costly damage to the reforming catalysts, as well as the clogging of transfer lines and damaging of compressors, or other downstream devices like engines used for power generation. This problem often results in the need for after gasification cleanup. Catalysts are expensive and contribute to the higher cost of thermochemical gasification systems that employ them (catalysts). Cost-effectively solving the problems caused by tar and other troubling impurities will help bring down the costs of thermochemical conversion systems.

Impact if Successful

Could lead to greater adoption of thermochemical conversion technologies, including those using forestry biomass from sustainable forest management activities and targeting the tree mortality issue.

Primary Users and/or Beneficiaries

Ratepayers in rural and urban communities; bioenergy technology developers and investors; communities impacted by the tree mortality crisis looking for community-scale solutions. IOUs dealing with tree mortality in their service territories; local air quality districts; California Air Resources Board; California Department of Forestry and Fire Protection; biomass industry groups; California Department of Resources Recycling and Recovery; Bioenergy Associations of California, independent power producers, and the U.S. Forest Service.

Metrics and/or Performance Indicators

- Measured reduction in biogas impurities (such as tar).
- Reduction in costs of demonstrated technology compared to other impurity removal systems
- Replicable solutions applicable to a variety of thermochemical conversion technologies.

Topic(s) addressed	Value Chain	Program Area(s)
Tar and other impurities impacting thermochemical conversion technologies	Generation	Applied Research and Development Technology Demonstration and Deployment

S4.4 Improve the Value Proposition of Bioenergy

Initiative 4.4.2

Demonstrating Modular Bioenergy Systems and Feedstock Densifying and Handling Strategies to Improve Conversion of Accessibility Challenged Forest Biomass Resources

Description

This initiative will demonstrate modular gasification systems in forest/urban interface areas and generate critical field demonstration data needed for larger scale deployment and commercialization while addressing technological challenges such as integration of multiple units, feeding systems to handle larger volumes of feedstock, gaseous fuel quality improvements, and emissions and waste management.

The initiative will also advance methods and strategies needed to more efficiently and cost-effectively bring accessibility-challenged but abundant woody biomass feedstock to power generation facilities. Anticipated projects will demonstrate innovative systems, such as densification and torrefaction, that reduce biomass volume, improve energy density, and could involve partial conversion onsite. (Torrefaction involves mild pyrolysis, or heating at about 200 to 320 ° C in the absence of oxygen, resulting to coal-like material with better fuel characteristics than the original biomass). Other biomass collection approaches such as a centralized biomass collection and distribution stations could also help the economics of bioenergy facilities.

S4.4 Improve the Value Proposition of Bioenergy

Initiative 4.4.2

Demonstrating Modular Bioenergy Systems and Feedstock Densifying and Handling Strategies to Improve Conversion of Accessibility Challenged Forest Biomass Resources

Impact if Successful

Wider adoption of community-scale biomass conversion systems using High-Hazard Zone (HHZ) feedstock is expected to result in reduced wildfire risk. This initiative is also expected to result in an overall reduction in waste feedstock transportation costs and better economics for bioenergy projects.

Primary Users and/or Beneficiaries

Ratepayers in rural and urban communities; bioenergy technology developers and investors; communities impacted by the tree mortality crisis, looking for community-scale solutions. IOUs dealing with tree mortality in their service territories; local air quality districts; California Air Resources Board; California Department of Forestry and Fire Protection; biomass industry groups; California Department of Resources Recycling and Recovery; Bioenergy Associations of California, independent power producers, and the U.S. Forest Service.

Metrics and Performance Indicators

Tons of forest biomass from HHZ converted

Megawatts of electricity

Power Purchase Agreements with IOUs

Reduction in costs compared with best available emission control technologies.

Measured reductions in air pollution compared to conventional emission control technologies.

Topic(s) addressed	Value Chain	Program Area(s)
Technical and Cost Advancements Modular Bioenergy Systems Flexible Generation Biomass densification, torrefaction, biomass collection	Generation	Applied Research and Development Technology Demonstration and Deployment

S4.4 Improve the Value Proposition of Bioenergy

Initiative 4.4.3

Demonstrate Improved Performance and Reduced Air Pollution Emissions of Biogas or Low Quality Biogas Power Generation Technologies

Description

At small scales, internal combustion engines have been the most reliable generation technology. However, the equipment needed to control air pollution emissions on these devices can be relatively expensive because cost does not scale down with system size. Other generation technologies, like microturbines and fuel cells, have lower emission profiles but are more costly and can be more complicated to operate. Research is needed to develop and test low-cost pollution controls for small generators and develop simple off-the shelf, low-emission generation technologies.

Furthermore, there is a need for technologies which can utilize low-quality biogas for bioenergy applications. Many sources of biogas, such as landfills and wastewater treatment plants, produce a "low-quality" gas whose energy content or contaminant levels make them challenging to use with conventional power generation equipment. For example biogas with high levels of hydrogen sulfide, also referred to as "sour gas," requires substantial pre- and post-combustion cleanup to meet local air quality standards. The capital and operating costs of the required equipment are often cost-prohibitive, stopping many potential projects before they even start.

Of the 181 California landfills identified with the potential to convert landfill gas to energy, only 25 are classified as "candidate" landfills that could be implemented cost effectively with today's technology due to scale or production of gas that cannot be used in conventional power generation equipment. There is a need to develop and demonstrate clean, fuel-flexible, and cost-effective technologies for converting low-quality biogas to electricity while meeting local air quality standards. Widespread deployment of these technologies would help California achieve its renewable energy goals, improve air quality, and encourage economic development in the waste management sector.

S4.4 Improve the Value Proposition of Bioenergy

Initiative 4.4.3

Demonstrate Improved Performance and Reduced Air Pollution Emissions of Biogas or Low Quality Biogas Power Generation Technologies

Impact if Successful

Improved air quality and likelihood of meeting or exceeding future air permitting requirements. Could lead to wider utilization of biogas that is otherwise emitted or flared.

Primary Users and/or Beneficiaries

Ratepayers in rural and urban communities, communities with waste management issues looking for community-scale solutions; IOUs required to procure bioenergy; industrial and commercial food processing facilities, dairy and agriculture facilities, and wastewater treatment facilities; California Department of Food and Agriculture; local air quality districts; California Air Resources Board; California Department of Forestry and Fire Protection; biomass industry groups; California Department of Resources Recycling and Recovery; waste management industry.

Metrics and Performance Indicators

- Reduction in costs compared with best available emission control technologies.
- Measured reductions in air pollution compared to conventional emission control technologies.
- Volume reduction in flared gas
- Volume of low quality biogas converted to electricity
- MW generated from biogas
- Use of onsite power or Power Purchase Agreements with IOUs.

Topic(s) addressed	Value Chain	Program Area(s)
Biomass gas collection Low-BTU gas technologies Emission controls	Generation	Technology Demonstration and Deployment

Theme 5: Create a Statewide Ecosystem for Incubating New Energy Innovations

S5.1 Shorten the Timeframe of New Energy Technologies from Idea to Investment

S5.2 Accelerate the Most Promising Energy Technologies from Prototype to Market Entry

S5.1 Shorten the Timeframe of New Energy Technologies from Idea to Investment

Initiative 5.1.1

Continue CalSEED Initiative to Provide Early Stage Support for Clean Energy Technology Entrepreneurs

Description

This initiative will build upon the CalSEED Initiative efforts established under the first two EPIC Investment Plans. The small-scale funding provided by the CalSEED Initiative gives entrepreneurs starting capital to develop their ideas into proof-of-concepts and early prototypes. This level of funding fills a crucial niche in the financing landscape for clean energy entrepreneurs as Venture Capital firms have decreased their level of investment at this level over the past several years. This initiative will allow the CalSEED Initiative to reach a greater number of entrepreneurs throughout California.

Impact if Successful

This initiative will enable clean energy technology entrepreneurs and startups to develop early stage ideas and concepts into proof of concept and prototype demonstrations. Innovations developed at this early stage can allow entrepreneurs to compete for follow-on funding from public or private sources to continue their technology development.

Primary Users and/or Beneficiaries

Clean energy entrepreneurs

Metrics and Performance Indicators

Increased diversity of clean energy entrepreneurs in California, number of technology developers able to increase the Technology Readiness Level of their innovations, number of new energy concepts successfully validated, increased amount of follow-on funding from public and private sector

Topic(s) addressed	Value Chain	Program Area(s)
Entrepreneur support	Grid Operations/Market Design Generation Transmission/Distribution Demand-side Management	Applied Research and Development

S5.1 Shorten the Timeframe of New Energy Technologies from Idea to Investment

Initiative 5.1.2

Expand Entrepreneurial Services from Innovation Clusters

Description

This initiative will expand the entrepreneurial support provided by the Regional Energy Innovation Clusters funded under the first two EPIC Investment Plans by expanding the suite of commercialization assistance and services available for clean energy entrepreneurs and startups. This expansion will include increased access to laboratory testing facilities, and increased mentorship on business development, commercialization, scale-up and intellectual property considerations. Together, these technical and non-technical resources create an ecosystem that fosters energy innovations at all Technology Readiness Levels. Additionally, while the existing Innovation Clusters are organized geographically, this initiative can create new Innovation Clusters focused on supporting specific technologies or market sectors.

Impact if Successful

Providing these services and bringing in these considerations early in the technology development process will help increase the sophistication of clean energy entrepreneurs. The result will be clean energy entrepreneurs that have a much more comprehensive pathway for deploying their innovations, thereby increasing their likelihood of success when they are ready to compete for larger amounts of public or private funding. More successful and sophisticated entrepreneurs will be better equipped to attract follow-on funding from multiple sources. This initiative will also help increase the quality of applicants that apply to public funding programs like EPIC.

Primary Users and/or Beneficiaries

Clean energy entrepreneurs, incubators, accelerators, national labs, universities, local economic development organizations

Metrics and Performance Indicators

Number of technology developers able to increase the Technology Readiness Level or Manufacturing Readiness Level of their innovations, increased amount of follow-on funding from public and private sector , shortened timeline for innovations to reach market, increased number of EPIC applicants that have used Innovation Cluster services.

Topic(s) addressed	Value Chain	Program Area(s)
Entrepreneur support	Grid Operations/Market Design Generation Transmission/Distribution Demand-side Management	Market Facilitation

S5.2 Accelerate the Most Promising Energy Technologies from Prototype to Market Entry

Initiative 5.2.1

Connect Clean Energy Entrepreneurs with Local California Manufacturing

Description

This initiative will leverage existing manufacturing infrastructure and provide clean energy entrepreneurs with access to high volume production technologies and expertise. Connecting energy entrepreneurs with advance manufacturers early in the technology development process to help shorten the time and cost required for hardware scale-up and deployment. Material selection, assembly processes, and other engineering and design considerations can have dramatic impacts on the performance, reliability, and safety of a technology. Local manufacturers can inform these practical design considerations and help address them early in the technology development process before costly redesigns are needed later in the process. This initiative will integrate with the efforts of the Regional Energy Innovation Clusters by leveraging their network of entrepreneurs, research institutions, and business development experts to inject manufacturing support where it can make the largest impact on an innovations development.

Impact if Successful

This initiative will lower commercialization risk for technology innovations and better prepare those innovations for manufacturing scale-up. Clean energy startups will be able to develop technology innovations that have an easier time integrating into existing manufacturing and supply-chain infrastructure. This will help those innovations achieve scale-up and wider deployment into the market.

Primary Users and/or Beneficiaries

Clean energy entrepreneurs, California based manufacturers

Metrics and Performance Indicators

Lowered time and cost for moving prototypes into production, increased amount of partnerships between clean energy entrepreneurs and local manufactures.

Topic(s) addressed	Value Chain	Program Area(s)
Entrepreneur Support Advanced Manufacturing	Grid Operations/Market Design Generation Transmission/Distribution Demand-side Management	Market Facilitation

S5.2 Accelerate the Most Promising Energy Technologies from Prototype to Market Entry

Initiative 5.2.2

Bringing Rapid Innovation Development to Green Energy (BRIDGE)

Description

This initiative will establish a new funding mechanism to provide crucially needed follow-on funding for the most promising innovations that come out of EPIC and APRA-e. This support will allow researchers to continue their technology development without losing momentum or pausing to fund raise from private sources. Even the most promising energy innovations typically require multiple rounds of funding to advance their technology to attract private sector interest and investment. Public research programs like EPIC and ARPA-e can provide this support, but significant amounts of time can pass between opportunities on any given area of energy research. At best, these gaps in funding can kill the momentum on a promising innovation and delay the advancement of that innovation; at worst these gaps can stop development on an innovation altogether allowing potential breakthroughs to die on the vine. This initiative will aid in avoiding these costly delays and accelerate the development of the most promising energy technologies that have the potential to have a significant impact in the market.

Impact if Successful

Clean energy technology innovators will have a smoother path through the innovation pipeline increasing their chances of successfully brining a technology to commercial market. This initiative will also help reduce delays faced by technology innovators that result from a lack of secure funding sources.

Primary Users and/or Beneficiaries

Energy researchers receiving EPIC or ARPA-e awards

Metrics and Performance Indicators

Number of EPIC or ARPA-e funded projects able to transition their innovations from an applied research stage to a demonstration stage

Topic(s) addressed	Value Chain	Program Area(s)
Entrepreneur support	Grid Operations/Market Design Generation Transmission/Distribution Demand-side Management	Applied Research and Development

Theme 6: Maximize Synergies in the Water-Energy-Food Nexus

S6.1 Reduce the Energy Intensity Required to Supply and Treat Water

S6.2 Increase the Energy and Water Efficiency of California's Food and Agricultural Sector

S6.3 Optimize Management Practices Associated with the Water-Energy Nexus

S6.1 Reduce the Energy Intensity Required to Supply and Treat Water

Initiative 6.1.1

Develop and Test Novel Energy Efficient Treatment Methods for Conventional and Non-conventional Sources of Water Supply

Description

This initiative will develop and test low energy water or wastewater treatment approaches for conventional and non-conventional water sources, such as brackish water from inland groundwater aquifers. The goal is to reduce energy use intensity for water treatment. Areas of emphasis could include:

- Optimize ultraviolet and ozone disinfection technologies, including ultraviolet light emitting diodes (UV LED) that address fouling reduction and low energy use
- System optimization of treatment plant and water distribution systems to balance energy optimization and operational flexibility including development of process controls, automation decision support tools and emote metering technologies for on-line efficiency improvement
- Advanced treatment systems to lower the energy use intensity needed to convert non-conventional water sources for community use, either as recycled water for non-potable applications, such as landscaping, or potable water production. These systems would consider the entire energy use of the treatment process (e.g, aeration, sedimentation and sludge processing and disposal, disinfection and chemical removal (e.g., ammonia)
- Evaluate and test low energy intensity desalination for brackish water, including advance membrane materials that have the potential of reducing energy consumption by at least 20 percent.

Impact if Successful

Will create ways to cost-effectively increase the efficiency of water treatment facilities, including those from non-conventional sources. An increased water supply will help with water demand related to population growth. Improved energy efficiency in conventional existing treatment process steps will lower costs and energy demand in a sector in which energy use has been growing.

Primary Users and/or Beneficiaries

Communities that are impacted by limited water resources due to drought, pollution, location or natural geology. Drinking water and wastewater treatment facilities

Metrics and Performance Indicators

Increased water yield, lower energy use compared to conventional approved treatment methods, and less waste for disposal.

Topic(s) addressed	Value Chain	Program Area(s)
Technical and Cost Advancements	Demand-side Management	Applied Research and Development

S6.1 Reduce the Energy Intensity Required to Supply and Treat Water

Initiative 6.1.2

Develop and Demonstrate Tools and Strategies to Help Water and Wastewater Agencies Lower Energy use, Increase Efficiency and Reduce the Carbon Intensity of its Operations

Description

Wastewater treatment plants use 200,000 MWh annually to treat and process wastewater. This initiative focuses on developing tools and strategies to help reduce the carbon intensity of water and wastewater agencies and then implementing the strategy in water and wastewater treatment plants in California. The demonstrations could include installation of advanced sensors, controls and monitoring equipment, and advanced energy efficiency technologies to allow for maximum de-carbonization that is economically feasible. The analysis will identify the resources and barriers to overcome that will be needed for full expansion into all wastewater and water treatment plants in California by facility size (such as million gallons per day of water treated). This initiative will also include measuring the energy benefits and cost savings, and greenhouse gas reductions associated with implementing water-energy saving technologies and could serve to benchmark the energy use of water and waste water related treatment processes and equipment.

Impact if Successful

Operators of water and wastewater facilities can prioritize future capital expenditures and determine which operations have the most potential for energy efficiency upgrades and take appropriate action in order to meet future state greenhouse gas reduction goal targets. The demonstrations will provide information to other water/wastewater facilities on what they can do in their facilities.

Primary Users and/or Beneficiaries

Water and Wastewater treatment facilities

Metrics and Performance Indicators

Reduced energy costs, reduced greenhouse gas emissions, number of water and wastewater treatment plants using the tool and making changes to their facility operations.

Topic(s) addressed	Value Chain	Program Area(s)
Technical and Cost Advancements	Demand-side Management	Applied Research and Development Technology Demonstrations and Deployment

S6.1 Reduce the Energy Intensity Required to Supply and Treat Water

Initiative 6.1.3

Develop and Demonstrate Advanced Energy Efficiency Improvements to Allow for On-site Wastewater Treatment for Industrial Facilities and Reuse for Water Intensive Industries

Description

Water intensive industries, such as refineries, beverage companies, industrial scale laundries, pharmaceuticals and paper/pulp mills are major energy and water users. The water, which contains contaminants, is generally disposed into the sewer system.

This initiative will focus on developing and demonstrating advanced, low energy treatment processes to allow for direct on-site reuse of the water, either for process or non-process purposes. The demonstrations will identify compatibility of low energy treatment processes and ability for retrofit into existing systems, capital and operating costs. The technologies must have the potential for high water reclamation relative to the amount of water to be treated and be at least 20 percent more efficient than current standard processes.

Impact if Successful.

Energy use and costs will be reduced and water will be conserved. Ability to reuse water on-site, reduces energy associated with transport, conveyance and treatment.

Primary Users and/or Beneficiaries

Various high water consuming industrial manufacturing facilities

Metrics and Performance Indicators

Reduced water consumption, energy savings, energy cost reduction, adoption by other water intensive industries.

Topic(s) addressed	Value Chain	Program Area(s)
Lower energy intensity of Process water used in manufacturing	Demand-side Management	Applied Research and Development Technology Demonstration and Deployment

S6.2 Increase the Energy and Water Efficiency of California's Food and Agricultural Sector

Initiative 6.2.1

Demonstrate Advanced Water and/or Energy Efficiency Technologies to Reduce Carbon Intensity of Agriculture

Description

The major challenges facing the agriculture industry is the availability of reasonably priced water and keeping energy costs low. As agriculture uses about 80 percent of the state's fresh water supply, technologies and strategies are needed to help growers and farm operators manage their water use and keep energy costs low. This initiative will demonstrate advanced technologies to reduce energy and water use in varying regions and crop types. Examples of technologies to be demonstrated could include those that use deficit irrigation, precision agriculture and ultra-efficient drip irrigation systems with high distribution uniformity. Demonstrated technologies will be independently monitored for energy and water savings and crop yield (e.g., yield/volume of water used) over several seasons.

Impact if Successful

Increase probability of the agricultural sector implementing demonstrated technologies if verified performance data is available.

Primary Users and/or Beneficiaries

California's agricultural and food processing sector

Metrics and/or Performance Indicators

Reduced on-site energy/water use, improved productivity, reduced wastewater discharge

Topic(s) addressed	Value Chain	Program Area(s)
Energy and/or Water Efficiency	Demand-side Management	Technology Demonstration and Deployment

S6.2 Increase the Energy and Water Efficiency of California's Food and Agricultural Sector

Initiative 6.2.2

Demonstrate Advanced Water and/or Energy Efficiency Technologies to Reduce Carbon Intensity of Food Processing Operations

Description

The food processing industry is faced with the many challenges. Foremost among those challenges are wastewater and waste management, thermal management, regulatory burdens and high operating costs. This industry is also very risk adverse. As a result, new technologies must be demonstrated over multiple seasons to show actual benefits and cost effectiveness, typically with a simple payback of less than 5 years. This industry is also very concerned about the future environmental challenges associated with the need and cost to reduce greenhouse gas and decarbonize. This initiative will demonstrate technologies with potential for cost effectiveness that will not impact their business operations or product quality while addressing the best opportunities to reduce carbon intensity of their operations. For each technology to be demonstrated, the team must include a food processing facility and an equipment manufacture that has the potential to make the technology production ready, if successful. Advanced technologies to be demonstrated can include:

- Process efficiency improvements that can include advanced motors and pumps and compressed air system improvements
- Advanced energy management controls for fault detection and diagnostics, and control and monitoring of motors, pumps and compressed air systems for optimal efficiency
- Refrigeration systems, including those using alternative refrigerants that are low global warming and low greenhouse gas emitting
- Advanced on-site water/wastewater systems including novel treatment systems to allow for on-site reuse
- Implementation of opportunities to cost-effectively decarbonize including waste heat recovery, onsite generation using renewable energy sources

Impact if Successful

Increase the probability of the food processing sector implementing demonstrated technologies if verified innovative solutions with verified performance data is available

Primary Users and/or Beneficiaries

California's food processing sector

Metrics and/or Performance Indicators

Reduced on-site energy/water use, improved productivity, reduced wastewater discharge

Topic(s) addressed	Value Chain	Program Area(s)
Energy and/or Water Efficiency	Demand-side Management	Technology Demonstration and Deployment

S6.3 Optimize Management Practices Associated with the Water-Energy Nexus

Initiative 6.3.1

Conjunctive Management for Improved Energy Resilience

Description

Conjunctive management in the water sector has traditionally meant combined management of groundwater and surface water resources. This initiative intends to harness the water-energy nexus to ensure reliable and clean water supply for multiple needs including electricity generation. This may include site-specific studies related to using pumped storage in combination with groundwater recharge and improving actual use of technologies and practices to secure groundwater and recycled water supply for electricity generation. This is especially important as proposals gain traction to use aquifers as reservoirs to replace the loss of snowpack in the Sierra, California's traditionally greatest natural reservoir.

Impact if Successful

Could ensure that policies and practices related to groundwater pumping, recharge, and management are tied to the needs and goals of the electricity sector. Could aid in securing water supplies for the electricity sectors while harmonizing with the needs of specific communities. Could avoid emissions associated with groundwater pumping.

Primary Users and/or Beneficiaries

Primary beneficiaries include ratepayers, businesses, and industry who rely on clean groundwater as an input for energy generation. Primary users would be all of the above plus utilities and private entities involved with water and energy systems.

Metrics and Performance Indicators

Use of research results by local government involved with conjunctive management and by utilities.

Topic(s) addressed	Value Chain	Program Area(s)
Groundwater and Energy	Generation	Applied Research and Development

S6.3 Optimize Management Practices Associated with the Water-Energy Nexus

Initiative 6.3.2

Develop Tools for Reducing Vulnerability to Hazards, Interconnected Infrastructure Risk, and Climate Impacts through Collaboration of Water and Energy Sectors

Description

This initiative addresses the growing need to respond to risks of systemic failure through interdependencies across water and energy systems, as expressed by the CPUC in its 2016 Annual Safety En Banc. This initiative builds off of ongoing work in Southern California for the state's Fourth Climate Assessment (e.g, EPC 15-080 and EPC 15-005). For example, as presented at the 2016 Annual Safety En Banc, in 2003 rolling electricity blackouts in the Northeastern United States led to raw sewage overflows in New York, and unavailability of potable water. During the same blackout communications between electricity providers and safety officials "failed due to lack of adequate capacity and back up power."*

Because risks vary by geography, tools to prevent and respond to risks may rely on methods developed in earlier studies, but will need to be tailored to the assets and challenges of sub-regions within California, while being cognizant of interconnected risks originating from more distant locations. As a precondition to develop these tools it may be necessary for studies in this area to conduct original research to delineate and respond to barriers to effective communication and management between the water and energy systems. As noted in the California Public Utilities Commission's "Key Takeaways from 2016 Safety En Banc":

> "All interconnected critical infrastructures [including energy and water] have one thing in common: human beings, interacting with each other within their organizations, with other organizations, and with technology. . . . 'Human error' should not be viewed as a way of ending inquiry . . . but as an opportunity to engineer the environment in which people work to reduce the impact of human factors." (CPUC 2016)

Tools may include decision-support systems, models, and innovative methodologies for engagement between water and energy systems. Tools may also include methods to integrate hydropower management across multiple river basins and tools to improve upon and create new decision-support systems to coordinate hydropower operation to meet energy, flood control, and environmental goals.

* California Public Utilities Commission, Case Study, 2016 Safety En Banc.
http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Safety/2016%20Safety%20En%20Banc%20Case%20Study.pdf

S6.3 Optimize Management Practices Associated with the Water-Energy Nexus

Initiative 6.3.2

Develop Tools for Reducing Vulnerability to Hazards, Interconnected Infrastructure Risk, and Climate Impacts through Collaboration of Water and Energy Sectors

Impact if Successful

Could ensure that California's electricity utilities and CAISO are able to avoid costs associated with systemic failure and interrupted services. Furthermore, to the extent that hydropower is addressed, could avoid financial and environmental costs related to shorter hydropower generation seasons and increased infrastructure risk related to high variability of extreme dry and wet years. May also ameliorate some of the aquatic habitat degradation related to traditional management—especially of hydropower generation—and exacerbated by climate impacts.

Primary Users and/or Beneficiaries

Primary beneficiaries would be ratepayers, businesses, and industry who rely on resilient electricity services. Primary users would be electric utilities as well as water sector planners, and risk managers in the water and energy sectors.

Metrics and Performance Indicators

Successful collaboration with IOUs and/or other electricity sector stakeholders (particularly populations vulnerable to impacts of climate change) in the research process.

Topic(s) addressed	Value Chain	Program Area(s)
Electricity Sector Resilience: Scientific Basis	Generation	Applied Research and Development

Theme 7: Develop Tools and Analysis to Inform Energy Policy and Planning Decisions

S7.1 Identify Pathways for Achieving California's Energy and Climate Goals

S7.2 Increase the Resiliency of the Electricity System to Climate Change and Extreme Weather Events

S7.3 Evaluate Strategies to Understand and Mitigate Impacts of the Electricity System on the Environment and Public Health and Safety

S7.1 Identify Pathways for Achieving California's Energy and Climate Goals

Initiative 7.1.1

Integrated Pathways for Energy Futures: Tools and Science-Based Research for Holistic Energy Decision Making

Description

This research will examine and model promising energy technologies to prioritize their potential contributions to deep GHG emissions. This work will be coordinated other proposed initiatives to properly consider effects of climate change and the interactions between the water and energy sectors.

Most of the existing energy models for California are statewide models that simulate California as one block. For this reason, this research includes in-depth integrated and holistic analyses of urban areas and regional studies to allow more detailed consideration of factors, such as geographical distribution of demand and local resources. Urban and regional studies are more likely to accomplish this resolution than large statewide studies.

The long-term energy scenarios must investigate equity issues, such as the potential costs and the benefits of electrification for disadvantaged and low income communities, because the electrification of energy services (e.g., electric cars and trucks) can result in drastic reduction of ambient air pollutants such as particular matter and oxides of nitrogen. The final outcome may have the ancillary benefit of achieving national ambient air quality standards in the San Joaquin and Los Angeles air basins.

This effort must be informed by the Integrated Resource Plans that IOUs are preparing. Additionally, since these plans only reflect what may happen in the next decade, this effort will examine a long-term perspective to 2030 and 2050.

S7.1 Identify Pathways for Achieving California's Energy and Climate Goals

Initiative 7.1.1

Integrated Pathways for Energy Futures: Tools and Science-Based Research for Holistic Energy Decision Making

Impact if Successful

This initiative brings together technological and scientific advancements, as well as external factors, and integrates them into a cohesive whole. In doing so, this research will provide results and insights about technology choices, and potentially inform regulatory and policy proceedings that can help California effectively achieve long-term system decarbonization goals.

Primary Users and/or Beneficiaries

Policy makers, IOUs, and the public in general.

Metrics and/or Performance Indicators

Research findings that are adopted formally or informally by energy agencies and/or IOUs.

Publications in peer-reviewed journals.

Adoption of models or their derivatives in models used for formal regulatory and/or policy deliberations.

Topic(s) addressed	Value Chain	Program Area(s)
Energy Modeling	Generation Transmission Distribution Demand-Side Management	Applied Research and Development

S7.1 Identify Pathways for Achieving California's Energy and Climate Goals

Initiative 7.1.2

Applied Social Science to Inform Technology Development and Adoption for Deep Decarbonization of the Energy System

Description

Technology solutions are incomplete if users do not adopt them or do not use them effectively (e.g., negating technology energy efficiency gains with contra productive behavior). Energy modeling assumes consumer adoption of the "best" technologies evaluated in technical terms that do not account for diverse consumer preferences.

Research under this subtheme will also target behavioral research and/or some level of behavioral components to facilitate the penetration of technically, environmentally, and economically sound demand response measures and energy efficiency programs. This research will be implemented by interdisciplinary teams to minimize the problem of not considering the new advances in economics and social sciences in technology development and deployment.

Impact if Successful

The findings would enable widescale, rapid, and cost-effective deployment of clean energy technologies and aid in the design of energy policies taking human behavior into account.

Primary Users and/or Beneficiaries

Policymakers, energy agencies, and IOUs.

Metrics and Performance Indicators

- Number of publications in scientific and policy journals.
- Number of findings that are incorporated in energy models.
- Number of findings that are directly or indirectly considered in regulatory and/or policy documents.

Topic(s) addressed	Value Chain	Program Area(s)
Applied social science research to improve the numerical modeling of the energy system.	Generation Demand-Side Management	Applied Research and Development

S7.2 Increase the Resiliency of the Electricity System to Climate Change and Extreme Weather Events

Initiative 7.2.1	**Assess Climate- and Weather-Related Risks to California's Electricity System and Develop Resilience Options to Inform Operations and Infrastructure-Related Decisions in California's Electricity Sector**
	Description Over the past two EPIC funding cycles as well as IEPR and *Safeguarding California* processes, the Energy Commission's engagement of utilities and CAISO in the research process has strengthened appreciably. This area will build planned projections that shed light on parameters of interest (e.g., coastal fog, cloud cover) to California's electricity system and for which the scientific basis was previously not available, as well as on development of probabilistic projections (ongoing) that can provide a basis for better seasonal and decadal planning. This area would also consider development of probabilistic forecasts for additional parameters (e.g., short-term precipitation forecasting) that could improve electricity sector operations (e.g., hydropower management). Research in this area will be closely coordinated with IOUs and CAISO to illuminate climate-related risk (including projections of additional or poorly understood parameters if necessary), potential impacts, and resilience options for the electricity sector and ultimately clarify the implications of new projections on operations and infrastructure. Given that California's electricity system already must contend with many weather-related challenges, this area of investment will seek to produce "win-win" strategies, which offer benefits under current and highly variable climatic conditions as well as those anticipated in the future. Development of win-win strategies will be supported by analysis of projected as well as recent historical data.

S7.2 Increase the Resiliency of the Electricity System to Climate Change and Extreme Weather Events

Initiative 7.2.1

Assess Climate- and Weather-Related Risks to California's Electricity System and Develop Resilience Options to Inform Operations and Infrastructure-Related Decisions in California's Electricity Sector

Impact if Successful

Could lead to integration of projected climate relevant parameters into all aspects of electricity sector planning, operations, and infrastructure investment; as well as identification of risks specific to disadvantaged communities as a starting point for developing solutions. Could ensure that California's electricity utilities and CAISO anticipate and are able to prepare for climate change with sufficient lead time that they are able to find ways to implement sound, cost-effective, practical resilience strategies. Will enable integration of a cross-sectoral, multi-regional portfolio research for California's Fifth Climate Change Assessment; this integration is only possible if studies use consistent scenarios.

Primary Users and/or Beneficiaries

Primary beneficiaries would be ratepayers, businesses, and industry who rely on resilient electricity services. Primary users include the utilities and CAISO.

Metrics and/or Performance Indicators

- Development of projected climate parameters requested by IOUs, CPUC, CAISO
- Use of projected climate scenarios and weather-related parameters by IOUs, CPUC, and other energy sector stakeholders
- Use of projected climate scenarios and weather-related parameters by state agencies involved with energy sector planning (e.g., demand forecast) and regulation (e.g., siting)
- Use of projected climate scenarios and weather-related parameters to promote climate resilience in disadvantaged communities
- Investigation of issues of importance to IOUs, CAISO, and disadvantaged communities
- Use of vulnerability assessments and/or resilience options by IOUs and/or CAISO
- Use of vulnerability assessments and/or resilience options by state agencies involved with energy sector planning (e.g., demand forecast) and regulation (e.g., siting)
- Use of vulnerability assessments and/or resilience options promote climate resilience in disadvantaged communities
- Successful collaboration with IOUs and/or other electricity sector stakeholders (particularly populations vulnerable to impacts of climate change) in the research process

Topic(s) addressed	Value Chain	Program Area(s)
High-Resolution Climate Projections for the Electricity Sector	Grid operations/market design, Generation, Transmission, Distribution	Applied Research and Development

S7.2 Increase the Resiliency of the Electricity System to Climate Change and Extreme Weather Events

Initiative 7.2.2

Clarify Interactions Between Renewable Electricity Systems and Climate Change to Ensure an Effective, Resilient Transition to Low-Carbon Energy in California

Description

To date, research on risks and resilience options for the electricity sector has focused primarily on existing systems and infrastructure. However, California's electricity system is undergoing rapid evolution, including ambitious and accelerating shift to renewable energy. This transition to a low-carbon grid must—if it is to be effective and resilient—anticipate and incorporate challenges and opportunities presented by a changing climate. Research in this area will clarify how climate change might affect renewable energy systems as well as how integrate these impacts into design, deployment, and operations. For example, wind resources are determined by atmospheric conditions that are in turn affected by climate change, which may have substantial impacts on the suitability of a given location for wind generation. California must anticipate climate-related changes to the availability and distribution of wind, solar, and biomass resources to ensure appropriate long-term investments in low-carbon energy systems. Research in sub-topic 7.1, "Identify Optimal Pathways for Achieving California's Energy and Climate Goals", will consider from a holistic perspective how to integrate these changes system-wide.

Impact if Successful

Could ensure that policies, planning, and operations related to renewable energy account for the adaptation imperative, such that this mitigation strategy is truly coherent with—and successful in—a changing climate.

Primary Users and/or Beneficiaries

Primary beneficiaries include developers of long-term energy scenarios as well as those who use such scenarios to inform energy policy in California, ratepayers, businesses, and industry, all of whom rely on cost-effectively meeting California's Renewable Portfolio Standard while maintaining reliable electricity services.

Metrics and Performance Indicators

- Use of research results by state agencies involved with energy sector planning and regulation
- Use of research results to identify and implement climate resilient strategies on the path to California's energy goals (e.g., RPS, Scoping Plan)
- Successful collaboration with IOUs and/or other electricity sector stakeholders in the research process

Topic(s) addressed	Value Chain	Program Area(s)
Climate-Ready Low-Carbon Grid	Generation	Applied Research and Development

S7.2 Increase the Resiliency of the Electricity System to Climate Change and Extreme Weather Events

Initiative 7.2.3

Advance Climate Readiness into Electricity System Operations and Ratepayer Readiness

Description

Integrating climate readiness into every aspect of the electricity system will require an additional layer of research to provide tools that feed directly into management, strategies for overcoming barriers to adaptation actions, and a clear understanding of the electricity sector's interconnectedness with other critical systems. This initiative will help adaptation planners to overcome legal, institutional, and other non-technical barriers as well as incorporate a clear understanding of the electricity system's interconnectedness with other areas (e.g., emergency response, public health) crucial to the state's overall readiness. Limited efforts in these areas are ongoing and will contribute to the basis for understanding non-technical barriers and interconnectedness throughout IOU territories. Another key element of this research area will build on the platform provided by Cal-Adapt to expand it with additional, operations-oriented tools that draw on research results from ongoing and planned EPIC-funded studies, including provision of probabilistic climate change projections at seasonal and decadal scales.

Impact if Successful

Could enable integration of best available scientific research on climate change into routine electricity sector planning, operations, and management

Could enable integration of best available scientific research on climate change into electricity sector efforts to build climate readiness

Could save ratepayer dollars by leveraging state-funded research to provide for IOUs needs, thereby avoiding unnecessary duplication of research or use of lesser-quality information

Primary Users and/or Beneficiaries

Primary beneficiaries would be ratepayers, businesses, and industry who rely on resilient and affordable electricity services. Primary users would be all of the above plus utilities and CAISO.

Metrics and Performance Indicators

Successful collaboration with IOUs and/or other electricity sector stakeholders (particularly populations vulnerable to impacts of climate change) in the research process

Topic(s) addressed	Value Chain	Program Area(s)
Electricity Sector Resilience: Tools	Grid operations/Market Design Generation Transmission Distribution	Applied Research and Development

S7.3 Evaluate Strategies to Understand and Mitigate Impacts of the Electricity System on the Environment and Public Health and Safety

Initiative 7.3.1

Find Environmental and Land Use Solutions to Facilitate the Transition to a Decarbonized Electricity System

Description

This initiative will fund research to find solutions to potential environmental barriers to deployment of renewable energy such as the costs to developers (and ultimately to ratepayers) of long permitting delays and post-construction monitoring and mitigation. The evolution of clean energy technologies, expansion into new energy resource areas, and climate change are likely to reveal knowledge gaps that will be a major focus of this initiative. Research topics will investigate risks to sensitive species and habitats from their interactions with energy facilities, and particularly to discover the mechanisms involved so that effective solutions can be developed. For example, as interest grows in developing offshore wind on California's Outer Continental Shelf, this initiative may conduct marine environmental research to assist the development, planning, and permitting of emerging wind and wave energy generation in response to the needs of the California Intergovernmental Renewable Energy Task Force. Specific topics of interest might include distribution and risk to marine mammals, birds and bats, and atmospheric and oceanic effects of large-scale offshore wind development (e.g., coastal fog and waves). In some cases, the search for mechanisms may require looking beyond conventional single-species studies to determine how renewable energy facilities influence complex ecosystem interactions on which species depend.

This initiative will also develop innovative avoidance, impact minimization, or compensatory mitigation tools or strategies for sensitive species known or discovered to be at greatest risk from renewable energy development or with the greatest opportunity to reduce energy costs. For example, novel deterrence systems may be developed and evaluated to reduce wildlife fatalities at renewable energy facilities. Some tools or strategies may have already been proven in initial prototype studies but need support to be advanced toward a commercial readiness level or further developed for widespread use beyond the case study site. As renewable energy generation encroaches on farmland, planners and developers face resistance about changing traditional land uses. The initiative may explore opportunities for co-uses of and co-benefits from the land, including ecosystem services as ways to increase the compatibility and public acceptance of renewable energy development.

S7.3 Evaluate Strategies to Understand and Mitigate Impacts of the Electricity System on the Environment and Public Health and Safety

Initiative 7.3.1

Find Environmental and Land Use Solutions to Facilitate the Transition to a Decarbonized Electricity System

Impact if Successful

This initiative could support the achievement of the state's energy and GHG reduction goals in several ways. First, the initiative could provide timely, best available science about potential impacts of renewables on species and habitats in support of landscape-level planning in new regions. Second, permitting is expected to become more expedited if proven mitigation methods are available to minimize impacts. Research may also determine which potential risks are actually insignificant and can be "retired" from further consideration in permitting, monitoring, and mitigation, thereby reducing soft costs and developer uncertainty. Those changes could be sufficient to make additional energy resource areas commercially viable. Some R&D mitigation tools have the potential to become commercially successful, creating California jobs and economic benefits.

Primary Users and/or Beneficiaries

The primary direct users of the research findings would be permitting and regulatory agencies. This would also benefit energy developers with greater certainty and assistance in siting projects and other stakeholders such as environmental groups. Developers of mitigation tools may also benefit from proving their concepts or advancing them toward commercialization that in some cases could have global markets.

Metrics and/or Performance Indicators

User adoption of market-ready decision support tools that were previously prototyped (e.g., DG Environmental Planner, Desert Tortoise Spatial Decision Support System)

User adoption of market-ready mitigation technologies that were previously prototyped (e.g., bat impact deterrent system)

Topics addressed	Value Chain	Program Area(s)
Improve understanding of the risks from interactions between energy facilities and species and their habitats Develop or advance tools and strategies to avoid, minimize, or compensate for impacts	Generation Transmission Distribution	Applied Research and Development Market Facilitation

S7.3 Evaluate Strategies to Understand and Mitigate Impacts of the Electricity System on the Environment and Public Health and Safety

Initiative 7.3.2

Enhance Human Health and Safety Associated with the Electricity Sector

Description

The forthcoming public health research roadmap, being developed with support from the first investment plan, will identify research priorities for this initiative. This initiative will fund research to support studies of human exposure to emerging energy-related health threats (such as indoor pollutants), quantification of the risks, and where significant, of finding solutions to reduce risks to an acceptable level. Research topics include identifying and addressing public health concerns associated with indoor air quality and advances in smart ventilation to reduce health risks. Some technologies to improve indoor air quality (e.g., smart ventilation and measurement technology) that have been proven in pilot stages may be ready for further advancement of their technology readiness.

Research will quantify risks associated with emerging electricity sector technologies, emphasizing health risks in environmental justice/disadvantaged communities. Approaches will be developed to reduce these risks. These may include potential public health hazards associated with fast ramping from black start and human health and safety risks from new electrical devices and how to reduce any risks.

Research topics will also investigate potential health and safety benefits of energy strategies. For example, the initiative may produce tools to strategically site energy storage to reduce air pollution and associated health risks generated by fossil fuel peaker power plants, particularly in disadvantaged communities. Energy performance and indoor air quality of passive (using ambient energy sources such as daylighting, natural ventilation, and solar energy) versus active (using purchased energy such as HVAC and electric lights) ZNE building designs may be compared. This initiative could also evaluate how energy efficiency technologies and standards would affect indoor environmental quality benefits (or disbenefits) and human well-being.

A third area of potential research in this topic would be to develop training and equipment to reduce risks for workers, such as for fire and code officials and inspectors to safely and effectively respond to incidents involving the emerging electricity system, e.g., solar power energy systems, storage, microgrids.

S7.3 Evaluate Strategies to Understand and Mitigate Impacts of the Electricity System on the Environment and Public Health and Safety

Initiative 7.3.2

Enhance Human Health and Safety Associated with the Electricity Sector

Impact if Successful

This initiative will identify and quantify health risks before they become public health crises. Some mitigation tools could become commercially successful. Quantifying indoor environmental quality benefits associated with ZNE retrofits for existing buildings could motivate more rapid adoption of the efficiency technologies by the owners. The initiative may also create a better-trained and equipped workforce that would be less susceptible to illness or injury.

Primary Users and/or Beneficiaries

The primary direct users of the research findings would be the building standards office of the Energy Commission, the CPUC, and the California Department of Public Health. It would also benefit disadvantaged communities. Developers of mitigation tools may also benefit from proving their concepts or advancing them toward commercialization.

Metrics and Performance Indicators

- Projections of improvements in Disability Adjusted Life Years (DALYs) linked to clean generation, storage, etc.
- Reduction in exposure to pollutants linked to health conditions from conventional technologies
- Decrease rate of injuries from safety incidents involving clean energy technologies

Topic(s) addressed	Value Chain	Program Area(s)
Indoor air quality and public health	Generation	Applied Research and Development
Public health and safety	Distribution	Market Facilitation
	Demand-Side Management	

S7.3 Evaluate Strategies to Understand and Mitigate Impacts of the Electricity System on the Environment and Public Health and Safety

Initiative 7.3.3

Improve Overall Environmental Performance in the Entire Supply Chain for the Electricity System

Description

This initiative will focus on finding substitute materials or processes (e.g., extracting natural resources to make devices and final disposal methods) that have the great potential to reduce emissions of global warming pollutants or other environmental impacts of energy technologies. For example, the initiative may fund research to search for substitutes for materials with high global warming potential, toxic chemicals that have less significant environmental impacts than conventional materials such as aluminum foil used in lithium ion batteries. Improved recycling or reuse methods may be developed and tested with smaller environmental impacts, e.g., to recycle toxic by-products, such as from polysilicon production for PV panels, or to reuse materials from damaged energy storage systems. Projects may assess the life-cycle environmental impacts of additional emerging energy technologies for efficiency, generation, storage, and transmission, such as disposal and recycling options, particularly for PV panels and batteries. Additionally, the initiative may investigate behavioral dimensions such as adoption rates, use patterns, rebound effects, and context of adoption.

Impact if Successful

This initiative could help reduce California's GHG emissions while also reducing other environmental burdens and their impacts associated with the materials used in energy technologies or the industrial processes used throughout their life cycles, especially disposal or retirement. If these potential solutions can be made cost-effective, they could become marketable here and elsewhere or open up new value propositions.

Primary Users and/or Beneficiaries

The state could benefit by having additional pathways to reduce GHG emissions. Ratepayers would all benefit from a healthier environment. Entrepreneurs may benefit from new market opportunities for less toxic materials or for technology disposal processes.

Metrics and Performance Indicators

Commonly used life cycle impact categories such as: global warming, stratospheric ozone depletion, acidification, eutrophication, photochemical smog, terrestrial toxicity, aquatic toxicity, human health, resource depletion, land use, and water use

Topic(s) addressed	Value Chain	Program Area(s)
Environmentally-friendly materials	Generation	Applied Research and Development
Environmentally-friendly disposal options	Transmission	Market Facilitation
	Distribution	
	Demand-side Management	
	Grid Operations	

Theme 8: Catalyze Clean Energy Investment in California's Disadvantaged Communities

S8.1 Inform Policy Efforts to Bring Low-Carbon Energy Solutions and Their Benefits to Low-Income Customers and Disadvantaged Communities

S8.2 Demonstrate Emerging Clean Energy Technology Solutions in Disadvantaged Communities

S8.3 Develop Innovative Strategies to Increase Clean Energy Investment in Disadvantaged Communities

S8.1 Inform Policy Efforts to Bring Low-Carbon Energy Solutions and Their Benefits to Low-Income Customers and Disadvantaged Communities

Initiative 8.1.1

Advancing the Information Infrastructure for California's Low-income and Disadvantaged Communities

Description

The overarching challenge to bringing clean energy to low-income and disadvantaged communities is the lack of information on energy-usage in these communities and the tools to analyze market gaps. This lack of information limits decision makers' understanding of how to advance technology development in low-income and disadvantaged community markets. To help these markets take advantage of the benefits of clean energy technologies, greater investment is needed to create the information infrastructure for this market to thrive.

This initiative will support continued public data and information collection as well as increase the state's analytical capacity to determine the most pressing market gaps for clean energy in low-income and disadvantaged communities.

Greater analytic capacity is needed to assess typical energy-use patterns, utility costs, and the quality of life for communities with and without clean energy community measures, and determine what non-energy benefits clean energy technology packages can provide. The analysis from this initiative will drive the value proposition of clean energy design packages for low-income and disadvantaged communities.

To ensure optimal replicability for clean energy technology packages, this initiative will explore the different typologies of disadvantaged or low-income communities. Greater understanding of low-income and disadvantaged community clean energy markets and the benefits of optimized clean energy technology packages will equip decision makers to develop market rules, incentives and regulatory policies that recognize the true societal benefit of deploying clean energy technologies in low-income and disadvantaged communities.

S8.1 Inform Policy Efforts to Bring Low-Carbon Energy Solutions and Their Benefits to Low-Income Customers and Disadvantaged Communities

Initiative 8.1.1

Advancing the Information Infrastructure for California's Low-income and Disadvantaged Communities

Impact if Successful

Decision makers at the local, regional and state levels will understand the energy market needs of low-income and disadvantaged communities. Energy data collection, policy research, and economic analysis will support a more strategic intervention into these markets, potentially supporting the prioritization of buildings, technologies, or neighborhoods, ensuring resources are channeled towards areas most in need.

Primary Users and/or Beneficiaries

Policy makers at local, regional, and state levels, property owners, developers, community organizations, financiers, clean energy community project designers, residents

Metrics and/or Performance Indicators

Increased policies targeting low-income and disadvantaged community adoption of clean energy community measures.

Topic(s) addressed	Value Chain	Program Area(s)
Clean energy community Solutions Low-Income Communities Disadvantaged Communities	Demand-Side Management	Applied Research and Development Market Facilitation

S8.2 Demonstrate Emerging Clean Energy Technology Solutions in Disadvantaged Communities

Initiative 8.2.1

Scaling ZNE and Building California's Resilient Neighborhoods in Low-income and Disadvantaged Communities

Description

One of the largest hurdles for expanding clean energy in low-income and disadvantaged communities is the lack of examples of successful clean energy demonstrations to serve as models for would-be adopters. Without completed, replicable clean energy projects for evaluation, California building owners, local governments, community organizations, and other decision makers in low-income and disadvantaged communities are not likely to invest in scaling clean energy demonstrations. Insufficient means to design, finance, and implement clean energy technologies, especially for retrofitting projects or community-scale projects, further impedes wide-spread customer adoption in these communities. With needs and designs varying from building to building and neighborhood to neighborhood, creating replicable designs will require a larger portfolio of completed projects in these markets, building on previous and ongoing EPIC deployments, to attract potential, future investors, or other flows of capital.

This initiative will demonstrate flexible and adaptive ZNE, or near ZNE, design packages in low-income and disadvantaged communities that include energy efficiency, renewable energy, demand response, and energy storage applications.

Demonstrations will include clean energy retrofits design packages with low upfront costs, proven track records, and guarantees for financial performance. Demonstrations will also further develop affordable solar and storage models for critical facilities and community spaces, and address the needs of urban, rural, multi-family, manufactured home communities, and other community typologies across California.

S8.2 Demonstrate Emerging Clean Energy Technology Solutions in Disadvantaged Communities

Initiative 8.2.1

Scaling ZNE and Building California's Resilient Neighborhoods in Low-income and Disadvantaged Communities

Impact if Successful

The optimization of ZNE, or near ZNE, clean energy design packages for low-income and disadvantaged communities will accelerate the adoption of clean energy technologies in these markets. The best practices produced under this initiative will help lower the uncertainty surrounding clean energy adoption, as will introducing what are likely new, and often unfamiliar, technologies to a local community through visible demonstration sites. This initiative will help de-risk the low-income and disadvantaged community clean energy market for would-be investors.

Primary Users and/or Beneficiaries

Community residents, community organizations, local governments, California utilities, manufactured home owners and producers, developers, and financiers.

Metrics and/or Performance Indicators

Number of identified ZNE, or near ZNE, clean energy design packages determined to be optimal for low-income and disadvantaged communities at the building and community scales.

Topic(s) addressed	Value Chain	Program Area(s)
Energy Efficiency Retrofits Disadvantaged Communities Low –Income Communities Zero Net Energy Near Zero Net Energy Clean Energy Financing Low-Income Communities Manufactured Home Communities	Demand-Side Management	Technology Demonstration and Deployment

S8.3 Develop Innovative Strategies to Increase Clean Energy Investment in Disadvantaged Communities

Initiative 8.3.1

The Inclusive Development through Equitable Adoption (IDEA) Challenge

Description

Driving California's clean energy economy will require innovative solutions to the financial barriers burdening low-income and disadvantaged communities. While California is at the forefront of the clean energy revolution, the immature clean energy markets for low-income and disadvantaged communities raise a host of financing concerns that must be de-risked in order to bring in capital. Conventional financing is not well suited, or often even available, for clean energy projects in low-income and disadvantaged communities. Credit underwriting, repayment assurance, demonstrated track records and portfolios, guarantees for financial performance, and even follow-on maintenance are concerns for would-be financers. Technical innovations and policy structures for these markets must be coupled with innovative, inclusive financial models that can promote equitable adoption of clean energy technologies and mobilize private investment.

This initiative will launch a new Prize-based Competition that will challenge project teams to design innovative and inclusive financial models providing for more flexible, sustainable flows of capital to help overcome barriers to clean energy adoption and deployment in low-income and disadvantaged communities. The winning team(s) will then receive funding to pilot their financial model in California, and validate their financial innovation.

Project teams will be encouraged to think outside the box using the latest innovation methodologies, such as lean startup principles and open innovation, to develop a financial model that will mobilize private clean energy investment, while assessing the potential for their model to be replicated.

This initiative will seek to narrow financing gaps for low-income and disadvantaged community clean energy markets such as predevelopment costs, working capital restrictions, grant leveraging, long-term project financing, price sharing for split incentives, affordable housing clean energy retrofit financing, and more.

S8.3 Develop Innovative Strategies to Increase Clean Energy Investment in Disadvantaged Communities

Initiative 8.3.1

The Inclusive Development through Equitable Adoption (IDEA) Challenge

Impact if Successful

Increased options for validated clean energy project financing will drive capital flows to low-income and disadvantaged communities, bringing with it energy and non-energy benefits.

Primary Users and/or Beneficiaries

Investors, local government, community organizations, environmental justice planning, residents

Metrics and/or Performance Indicators

Increased portfolio of financing models available to low-income and disadvantaged communities pursuing clean energy communities.

Topic(s) addressed	Value Chain	Program Area(s)
Clean Energy Financing Clean Energy Communities Low-Income Communities Disadvantaged Communities	Demand-side Management	Market Facilitation