Application No.:	A.19-08-
Exhibit No.:	SCE-04 Vol. 5
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SOUTHERN CALIFORNIA EDISON®

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(U 338-E)

2021 General Rate Case

Wildfire Management

Before the

Public Utilities Commission of the State of California

Rosemead, California
August 30, 2019

SCE-04, Volume 5: Wildfire Management

Table Of Contents

SCE-04, Volume 5: Wildfire Management

Table Of Contents (Continued)

Section	Page	Witness

SCE-04, Volume 5: Wildfire Management

Table Of Contents (Continued)

SCE-04, Volume 5: Wildfire Management

Table Of Contents (Continued)

Table Of Contents (Continued)

I.

INTRODUCTION

A. Content and Organization of Volume

There are two different discrete sets of wildfire-mitigation-related activities and programs at issue in this proceeding for review and cost recovery purposes. First, consistent with SB 901 (as confirmed by D.19-05-038) and AB 1054, in supplemental testimony of this proceeding SCE will set forth a reasonableness review for the incremental (*i.e.*, amounts above authorized, or will be authorized by a final decision in A.18-09-002 (SCE's Grid Safety & Resiliency Program (GSRP)) 2018-2020 costs tracked in SCE's Wildfire Mitigation Plan Memorandum Account (WMPMA),[1] Fire Risk Mitigation Memorandum Account (FRMMA),[2] and Fire Hazard Prevention Memorandum Account (FHPMA).[3] The Application that this testimony supports sets forth a procedural proposal and schedule detailing how SCE believes those costs should be reviewed for reasonableness. The specific amounts recorded in the relevant memorandum accounts for 2018, 2019, and 2020, as well as the justification of their reasonableness and a demonstration of how those amounts are incremental to costs authorized in the 2018 GRC and other related memorandum accounts, will be set forth pursuant to that procedural schedule, and are therefore not included in this volume.

Second, as is done in traditional GRC ratemaking, in this volume SCE has set forth its forecast of the 2021-2023 wildfire-related costs that SCE proposes to be included in customer rates starting in 2021 and continuing throughout the 2021-23 GRC cycle.

Because most (but not all) of the wildfire-mitigation-related programs and activities for the 2018-2023 period overlap, in this volume SCE has put forth the detailed descriptions, rationales, and justifications for those programs and activities and the specific levels at which they were/will be executed in the 2018-2020 period. SCE's proposed forthcoming testimony for those historical costs will be dedicated solely to the review of the specific incremental costs (and the reasonableness of those costs)-for those historical costs. To the extent that pre-2021 costs are set forth in this volume, it is not done for cost recovery purposes; rather, those costs are shown to compare to the forecast costs (like for

[1] Established in Advice Letter 4022-E.

[2] Established in Advice Letter 3936-E and 3936-E-A.

[3] Established in Advice Letter 3936-E.

any other non-wildfire-related program or activity in typical GRC ratemaking support). In other words, there will be no overlap or "double recovery" of costs.

This volume presents Southern California Edison's (SCE) 2019-2023 forecast of operations and maintenance (O&M) expenses and capital expenditures to implement measures directed at reducing wildfire risk, the increasing magnitude of which was brought to light in a series of devastating fires beginning in the latter half of 2017. These unprecedented events continued into 2018, and well outside of the typical "fire season"—ushering in a new normal of year-round exposure to potentially catastrophic wildfires. This increasing risk must be addressed: wildfires not only threaten the state's residents' safety and its economy, they also undermine its ambitious environmental policies for reducing greenhouse gas emissions.

The testimony in this volume will explain the scope of planned work activities, including identifying key regulatory requirements and other drivers for the planned work. It will also explain the important role these activities play in wildfire prevention (*i.e.*, reducing potential ignitions) and supporting suppression (*i.e.*, more rapid identification and assessment of wildfires), as well as enhancing system resiliency.

Certain of these forecasts will be updated pursuant to the discussion in Chapter IV.A in the Application.

B. <u>Summary of O&M and Capital Request</u>

This volume presents SCE's requests for $109 million (constant 2018 dollars) in O&M expenses for the 2021 Test Year and $4,219 million in capital expenditures for 2019-2023 to effectively implement its approved 2019 wildfire mitigation plan (WMP) (including GS&RP activities) and anticipated GRC cycle wildfire mitigation activities that will also be reflected in future annual WMPs as described in this exhibit. SCE's total requests for Wildfire Management are presented in Figure I-1 and Figure I-2. The requests are presented in Figure I-1 for the 2021 O&M Expenses and Figure I-2 for the total 2019-2023 Capital Expenditures. This funding is crucial to implement effective wildfire mitigation programs and activities designed to reduce the number and likelihood of ignitions as well as to increase resiliency to wildfires.

__Figure I-1__
Wildfire Management 2021 O&M Expenses
(Constant $Million)

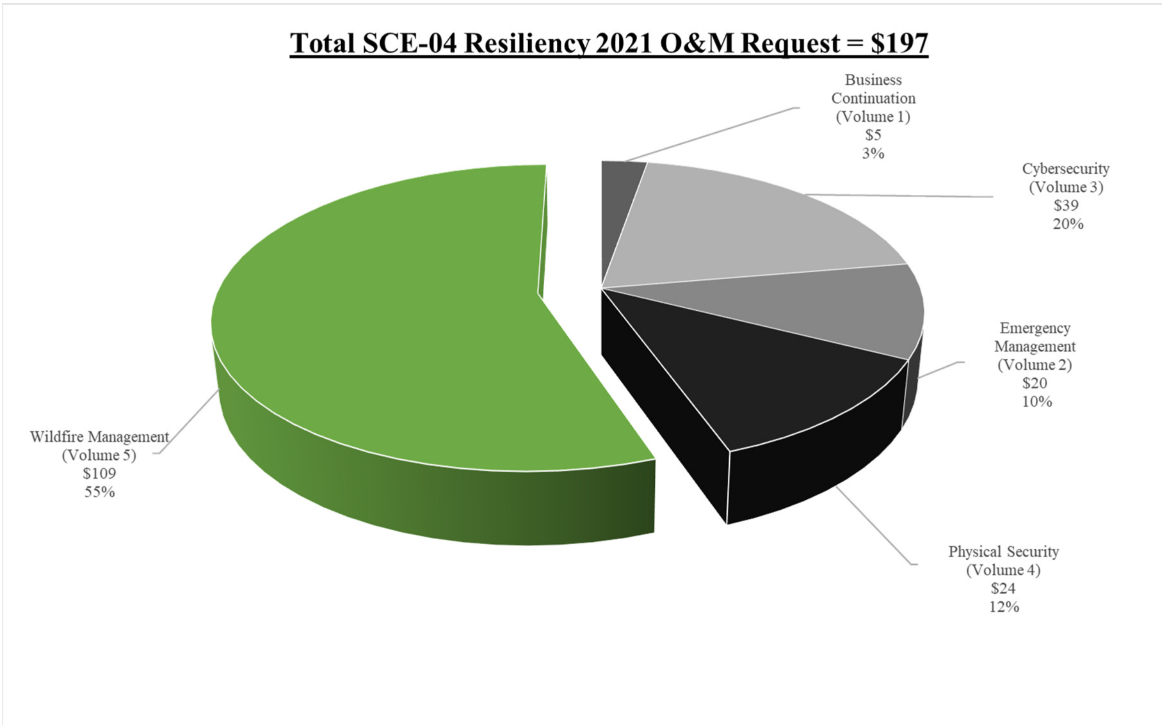

Figure I-2
Wildfire Managment Capital Expenditures 2019-2023
(Total Company Nominal $Million)

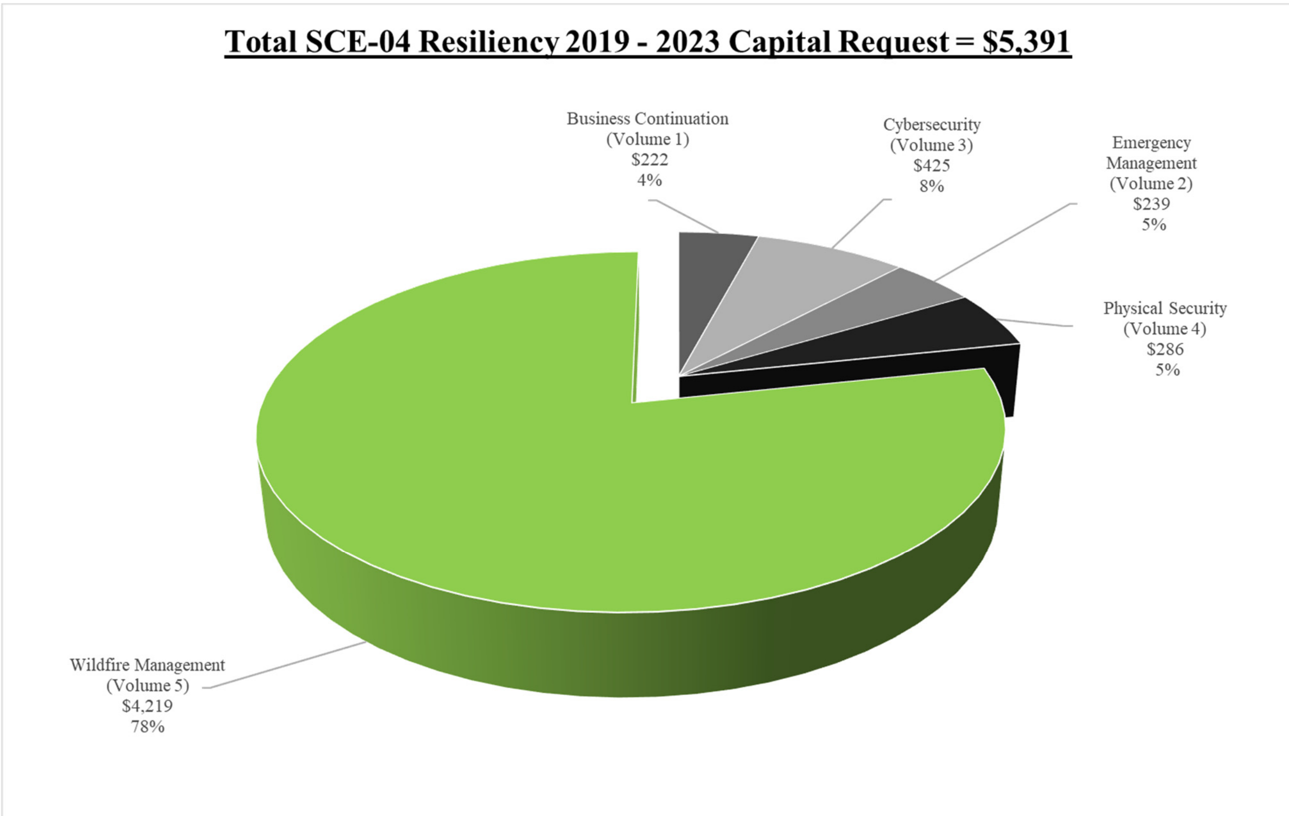

Table I-1
O&M Activities
(Constant 2018 $000)

	Recorded		Forecast	
	2018	2019	2020	2021
Asset Reliability Risk Analytics	$128			
Community Resiliency Incentives				$3,450
Distribution Fault Anticipation		$729	$205	$68
Enhanced Overhead Inspections and Remediations	$4,863	$211,260	$182,329	$61,537
Enhanced Situational Awareness	$382	$5,336	$3,272	$3,594
Fire Science and Advanced Modeling	$1,873	$2,110	$4,974	$3,948
Fusing Mitigation		$52	$7,801	$1,122
Grid Resiliency PMO	$57	$22,655	$12,271	
HFRA Sectionalizing Devices	$2,727	$1,231	$151	
Infrared Inspection Program	$0	$5,122	$5,018	$5,018
Organizational Support		$2,171	$3,354	$3,354
PSPS Customer Support	$852	$13,877	$13,365	$13,311
PSPS Execution	$169	$13,727	$14,030	$13,922
Weather Stations	$253			
Wildfire Covered Conductor Program		$50		
Totals	**$11,305**	**$278,319**	**$246,771**	**$109,324**

Table I-2
Capital Activities
(Total Company Nominal $000)[4]

	Recorded			Forecast		
	2018	2019	2020	2021	2022	2023
HFRA Sectionalizing Devices		$6,292	$28,452	$5,209	$5,360	
Distribution Fault Anticipation		$2,340	$0	$6,270	$12,903	$13,274
Enhanced Overhead Inspections and Remediations	$100	$152,331	$155,741	$56,174	$49,823	$46,276
Enhanced Situational Awareness	$2,997	$6,364	$4,159			
Fire Science and Advanced Modeling		$12,953	$5,685	$1,102		
Fusing Mitigation		$50,173	$11,885			
PSPS Execution		$180	$1,212	$738		
Undergrounding				$22,507	$42,457	$43,678
Wildfire Covered Conductor Program		$156,337	$533,803	$771,099	$906,746	$1,107,732
Totals	**$3,097**	**$386,970**	**$740,938**	**$863,099**	**$1,017,289**	**$1,210,960**

4 Refer to WP SCE-04 Vol. 05, Part 1 pp. 1 - 2 – Capital Summary for Wildfire Management SCE-04, Volume 5.

II.

WILDFIRE MANAGEMENT

A. Overview

1. Risk factors, Safety, Reliability and Connection with RAMP

Wildfire is SCE's top public safety risk. This volume identifies several critical activities necessary to combat this risk. SCE has identified this portfolio of activities and associated work volumes using a risk-informed approach. This approach leverages wildfire risk analysis frameworks documented in various Commission proceedings (e.g., SCE's 2018 Grid Safety & Resiliency Program (GSRP), SCE's 2018 Risk Assessment Mitigation Phase (RAMP) report,[5] SCE's 2019 WMP), as well as evolving and improving methods to evaluate wildfire risks using advanced analytics designed to assess the potential for wildfire spread at granular levels across SCE's system.

In its 2018 RAMP report, SCE evaluated the risks of wildfires associated with SCE using a risk bowtie method. As discussed in SCE's RAMP report, the bowtie helps to map the progression of the risk from the drivers of ignition, to discrete outcomes when an ignition occurs, which are then measured in terms of safety, reliability, and financial costs impacts. The wildfire bowtie used in the 2018 RAMP report is shown in Figure II-3 below.

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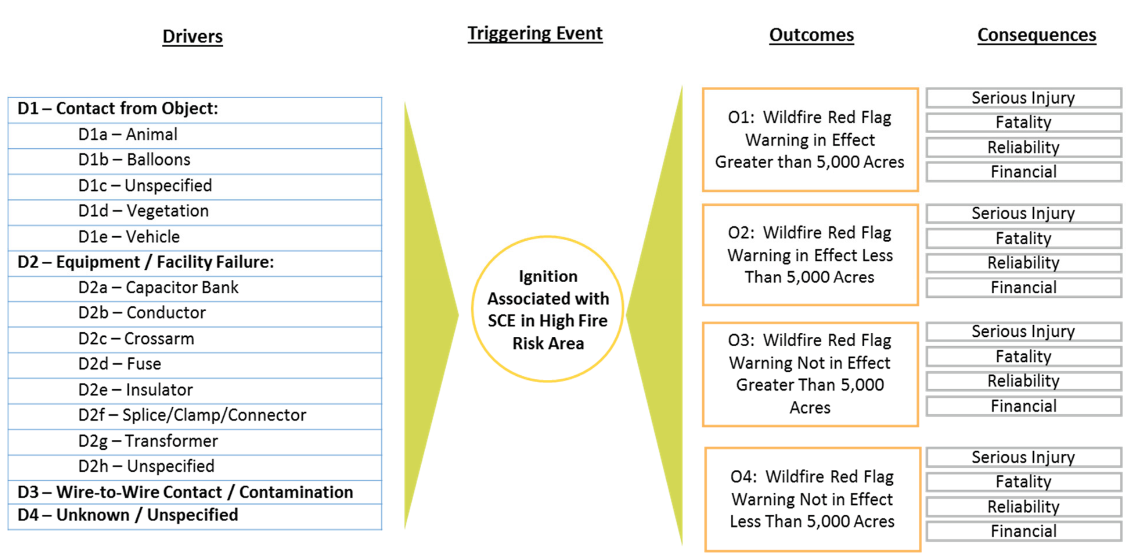
[5] *See* Chapter 10 (Wildfire) of SCE's RAMP report.

Figure II-3
2018 RAMP Wildfire Risk Bowtie



In the RAMP report, SCE constructed a portfolio of wildfire mitigations to address the components of this risk bowtie. These mitigations largely focused on reducing the frequency of occurrence for the Drivers of ignitions (left side of the bowtie).[6] The wildfire risk mitigations presented in this testimony, as well as the vegetation management activities presented in SCE-02, Volume 6, represent SCE's continued efforts to refine and improve upon the portfolio of activities previously presented in SCE's GSRP, RAMP, and WMP filings, to most effectively and expeditiously mitigate the wildfire risk. Table II-3 maps the GRC activities presented in this testimony to the corresponding risk mitigation activity presented in SCE's 2018 RAMP report.

6 *See* Chapter 10 of SCE's RAMP report for a detailed discussion of the wildfire risk bowtie and its components.

Table II-3[7]
Wildfire Activities Included in SCE's 2018 RAMP Filing

GRC Activity	RAMP Control / Mitigation Name	RAMP ID	Risk Addressed
Infrared Inspections	Infrared Inspections	M4	Contact with Energized Equipment / Wildfire
Enhanced Situational Awareness	Enhanced Situational Awareness	M2a / M7	Climate Change / Wildfire
Fusing Mitigation	Fusing Mitigation	M8	Wildfire
HFRA Sectionalizing Devices	Remote-Controlled Automatic Reclosers and Fast Curve Settings	M2	Wildfire
Wildfire Covered Conductor Program	Wildfire Covered Conductor Program	M1/ M5	Wilfire / Contact with Energized Equipment
PSPS Execution / PSPS Customer Support	PSPS Protocol and Support Functions	M3	Wildfire

a) <u>SED / Intervenor Comments</u>

In its comments on SCE's RAMP report,[8] SED recommends that SCE provide a full accounting for activities related to transmission wildfire risks in conjunction with its efforts related to its distribution assets.

SCE has and continues to undertake efforts that either directly or indirectly mitigate wildfire risks associated with its transmission system. These activities are presented both within this testimony and elsewhere in this GRC. Table II-4 identifies several of these transmission level mitigations and their location within testimony of this GRC.

[7] Note that Vegetation Management is discussed in Exhibit SCE-02, Vol. 6 (Vegetation Management).

[8] *See* SED's "A Regulatory Review of the Southern California Edison's Risk Assessment Mitigation Phase Report for the Test Case 2021 General Rate Case," dated May 24, 2019, I.18-11-006, p. 32.

Table II-4
Transmission System Wildfire Mitigations Activities

GRC Activity	Location
Enhanced Overhead Inspections & Remediation	SCE-04, Volume 5
Infrared Inspections & Corona IR Scans	SCE-04, Volume 5
Transmission Vegetation Management	SCE-02, Volume 6
Hazard Tree Removal Program	SCE-02, Volume 6
Transmission Line Rating & Remediation	SCE-02, Volume 2
Various Transmission Inspection & Maintenance Programs	SCE-02, Volume 2

In addition, SCE has performed an initial risk assessment of wildfire risk associated with transmission assets. This is presented as part of Exhibit SCE-01, Volume 2.

2. Compliance Requirements

D.19-05-020 identified no compliance requirements related to the activities included in this volume of testimony.

3. Updates to SCE's High Fire Risk Area (HFRA) Boundaries

SCE's HFRA includes areas that SCE previously designated as high fire risk areas (known as System Operating Bulletin Number 322, or "SOB322", or "BL322") that are not in the CPUC's High Fire Threat District (HFTD) maps. In 2018, SCE initiated a cross-functional effort including utilizing external expertise to review SCE's non-CPUC HFRA. This team subdivided these areas into over a thousand smaller areas (polygons) to enable their systematic evaluation, which included consideration of multiple factors such as overhead and underground circuitry, historical fires within each polygon's vicinity, whether areas bordered HFTD areas, vegetation density, wind data, and other factors to determine what areas (at a polygon level) should be retained as SCE HFRA or removed. In August of 2019, SCE filed a Petition for Modification (PFM) of D.17-12-024,[9] in which SCE proposed retaining some areas of the non-CPUC HFRA to be treated as CPUC HFTD Tier 2 and requested that the Commission formally include these areas in its HFTD. The areas retained are

[9] *See also* July 5, 2019 AL4030-E.

considered by SCE to contain SCE facilities and have a relatively higher potential for a fire to propagate when compared with other non-CPUC HFRA. It is important to note that the forecasts included throughout this Volume were developed before finalization of the "retain/remove" systematic evaluation exercise described above. As a result, certain forecasts in this Volume and others assume a non-CPUC HFRA polygon retention percentage that may differ from the percentage reflected in SCE's final analysis.[10] References to work SCE is proposing in SCE's overall HFRA in this testimony are generally intended to pertain to SCE's final retained non-CPUC HFRA. SCE will modify (*i.e.*, reduce) the relevant forecasts to conform to the final analysis. Please see the Application at Chapter IV.A for details.

4. Regulatory Background/Policies Driving SCE's Request

SCE filed its Grid Safety and Resiliency Program (GSRP) Application (A.18-09-002) in September 2018 seeking approval of, and cost recovery for, incremental costs to implement the program over the 2018 to 2020 period. The GSRP filing was designed to bridge the gap between the 2018 and 2021 GRC cycles. SCE's proposed GSRP is a portfolio of mitigation measures primarily focused on preventing wildfire ignitions associated with electrical distribution infrastructure in High Fire Risk Areas (HFRA). GSRP's focus areas are: (1) further grid hardening; (2) enhanced situational awareness; and (3) enhanced operational practices. Given the increased wildfire risk, SCE began implementing GSRP in 2018 and will continue to implement GSRP activities in 2019 while program and cost recovery approval is pending.

Since filing its GSRP Application, SCE has continued to review and refine the strategies and programs described in that filing. California Senate Bill 901 (SB 901) was also enacted in 2018 and requires electric utilities to prepare and submit WMPs that describe the utilities' plans to prevent, combat, and respond to wildfires affecting their service territories. Through a proceeding it opened on Oct. 25, 2018 (R.18-10-007), the CPUC reviewed the utilities' initial 2019 WMPs. SCE's 2019 WMP was approved by the Commission in D.19-05-038, and it includes efforts to assess acceleration of some GSRP elements and development of programs that go beyond the scope of GSRP. For example, as set forth in GSRP, SCE plans to deploy at least 96 circuit miles of covered conductor in HFRA in 2019. Notwithstanding execution risks such as skilled-labor resource constraints, supply chain disruptions, and unanticipated events, SCE will install additional covered conductor in HFRA in 2019.

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[10] The final analysis was used as the basis for SCE's PFM of D.17-12-024.

5. Risk-Informed Approach to Wildfire Mitigations Presented in this Testimony

The wildfire mitigation activities requested in this testimony are directly informed by risk analysis. SCE-01, Volume 2 describes various wildfire risk analyses performed in various regulatory forums, including SCE's 2018 GSRP, SCE's 2018 RAMP report, and SCE's 2019 WMP. Further, that testimony describes various enhancements SCE is building to improve wildfire risk analysis and mitigation prioritization, as well as SCE's continuous improvement philosophy for wildfire risk analysis. Collectively, these efforts provide a significant body of work that SCE has drawn upon to develop the scope and cost forecasts for the risk mitigation activities presented in this testimony.

Here, SCE's describes the general approach taken to evaluate wildfire risk and determine actions necessary to reduce this risk. SCE began by developing an understanding of the fundamental elements that enable fire to ignite, the statistical trends associated with fires across California, particularly associated with electrical power lines, the historical data surrounding fires associated with SCE's grid infrastructure, and the geographic locations within SCE's service area that represent the greatest wildfire risk (both likelihood and consequence of ignition). From there, SCE identified various mitigation measures that can reduce the likelihood of faults that could cause an ignition and potentially result in a wildfire and estimated the risk reduction (benefits) associated with each measure.
SCE considered multiple factors including each mitigation's effectiveness, deployment timing, resource allocation, alternatives, and other constraints to develop a comprehensive and complementary suite of solutions to reduce wildfire risks. The activities requested in this testimony reflect the collective input from these activities.

Consistent with SCE's enterprise risk management approach,[11] the activities requested in this testimony result from a systematic risk-informed decision-making framework. For purposes of this testimony, SCE provides an abbreviated discussion of how this framework was used to evaluate wildfire risk. Accordingly, SCE summarizes how it has identified and evaluated the wildfire risk and identified and evaluated wildfire risk mitigations. Further, this testimony describes how these efforts were used to develop SCE's suite of enhanced mitigation measures, its philosophy for selecting and deploying these measures, and how each one addresses the broader wildfire risk landscape for the benefit of the State and the communities in (and surrounding) SCE's service area.

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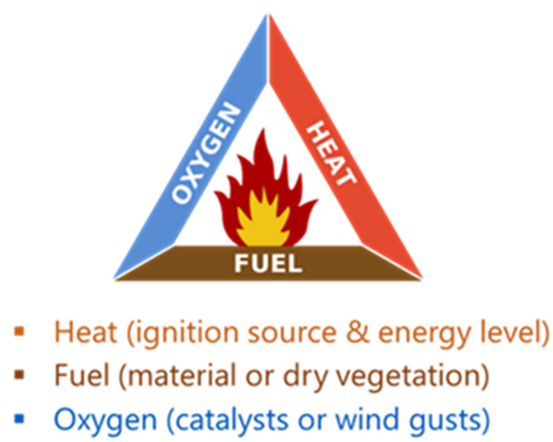
[11] *See* Exhibit SCE-01, Volume 2 for further detail on SCE's enterprise risk management framework.

a) **Risk Identification and Evaluation**

SCE began by identifying and evaluating the wildfire risk, the driver(s) and potential resulting negative outcomes. Chapter II discussed the increased wildfire risks facing California and projections for future changes. Addressing these new risks requires both an understanding of the basic drivers of wildfires and how these drivers may change over time.

To understand the fundamental behavior of fire ignitions, SCE looked to the elementary science behind fire ignitions and propagations. The fire triangle in Figure II-4 shows that a fire requires three necessary elements: (1) heat source that starts the ignition; (2) fuel, or dry vegetation in the case of a wildfire; and (3) oxygen, or catalysts such as wind gusts to propel the wildfire. Eliminating or reducing any one of these three elements in turn reduces the risk of fire ignition and its propagation. This provided a framework for SCE to subsequently identify and consider potential mitigation measures that target each element.

Figure II-4
The Fire Triangle



Within the context of ignitions associated with SCE's electrical infrastructure, the heat comes from the energy and flow of electricity within the grid. Conditions, such as arcing, are the root ignition source. The fuel in SCE's service area is principally associated with trees and other vegetation in proximity to electrical facilities, which is exacerbated by drought and other climate changes that increase the quantity of flammable dry fuel. Increased flow of oxygen from strong winds combined with low humidity heightens the risk associated with ignitions that can quickly spread and become difficult to suppress or contain. In 2017 and 2018, the state was subjected to "unprecedented" strong winds that have the potential to carry palm fronds and other debris from even greater distances into utility lines. Not only has California entered into this "new normal," but former Governor Brown stated that this will continue into the next 20 years.[12]

To further understand the cause of fires associated with its electrical system, SCE analyzed fires that occurred in its HFRA from 2015 through 2018 that were of significant size and reportable to the Commission. The results indicated that approximately 90 percent of all of the fires associated with electrical equipment in SCE's service area were related to distribution level voltages (33kV and below). As a result, much of SCE's subsequent risk analyses targeted distribution infrastructure. Table II-5 below details the breakdown of contact from object and equipment/facility failure related wildfires.

[12] Los Angeles Times, Gov. Brown: Mega-fires 'the new abnormal' for California, (November 11, 2018).

Table II-5
Drivers of Ignitions Associated with SCE - Distribution
(Distribution Voltage Infrastructure in HFRA from 2015-2018)[13]

Suspected Initiating Event	Count	Percentage*
Contact from Object	80	56%
Equipment/Facility Failure	40	28%
Other, Unknown, Wire-Wire Contact	23	16%
Total	143	100%

Contact From Object	Count	Percentage*
Animal	18	13%
Balloons	18	13%
Other	7	5%
Vegetation	21	15%
Vehicle	16	11%
Total	80	56%

Equipment/Facility Failure	Count	Percentage*
Capacitor Bank	1	1%
Conductor	10	7%
Fuse	1	1%
Insulator	6	4%
Splice/Clamp/Connector	9	6%
Transformer	5	3%
Other	8	6%
Total	40	28%

** Percentages shown are rounded to whole numbers*

The two largest ignition drivers are "contact from object" followed by "equipment/facility failure." Accordingly, SCE analyzed these two ignition drivers to develop a nuanced understanding of the precise causal chain that can lead to a wildfire outcome. Specifically, faults on the distribution system primarily occur either due to contact from an object or an equipment/facility failure.

[13] This table reflects ignition drivers associated with SCE in the updated HFRA only, as described in the section above titled "Updates to SCE's High Fire Risk Area (HFRA) Boundaries." However, in an effort to broadly identify all drivers of ignitions and to develop mitigations to prevent them, SCE also evaluates drivers of ignitions that occur outside of this new HFRA, including those in Tier 1 and those experienced by other utilities in California. Similar data for the initiating events of ignitions associated with SCE's transmission infrastructure in HFRA are presented in Exhibit SCE-01, Volume 2.

Although rare, these faults can result in high-energy and high-temperature arcing between two conductors (phase-to-phase) or between one conductor and the ground (phase-to-ground). Faults can also result in the failure of other electrical equipment. In either case, if arcing contains sufficient energy—given local conditions such as temperature, humidity, and adjacent dry vegetation—ignition could lead to a wildfire.

Next, SCE focused on the portions of its service area where the likelihood and consequence of ignitions pose the greatest threat, *i.e.*, HFRA, to guide the prioritization of mitigation strategies. Since ignitions in SCE's HFRA represent the greatest wildfire threats and most historical ignitions related to SCE's facilities in these areas are principally associated with overhead distribution infrastructure, the greatest wildfire risk associated with SCE electrical facilities is largely concentrated in bare overhead distribution facilities within HFRA. This risk falls into two areas: (1) objects contacting bare overhead distribution conductor, which is primarily caused by animals, balloons, and vegetation (these total approximately 71 percent of all contact from object caused fires); and (2) failure of equipment or facilities that is predominately induced by faults associated with overhead conductor.

The quantitative risk analyses performed as part of GSRP and RAMP are discussed further in SCE-01, Volume 2. In that testimony, SCE provides an updated wildfire risk analysis using the RAMP multi-attribute risk scoring methodology. While SCE recently filed its RAMP report in November of 2018, the risk analysis largely included wildfire data through 2017. The updated risk analysis presented in SCE-01, Volume 2 updates that analysis to include more recent data in 2018. Further, that testimony describes the advancements SCE has made in developing more granular and comprehensive wildfire risk models that are continuously improving our understanding and visibility to location, propagation potential, and equipment-based factors that influence wildfire risk. In addition, SCE has performed a preliminary risk assessment for wildfire risk associated with transmission assets. This analysis can also be found in SCE-01, Volume 2.

b) <u>Risk Mitigation Identification</u>

SCE next identified potential mitigation measures that could reduce either the likelihood or impact of wildfires. To do this, SCE combined, and corroborated various mitigation identification techniques employed in SCE's GSRP, RAMP, and WMP filings.

For example, the fire triangle shown in Figure II-4 helps frame possible mitigation measures for wildfire ignitions by targeting specific sides of the triangle. SCE characterizes mitigation measures that reduce risk by addressing wildfire drivers as "prevention" measures, and those measures that reduce risk by addressing wildfire outcomes and consequences as "resiliency" measures.

Further, SCE evaluated the work performed in SCE's 2018 RAMP report, where mitigation activities were identified on the basis of their ability to affect the drivers, outcomes, and consequences of wildfire ignitions. As described in chapter 10 of SCE's RAMP report, each wildfire mitigation was evaluated for its ability to reduce the drivers of wildfire ignitions or reduce the impacts of a wildfire should an ignition occur.

In its 2019 WMP, SCE identified an even more comprehensive portfolio of wildfire risk mitigations based on SCE's experience throughout 2018. For example, SCE established an Enhanced Overhead Inspection (EOI) program that builds upon existing inspection programs to perform more comprehensive inspections of overhead equipment in HFRA. This is representative of SCE's continuous improvement approach to mitigating the public safety risks of wildfires.

c) Risk Mitigation Evaluation

SCE evaluated a range of potential mitigation solutions warranting serious consideration. SCE corroborated selected mitigation solutions by benchmarking international practices in jurisdictions with comparable wildfire conditions, such as Australia.[14] SCE also reviewed certain international standards related to risk management and asset management to leverage components that could be applied directly to wildfire mitigation.

SCE analyzed faults tracked in its Outage Database and Reliability Metrics System (ODRM) over the 2015-2018 period to better understand how the different types and frequencies of fault incidence relate to the actual occurrence of fire events discussed above. In light of this analysis, SCE evaluated possible solutions based on a number of factors, including both technical capability (*i.e.*, demonstrated ability to reduce the likelihood of fire ignition by, for example, reducing faults) and the operational feasibility of implementing the solution given the current design and configuration of the system. To evaluate technical capability, SCE performed internal testing, commissioned external testing, and consulted with electric/utility industry experts. To assess operational feasibility SCE considered, for instance, how changing protection philosophies might impact reliability, or how using covered conductor in high fire risk areas would affect other components of the system (such as poles), covered

[14] Refer to WP SCE-04 Vol. 05, Part 1 pp. 4 - 177 – Covered Conductor Compendium.

conductor installation work methods and procedures, and its long-term performance in inclement weather and environmental conditions.

Given the significance of contact from objects as a cause of fire ignitions, SCE evaluated a number of potential risk mitigation measures focused on: (1) reducing the population of potential objects (e.g., reducing tree branches and other vegetation located near overhead lines); and (2) designing the system to be able to withstand such contact without leading to a fire ignition. Regarding the first approach, enhanced vegetation management practices can further reduce the likelihood that vegetation will contact overhead distribution system by increasing clearances and removing certain tree species. But this approach has certain limitations, including the utility's limited ability to increase clearances in certain areas, the fact that wind can often blow debris into lines from significant distances despite appropriate clearances to nearby trees, and that taller trees can fall onto lines even when located well outside of the utility's right-of-way. Thus, SCE also evaluated mitigation measures focused on the second approach (withstanding contact), concluding that covered conductor is the most feasible longer-term mitigation solution for fault and ignition prevention.

SCE's RAMP report quantified the risk reduction and effectiveness of wildfire mitigations. This was done using a multi-attribute risk scoring approach that employed probabilistic methods and Monte Carlo simulations. These quantitative evaluations complemented the qualitative assessments from subject matter experts and experiences gained from utilities across the world, in SCE's determination of the set of wildfire mitigations presented in this testimony.[15]

6. Interactions of Mitigations

When selecting each mitigation portfolio, SCE observed how various mitigations complement one another. For example, covered conductor provides mitigation benefits associated with multiple drivers, including vegetation, balloons, animals, and conductor failure. This is different from the mitigation profile of Current Limiting Fuses (CLFs), which would additionally mitigate equipment failure drivers beyond conductor failure. This is different from the mitigation profiles of the Vegetation Management Hazard Tree Removals activity discussed in SCE-02 Volume 6, which would mitigate vegetation "fall-ins." The Public Safety Power Shutoff activity is associated with reactive efforts related

[15] In addition to the mitigations presented in this testimony, SCE's vegetation management activities presented in SCE-02, Vol. 6 were also considered through this process. Please see Exhibit SCE-01, Vol. 2 for additional information on this wildfire risk analysis in RAMP, and updates made to this analysis since SCE's submission in 2018.

to actual de-energization events and public awareness efforts to ensure public safety during times of elevated wildfire risk events. Similarly, the Enhanced Situational Awareness activity provides key information to better predict and respond to elevated wildfire risk events and wildfire events. SCE's portfolio is a coordinated, holistic plan that addresses the wide variety of potential ignitions. This approach is supported by the practices adopted by operators of transmission and distribution networks in Victoria, Australia. As a result of devastating bushfires in Australia, the 2009 Victorian Bushfires Royal Commission issued a report listing a variety of recommendations, among which were installing covered conductor and removing trees outside of the clearance zone but that could come into contact with electrical power line. The implementation of such multiple mitigations has resulted in marked improvements in bushfire risk performance.

In addition, deployment of covered conductor will take multiple years. Other mitigations such as enhanced vegetation management, fuses, recloser blocking and fast curve settings can be deployed more quickly in order to mitigate risk across SCE's HFRA in the near term. This portfolio strategy aims to maximize near-term risk reduction benefits by layering both short term strategies with longer-term capital-based mitigations such as covered conductor. SCE plans to deploy mitigations in the same location and within the same timeframe when they complement each other to provide the necessary aggregate risk reduction benefits for the system.

B. Wildfire Activities

1. Grid Hardening

a) Wildfire Covered Conductor Program (WCCP)

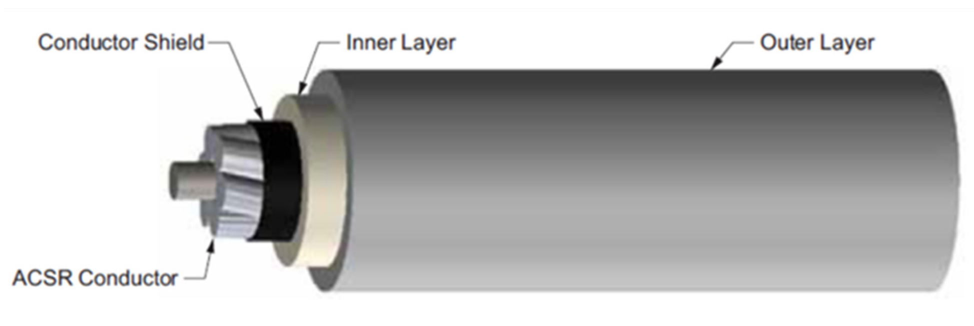
(1) Work Description

The Wildfire Covered Conductor Program (WCCP) is SCE's principal grid hardening wildfire mitigation solution. SCE expects the use of covered conductor in HFRA to reduce the wildfire ignition risks associated with overhead electrical distribution system facilities.

SCE designs and maintains its systems to meet or surpass all current safety code and compliance requirements. Nevertheless, some wildfire risks associated with operating a high voltage electric system remain. For instance, in HFRA, SCE's overhead distribution system can serve as a potential fire ignition source when faults occur. Faults can occur when vegetation, metallic balloons, animals, or other debris come into contact with overhead conductor, causing short circuit conditions. Fault conditions can weaken and sometimes cause conductor failures, resulting in energized wire down events, which could result in electrical arcing in the air or on the ground, each of which can lead to ignitions when it occurs in close proximity to airborne debris, vegetation or ground-based fuels. SCE has identified covered conductor as an important mitigation solution to reduce the wildfire risks associated with contact-related faults on overhead conductor and, at the same time, address small conductors that are more prone to failure due to fatigue from cumulative mechanical stresses and/or damage from electrical faults experienced through its service life.

The WCCP seeks to reduce the risk of fire ignition through targeted replacement of existing bare overhead conductor in HFRA with covered conductor. Covered conductor, unlike bare conductor, is specifically designed to withstand incidental contact with vegetation, other debris, and even the ground in a wire down event. As illustrated in Figure II-5, covered conductor is aluminum or copper wire insulated with a three-layer design, providing effective protection against transient contact-related faults and the electrical arcing associated with a variety of fault conditions. SCE has performed extensive benchmarking and testing to validate the effectiveness of covered conductor at reducing contact from object faults.[16] SCE also commissioned a test of covered conductor that demonstrated public safety benefits should the public come into contact with a downed energized conductor.[17]

Figure II-5
Three-Layer Covered Conductor Design and Installation



WCCP will involve more than simply replacing existing bare conductor with covered conductor. SCE will also complete a number of related grid hardening improvements on

[16] Refer to WP SCE-04 Vol. 05, Part 1 pp. 178 - 223 – An Engineering Analysis on Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors.

[17] Refer to WP SCE-04, Vol. 05, Part 1 pp. 242-246 – SCE Summary of Covered Conductor Touch Current-NEETRAC Report; Refer to WP SCE-04, Vol. 05, Part 1, WP, pp. 224-241 – NEETRAC Report.

the relevant portions of the distribution system that go hand-in-hand with re-conductoring using covered conductor. For instance, re-conductoring work will include the installation of composite cross arms and wildlife protection, such as covers, tubing, and covered jumper wire.[18] Covers protect a variety of overhead equipment (transformer bushings, recloser bushings, fuses, cable terminations, insulator, fuses, arrestors, etc.). Two specific upgrades associated with WCCP are discussed in more detail below: poles and tree attachments.

(a) Poles

WCCP will require pole upgrades in certain circumstances. Covered conductor is heavier and has a larger cross-sectional area than bare conductor. Accordingly, implementing WCCP will require SCE to determine the adequacy of existing poles to support this extra weight and associated wind loading due to larger cross-sectional area. As part of this re-conductoring work, SCE will conduct a pole loading assessment on existing poles where covered conductor is to be installed to determine if pole replacement is required. If the pole loading analysis shows that G.O.-mandated minimum safety factors would not be maintained after installing covered conductor, SCE will also install new poles able to support the new covered conductor.

Additionally, when WCCP-affected poles do not meet loading requirements and therefore need to be replaced anyway, SCE intends to utilize fire-resistant poles as replacements, where appropriate, which include composite poles with a fire-protective shield, fire-resistant wood poles, or other technologies that can provide similar fire-resistant properties. A fire-resistant wood pole can be created by applying surface treatments, such as wrapping a sacrificial wire mesh covered in an intumescent polymer around the pole.

(b) Tree Attachments

As part of WCCP, SCE will also eliminate instances where existing electrical equipment, including overhead conductor, is attached to trees. Approximately 3,200 tree attachments will be replaced as part of WCCP in the 2019-2023 time period. Generally, SCE plans to replace tree attachments together with covered conductor deployment. In some cases, where tree attachments are located in forested areas with dense vegetation, SCE may use spacer cable system construction for covered conductor. Spacer cable is a more compact construction and has a steel messenger wire that helps to strengthen and support the covered conductor in forested areas.

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[18] Jumper wires connect the overhead conductor to other pieces of conductor or equipment.

An illustration of spacer cable configuration is shown in Figure II-6 below. This design can generally, within reason, withstand trees falling on the wire without coming down. It is a construction design in many parts of the United States and Canada where electric lines pass through forest, where trees and vegetation well outside the utility right-of-way pose threats and it is either impractical or infeasible to eliminate the trees and vegetation.

Figure II-6
Spacer Cable Configurations

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(2) <u>Need for Activity</u>

As shown in Table II-5 above, approximately 56 percent of wildfire ignitions associated with SCE distribution equipment have been caused by contact from objects, approximately 28 percent have been caused by equipment/facility failure, and the rest comprising approximately 16 percent.

SCE's WCCP is an important step forward in the mitigation of wildfire risks, specifically the drivers of wildfire ignitions related to electrical equipment. As The Utility Reform Network (TURN) recently concluded after reviewing SCE's internal testing documentation, "if targeted properly, covered conductor can be an important and extremely effective wildfire risk mitigation tool."[19] Since covered conductor has robust layered insulation, replacing bare conductor with covered conductor is an effective way to prevent contact-related faults. Preventing the occurrence of faults in turn reduces the likelihood of the anomalies that lead to fault-related fire ignitions. As secondary benefits, the thick

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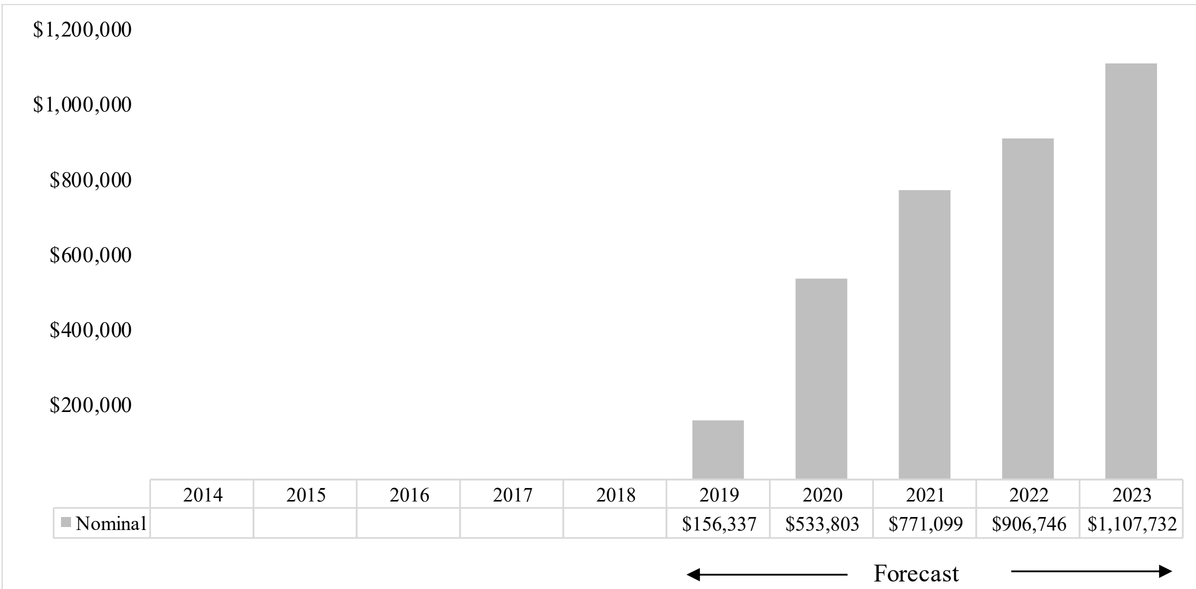
[19] *See* Prepared Testimony of Eric Borden, Addressing Southern California Edison's Grid Safety and Reliability Program Infrastructure Proposal, page 8.

insulating layer of covered conductor is highly durable, also improves reliability, and can reduce the risk associated with human contact with energized conductor, such as during a wire down event. Additionally, the replacement of older conductor, installation of new cross arms, insulators, and other equipment that is commonly replaced during reconductoring projects will also help prevent the occurrence of faults related to these types of equipment/facility failures.

In addition to installation of covered conductor, SCE will replace poles as necessary to comply with G.O.-mandated minimum safety factors. As part of this re-conductoring work, SCE will conduct a pole loading assessment on existing poles where covered conductor is to be installed to determine if pole replacement is required. The primary driver for pole replacement rates is attributed to larger conductor diameters that increase the wind forces that are transmitted from the conductor to the pole. The use of fire-resistant poles discussed above will enhance the resiliency of SCE's infrastructure in HFRA because they are designed to survive fires. SCE's forecast for WCCP is shown in Figure II-7.

(3) WCCP Capital Expenditure Forecast

Figure II-7
Wildfire Covered Conductor Program
2019-2023 Forecast
(Total Company Nominal $000)[20]



(a) Scope of WCCP

Considering the devastating impacts of wildfires in recent years, SCE believes it prudent and necessary to drive wildfire risk to very low levels as quickly as possible. Covered conductor presents one of the most significant ways to achieve this. Accordingly, SCE's forecast for covered conductor in this GRC is constructed based on the amount of work SCE can execute through 2023. As discussed in SCE-01, Volume 1, SCE is temporarily diverting resources from traditional programs, such as infrastructure replacement, to programs that directly and effectively mitigate California's wildfire risk. This allows SCE to focus resources on wildfire mitigations programs such as this Wildfire Covered Conductor Program. SCE's forecast for WCCP consists of approximately 6,200 circuit miles of covered conductor.

[20] Refer to WP SCE-04, Vol. 05, Part 1 pp. 247 - 250 – Capital Detail by WBS Element for Wildfire Covered Conductor Program.

While SCE's WCCP forecast is based on executable work volumes, SCE validated this volume of work would be prudent and reasonable through several risk-based approaches.

First, the volume of covered conductor that SCE is planning to install from 2019-2023 will equate to approximately 60 percent of the overhead conductor circuit miles in SCE's HFRA. As discussed previously, SCE's HFRA is composed of areas where the CPUC has indicated are affected by Tree Mortality Zones (HHZ, or Zone 1), or represent an Elevated (Tier 2), or Extreme (Tier 3) wildfire risk due to utility infrastructure, as well as limited additional areas SCE is proposing to be included in SCE's Non-CPUC HFTD HFRA as described in II.A.3. Table II-6 shows the number of overhead distribution conductor circuit miles that SCE has within each of these areas.

Table II-6[21]
Overhead Distribution Conductor Circuit Miles in HFRA

HFRA Component	# of Overhead Circuit Miles
CPUC Tier 3 (Extreme)	5,900
CPUC Tier 2 (Elevated)	4,100
Non-CPUC HFRA	200
Total HFRA	**10,200**

Based on this breakdown, the volume of covered conductor that SCE plans to install in this GRC period is roughly equivalent, in fact only marginally more, than the total number of overhead conductor miles included in what the CPUC characterizes as Tier 3 "Extreme" wildfire risk areas. Deployment of covered conductor across Tier 3 would provide meaningful reduction given the extreme nature of the wildfire in these areas. In fact, in its decision approving SCE's 2019 Wildfire Mitigation Plan the CPUC supported SCE's plan to install covered conductor in the highest fire threat zone – Tier 3.[22]

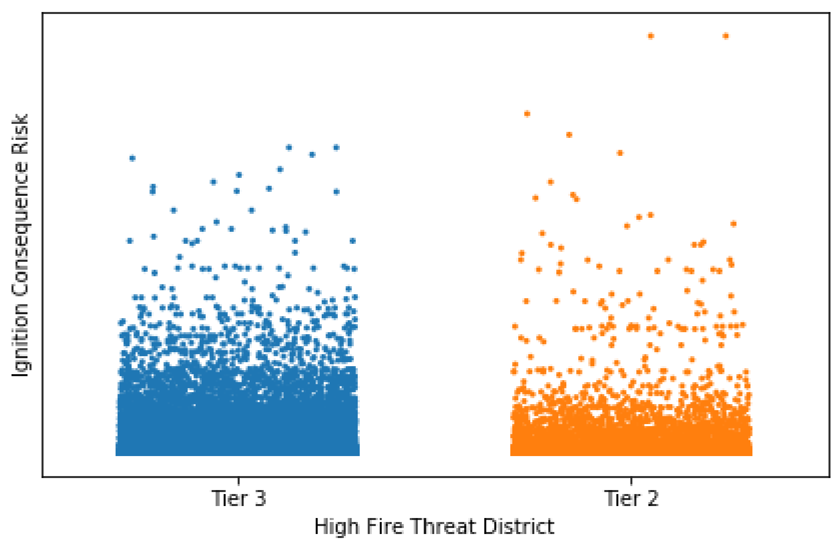
Second, while SCE's forecast would be sufficient to theoretically install covered conductor throughout all of the CPUC-designated Tier 3 "Extreme" wildfire risk area,

[21] *See* Chapter IV.A of the Application.

[22] *See* D.19-05-038, page 16.

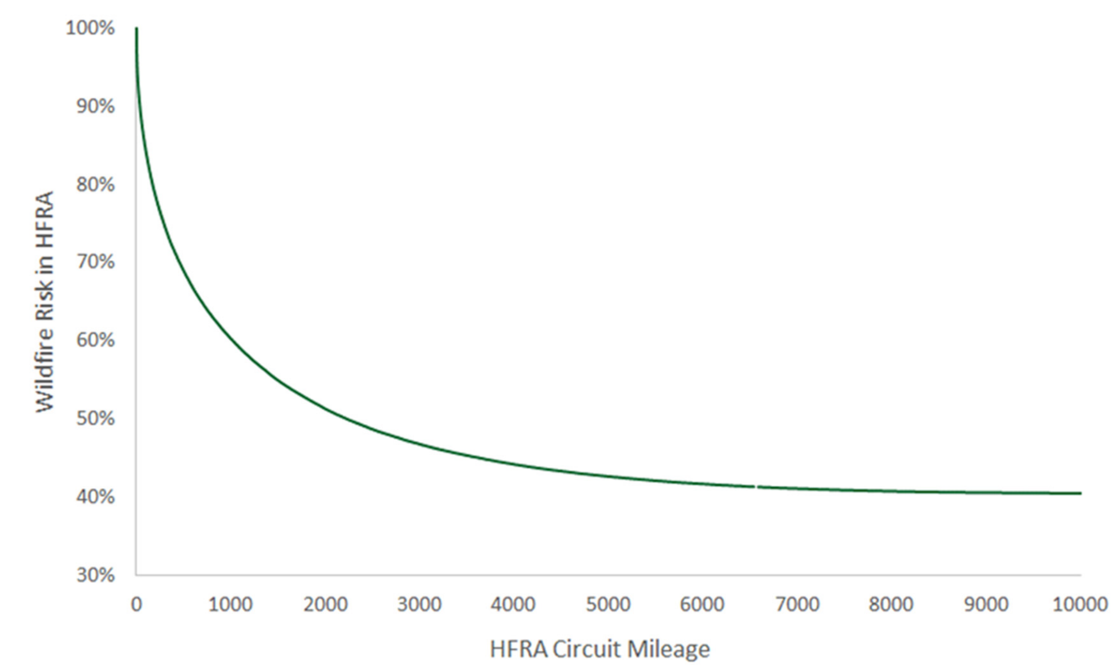
SCE believes that targeting higher risk circuit segments in Tier 2 ahead of lower risk segments in Tier 3 will provide greater overall risk reduction. As discussed in SCE-01, Volume 2, SCE has developed improved risk assessment methods and tools to further evaluate HFRA wildfire consequence risk at the circuit and circuit segment levels. These continuing refinements provide a more granular understanding of risk beyond relatively simplistic Tier 2 and Tier 3 designations. The results of this analysis allow SCE to prioritize circuit segments and areas within all HFRA in order to target the highest risk ones first. This analysis indicates that the total forecast volume of work is needed, but simply installing covered conductor within the CPUC Tier 3 area may not be sufficient to adequately address the wildfire risk, because certain Tier 2 circuit segments may exhibit more risk than those in Tier 3. This is illustrated in Figure II-8, below, where selected segments in Tier 2 have higher ignition consequence risks than many segments in Tier 3.

Figure II-8
Wildfire Risk in Tier 3 and Tier 2



Additionally, Figure II-9 plots the circuit segments in order of their modelled wildfire risk. The horizontal axis in the figure represents the cumulative circuit mileage in the HFRA, and the vertical axis represents the sum of all the wildfire risk in terms of both probability of ignition risk and magnitude of ignition consequences for circuit segments in HFRA.

Figure II-9
Modelled Wildfire Risk per Mile in HFRA



The results shown in Figure II-9 also illustrate how risk within the HFRA (and within the HFTD Tiers) is not uniform, and that some segments exhibit significantly more wildfire risk than others. In addition, the risk associated with each circuit may not be uniform along its length: the risk can vary extensively between a specific mile or segment within a circuit, especially if that circuit traverses various tiers and is exposed to different probabilities of ignition by contact from objects, or varying topography and vegetation that can influence fire propagation and consequence. This analysis also indicates that there is inherent and unavoidable risk in operating overhead circuits in the HFRA, and residual risk remains even after these circuits are mitigated. For example, SCE is seeking to install approximately 6,200 miles of covered conductor in the HFRA by the end of 2023 and is proposing the prioritization of higher-risk segments over lower-risk segments. As currently modelled, the risk associated with initial mitigation deployment would focus on the higher risk segments, such as a circuit or series of contiguous circuit segments in HFRA that is subject to high winds, where there is higher risk of ignition, higher ground fuel loading, and higher fire consequence scoring. The next mile beyond what SCE is proposing to cover in this GRC period could potentially be subjected to high winds but may also be located in an area that may have slightly less ground fuel loading to support fire propagation. The installation of covered conductor at the volume requested in this GRC represents a significant step forward in reducing risk as quickly as possible by deploying covered conductor to the highest risk circuits and circuit segments first. This level of prioritization leverages the latest advancements in SCE's continuously improving risk modelling capability,[23] in concert with prior risk evaluation, engineering scoping, bundling efficiencies, and work management practices.

(b) Basis for Capital Expenditure Forecast

This forecast is primarily driven by the volume of circuit miles of covered conductor proposed above. SCE estimates the unit cost for covered conductor to be $421k per circuit mile. This unit cost was estimated by using 2017 Overhead Conductor Program projects that were in the HFRA, adjusted for the expected cost for additional resources required for more complex installations and higher material costs. It also includes expected increases in pole replacements driven by heavier conductor with a larger profile. These pole replacements are assumed to use fire resistant composite poles which are estimated have an incremental cost over a standard wood pole.[24]

Additionally, the forecast includes the remediation[25] of all tree attachments in SCE's HFRA. Primary and secondary tree attachments in the HFRA are estimated to number approximately 3,200. The unit cost was estimated using the average cost per attachment projected in the Dinkey Creek pilot project.[26]

The units and unit costs for covered conductor, fire resistant poles, and tree attachments are presented in Table II-7 below.[27]

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[23] *See* Exhibit SCE-01, Vol. 2 for additional discussion on these risk analysis capabilities.

[24] The $421k covered conductor unit cost includes pole replacement costs as if they were going to be replaced with wood poles. Additionally, SCE has identified an incremental $5k per pole to account for using fire resistant composite poles.

[25] In this context, "remediation" means relocating the tree attachment to a pole and eliminating the attachment to the tree.

[26] The Dinkey Creek project includes the replacement of approximately 40,000 circuit feet of 1950s era primary voltage rubber insulated aerial cable with new XPL insulated aerial cable and relocates approximately 120 dead or dying tree connected cable attachment to new wood poles. All other supporting equipment such as switches, branch line fusing, service transformers and service cable will be brought up to current standards as needed.

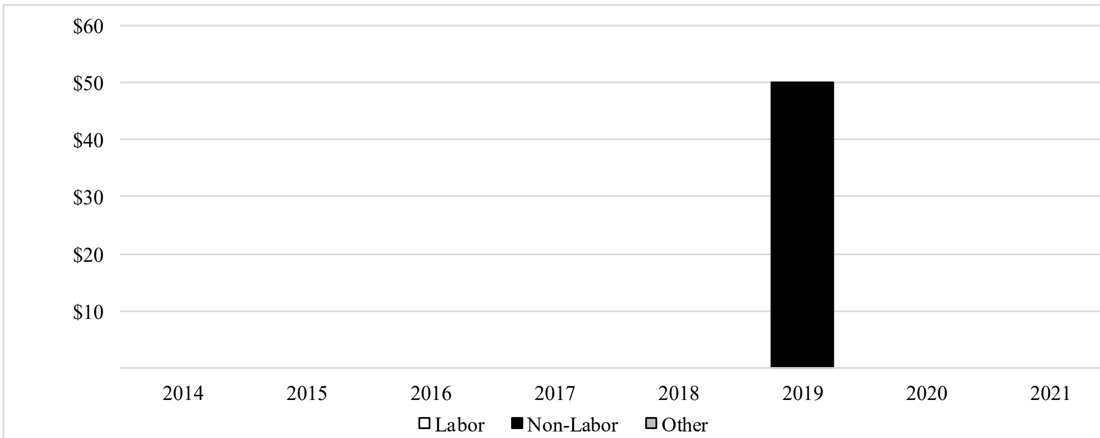
[27] Refer to WP SCE-04, Vol. 05, Part 1 pp. 251 - 262 – Wildfire Covered Conductor Program (Capital).

Table II-7
Wildfire Covered Conductor Program Unit Forecast
(Total Company Constant 2018 $000; Converted to Total Company Nominal $000)

Description		2019	2020	2021	2022	2023
Primary Tree Attachment Remediation	Units	129	176	247	282	335
	Unit Cost	$ 36	$ 36	$ 36	$ 36	$ 36
	Sub-Total	$ 4,616	$ 6,323	$ 8,852	$ 10,117	$ 12,014
Secondary Tree Attachment Remediation	Units	229	305	427	488	579
	Unit Cost	$ 25	$ 25	$ 25	$ 25	$ 25
	Sub-Total	$ 5,828	$ 7,751	$ 10,851	$ 12,402	$ 14,727
Covered Conductor	Circuit Miles	291	1,000	1400	1600	1900
	Unit Cost	$ 421	$ 421	$ 421	$ 421	$ 421
	Sub-Total	$ 122,733	$ 421,185	$ 589,659	$ 673,896	$ 800,252
Fire Resistant Poles	Units	3410	11700	16381	18721	22231
	Unit Cost	$ 5	$ 5	$ 5	$ 5	$ 5
	Sub-Total	$ 17,356	$ 59,559	$ 83,383	$ 95,295	$ 113,162
Total Company Constant (2018 000's $)		**$ 150,533**	**$ 494,818**	**$ 692,745**	**$ 791,709**	**$ 940,154**
Escalation		*$ 5,804*	*$ 38,985*	*$ 78,354*	*$ 115,037*	*$ 167,577*
Total Company Nominal (000's $)		*$ 156,337*	*$ 533,803*	*$ 771,099*	*$ 906,746*	*$ 1,107,732*

(4) WCCP O&M Cost Forecast

Figure II-10
Wildfire Covered Conductor Program
2019-2023 O&M Forecast
(Constant 2018 $000)[28]



	Recorded					Forecast		
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Labor								
Non-Labor						$50		
Other								
Total Expenses						**$50**		
Ratio of Labor to Total	-	-	-	-	-	0%	-	-

(a) Basis for O&M Cost Forecast

In 2019, SCE will perform a fire test and subsequent analyses on fire resistant wrapped wood poles to validate their performance prior to their potential use. The forecast cost is based on a vendor quote to perform validation testing and analysis for fire resistant wrapped wood poles.

(5) RAMP Integration

In Chapter 10 of SCE's 2018 RAMP report, SCE evaluated the ability for covered conductor to address the wildfire risk. This risk analysis identified several drivers of wildfire ignitions which covered conductor can mitigate, including:[29]

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[28] Refer to WP SCE-04, Vol. 05, Part 1 pp. 263 - 269 – O&M Detail for Wildfire Covered Conductor Program.

[29] *See* SCE 2018 RAMP report, Chapter 10, Section IV – Mitigations, as well as associated workpapers, for further discussion on how covered conductor affects these drivers.

- Contact from Object (*i.e.*, animal, balloons, vegetation, unspecified): Re-conductoring with covered conductor reduces Contact from Object faults as the new conductor has a physical barrier that prevents foreign objects such as animals, balloons, and vegetation, from contacting the conductor.
- Equipment / Facility Failure (i.e., Conductor, Splice, Clamp, Connector): Re-conductoring with covered conductor reduces Equipment /Facility Failure by replacing small wire with large wire, which will increase the conductor's ability to withstand higher short circuit duty. This makes the conductor less susceptible to failure from faults on the line.

(a) <u>SED / Intervenor Comments</u>

In its report on SCE's RAMP report,[30] SED stated that a more refined risk analysis, circuit by circuit or line segment by line segment, especially for the WCCP where Index Scores have already been calculated by SCE, would be worthwhile for SCE to pursue. TURN and the Public Advocates had similar recommendations. SCE agrees that obtaining an understanding of the risks at the circuit or line segment level of granularity is beneficial to mitigating the greatest amount of risk as quickly as possible. Prior to receiving SED/Intervenor comments, SCE was already in the process of improving its risk analysis. Following submission of its RAMP filing, SCE completed the risk analysis refinements referenced above, which is described in detail in SCE-01, Volume 2, and will continue to improve and enhance its risk analysis capabilities.

(b) <u>Reconciliation Between RAMP and GRC</u>

Table II-8 provides a comparison between the RAMP and GRC capital expenditures forecasts for WCCP.

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[30] *See* SED's "A Regulatory Review of the Southern California Edison's Risk Assessment Mitigation Phase Report for the Test Case 2021 General Rate Case," dated May 24, 2019, I.18-11-006, p. 48.

Table II-8
Wildfire Covered Conductor Program Mitigations
RAMP vs GRC Capital Forecast Comparison
(Nominal $000)

RAMP Risk	RAMP ID	RAMP Control / Mitigation Name	Filing Name	2019	2020	2021	2022	2023
Wildfire[1]	Various[2]	Wildfire Covered Conductor Program[2]	RAMP	$ 60,437	$ 231,501	$ 278,977	$ 346,187	$ 417,269
			GRC	$ 156,337	$ 533,803	$ 771,099	$ 906,746	$ 1,107,732
			Variance	$ 95,900	$ 302,302	$ 492,122	$ 560,559	$ 690,462

[1] The same mitigation was used to mitigate Wildfire and Contact with Energized risks in the RAMP report. The funding for this work will be entirely requested in this volume

[2] The Wildfire Covered Conductor Program contains RAMP Control C2: FR3 Overhead Distribtion and Mitigations M1: Wildfire Covered Conductor Program and M9: Fire Resistant Poles

The increase between RAMP and GRC for WCCP capital expenditures is primarily driven by the addition and acceleration of approximately 1,500 additional circuit miles of covered conductor and associated pole replacements into the 2019 – 2023 time-frame. An increase of the fire-resistant pole unit cost attributed to additional B-materials associated with these poles also contributes to the overall increase of this activity. These two increases were slightly counteracted by a slight decrease in the unit cost for covered conductor, which was driven by the removal of pensions and benefits from the estimates from the unit costs.

b) High Fire Risk Area (HFRA) Sectionalizing Devices

(1) Work Description

SCE intends to install new, and relocate existing, Remote-Controlled Automatic Reclosers (RARs) and Remote-Controlled Switches (RCSs) to poles just outside the HFRA boundaries on HFRA circuits that originate from substations outside the boundary. RARs are switching devices capable of interrupting fault current. They operate in a similar fashion to a substation circuit breaker but are located out on distribution lines. RCSs are a less robust sectionalizing device, not rated to interrupt fault current but capable of dropping load current. SCE plans to install 122 RARs from 2019-2021.

In some instances, SCE will install RCSs rather than RARs. RCSs are able to drop load current, which provides benefits associated with mitigating outage impacts associated with Public Safety Power Shutoff (PSPS). In these locations, the benefits provided by RARs to interrupt faults, utilize fast curve operating settings, and provide reclose relay blocking capabilities of RARs, are not needed because a nearby upstream device is already providing the desired protection.

Accordingly, SCE believes that deploying RCSs, which are lower cost than RARs, is appropriate for these applications. SCE plans to install 47 RCSs from 2019-2020. In remote locations where topography affects SCE's ability to maintain reliable radio coverage which is used to remotely control these devices, it may elect to install manual Pole Switches (PSs) rather than RCSs.

SCE will also employ Fast Curve Settings for RARs and circuit breakers (CBs), which modify the relay fault detection curve providing faster fault detection and interruption. Once the updated settings are installed, the Fast Curve can be remotely activated or deactivated through SCE's monitoring and control network. During fire weather conditions, the Fast Curve settings will be enabled by SCE's Distribution Control Center operators, resulting in typical faults being cleared more quickly. These settings can be toggled remotely during elevated fire weather conditions. Fast Curve settings reduce fault energy by increasing the speed with which a relay reacts to most fault currents. Compared to conventional settings, reduced fault durations anticipated with Fast Curve operating settings are expected to reduce heating, arcing, and sparking for many faults. The Fast Curve reduction in fault energy is dependent on the fault magnitude and existing settings; as a general comparison, the configuration with fast-curve setting is expected to typically result in 2 to 3 times reduction in fault energy compared to pre-existing protective schemes prior to the installation of fast-curve settings. During initial fault review efforts of the Fast Curve Settings development energy reductions of up to 10 times were observed. Additionally, SCE will replace relays and associated equipment in order to enable multiple settings groups to be toggled remotely, where existing relays lack the ability to do so. This will allow a single operator to respond more quickly by changing the protection settings on large quantities of devices covering a large geographic area simultaneously.

(2) <u>Need for Activity</u>

These sectionalizing assets will assist SCE in four important ways:[31]

1. Public Safety Power Shutoff (PSPS)[32] – When SCE proactively de-energizes circuitry due to elevated fire conditions SCE will be able to utilize sectionalizing devices (RARs and RCSs) to further limit the number of customers impacted;

[31] RCSs do not interrupt faults and therefore do not provide benefits (2) through (4).

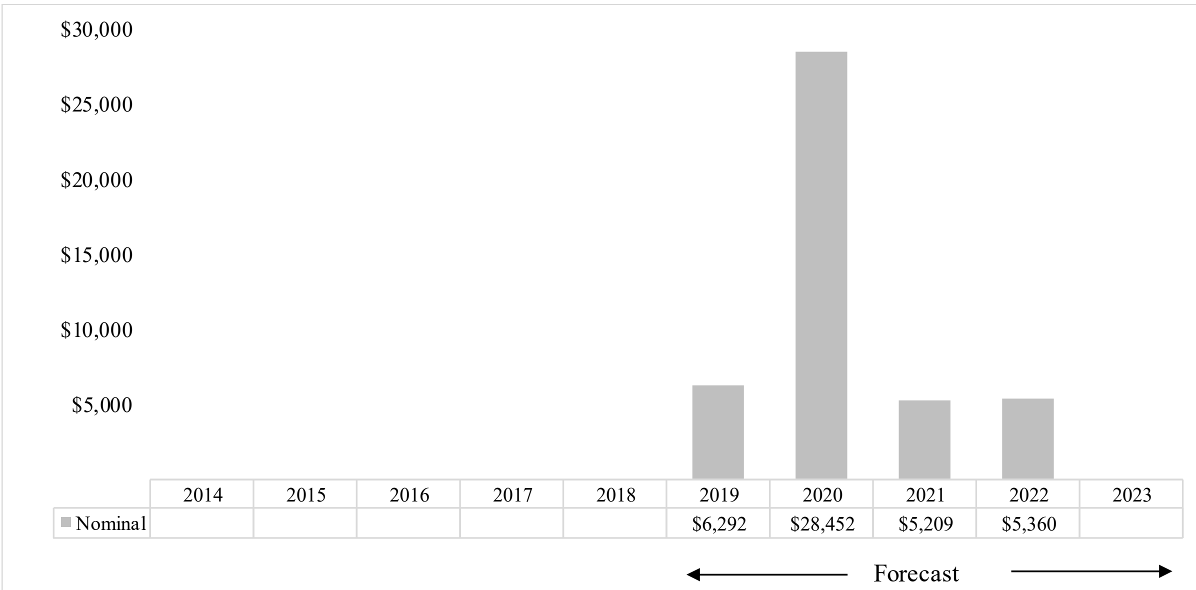
[32] PSPS is further discussed below in Section II.B.4.

2. Fault Interruptions - RARs will be applied to automatically interrupt faults on the HFRA circuit and will minimize the amount of circuitry, and thereby customers, sectionalized;
3. Fast Curve Operating Settings - during Red Flag Warnings and other elevated fire danger conditions, the RARs and Circuit Breakers will be remotely configured to operate with Fast Curve Settings, thereby isolating many faults faster, limiting total energy delivered to these faults, and reducing ignition risks; and
4. Reclose Relay Blocking - permits SCE to remotely block reclosing of RARs and CBs to SCE's HFRA during Red Flag Warnings and other elevated fire danger conditions while permitting reclosing in non-HFRA, thus enabling a lesser degree of outage and public impact in the event of a fault.

The remote-control capabilities associated with RARs, RCSs, and replacement of relays and associated equipment to enable group control are necessary to enable SCE to quickly respond to emergent fire danger conditions. Without the remote-control capabilities, a field employee would be required to manually toggle settings at the physical location of each device every time conditions warrant such action, which would reduce SCE's ability to quickly activate these settings when needed. Additionally, due to the large number of devices that may potentially be enabled at a given time, the group control capabilities enable SCE operators to quickly activate the desired protection settings more quickly.

(3) HFRA Sectionalization Capital Expenditure

Figure II-11
HFRA Sectionalizing Devices
2019-2023 Forecast
(Total Company Nominal $000)[33]



(a) Basis for Capital Expenditure Forecast

This forecast is primarily driven by the number of RARs, RCSs, and PSs needed to provide the necessary isolation points for circuits crossing the HFRA boundary. SCE estimates the unit costs for RARs to be $93k based on historical RAR projects from 2017. SCE estimates the unit costs for RCSs to be $54k based on initial detailed project estimates. SCE estimates the unit costs for PSs to be $12k based on initial detailed project estimates. Additionally, SCE will replace 261 electromechanical relays with microprocessor relays to enable fast curve setting on all HFRA circuit breakers. The unit costs for these relay replacements vary by the scope and complexity of each project. The units, unit costs and forecasts are presented in Table II-9 below.[34]

[33] Refer to WP SCE-04, Vol. 05, Part 1 pp. 270 - 275 – Capital Detail by WBS Element for HFRA Sectionalizing Devices.

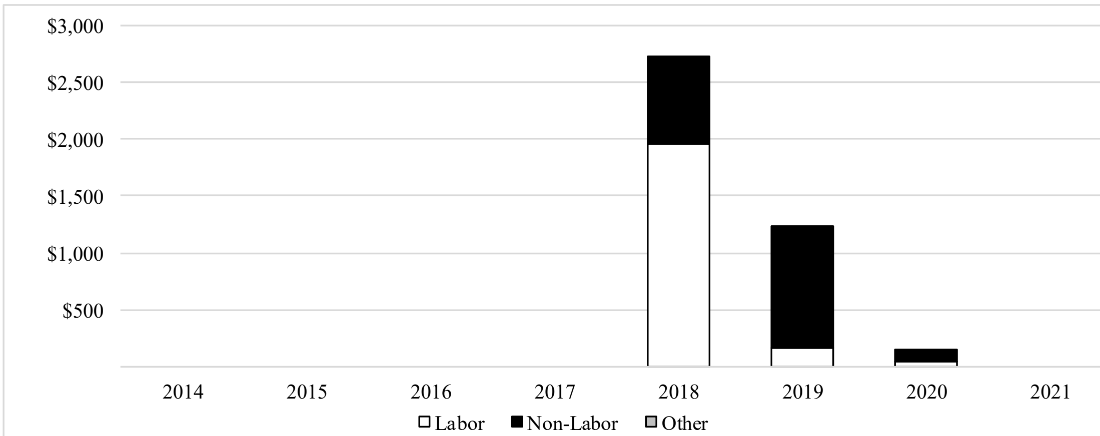
[34] Refer to WP SCE-04, Vol. 05, Part 1 pp. 276 - 284 – HFRA Sectionalizing Devices (Capital).

Table II-9
HFRA Sectionalizing Devices Unit Forecast
(Total Company Constant 2018 $000; Converted to Total Company Nominal $000)

Description			2019		2020		2021		2022		2023
New RARs	Units		53		69		0		0		0
	Unit Cost	$	93	$	93	$	93	$	93	$	93
	Sub-Total	$	4,920	$	6,405	$	-	$	-	$	-
New RCSs	Units		20		27		0		0		0
	Unit Cost	$	54	$	54	$	54	$	54	$	54
	Sub-Total		1078		1456		0		0		0
New PSs	Units		5		0		0		0		0
	Unit Cost	$	12	$	12	$	12	$	12	$	12
	Sub-Total	$	60	$	-	$	-	$	-	$	-
CB Relay Hardware for Fast Cu	Sub-Total	$	-	$	18,513	$	4,680	$	4,680	$	-
Total Company Constant (2018 000's $)		**$**	**6,059**	**$**	**26,374**	**$**	**4,680**	**$**	**4,680**	**$**	**-**
Escalation		*$*	*234*	*$*	*2,078*	*$*	*529*	*$*	*680*	*$*	*-*
Total Company Nominal (000's $)		*$*	*6,292*	*$*	*28,452*	*$*	*5,209*	*$*	*5,360*	*$*	*-*

(4) HFRA Sectionalization O&M Cost Forecast

Figure II-12
HFRA Sectionalizing Devices
2019-2023 Forecast
(Constant 2018 $000)[35]



	Recorded					Forecast		
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Labor					$1,965	$171	$48	
Non-Labor					$762	$1,060	$104	
Other								
Total Expenses					**$2,727**	**$1,231**	**$151**	
Ratio of Labor to Total	-	-	-	-	72%	14%	32%	-

(a) Basis for O&M Forecast

This forecast is primarily driven by the number of relocations needed to provide the necessary isolation points for circuits crossing the HFRA boundary. SCE estimates the unit costs for RAR relocations to be $76k based on the average of estimated project cost for situations ranging from simple relocations to relocations with major component repairs/replacement. Additionally, SCE will program all remaining RARs and CBs capable of being programed with Fast Curve settings in the HFRA. SCE estimates the unit costs for Fast Curve setting programing to be $1k based on detailed project estimates. The units, unit costs and forecasts are presented in Table II-10 below.[36]

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[35] Refer to WP SCE-04, Vol. 05, Part 1 pp. 285 - 291 – O&M Detail for HFRA Sectionalizing Devices.

[36] Refer to WP SCE-04, Vol. 05, Part 1 pp. 292 - 298 – HFRA Sectionalizing Devices (O&M).

Table II-10
HFRA Sectionalizing Devices Unit Forecast
(Total Company Constant 2018 $000)

Description		2019	2020	2021	2022	2023
RAR Relocations	Units	14	2	-	-	-
	Unit Cost	$ 76	$ 76	$ 76	$ 76	$ 76
	Sub-Total	$ 1,060	$ 151	$ -	$ -	$ -
RAR and CB Relay	Units	156	-	-	-	-
Fast Curve Settings	Unit Cost	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.1
	Sub-Total	$ 171	$ -	$ -	$ -	$ -
Total Company Constant (2018 000's $)		**$ 1,231**	**$ 151**	**$ -**	**$ -**	**$ -**

(5) RAMP Integration

In SCE's 2018 RAMP filing, RARs and Fast Curve Settings were modeled as reducing the outcomes associated with Red Flag condition wildfire outcomes.[37] During Red Flag Warning conditions, Fast Curve settings will be remotely enabled by SCE's Distribution Control Center operators, resulting in typical faults being cleared more quickly. Fast Curve settings reduce fault energy by increasing the speed with which a relay reacts to most fault currents. Compared to conventional settings, reduced fault durations anticipated with Fast Curve operating settings are expected to reduce heating, arcing, and sparking for many faults thereby reducing the potential for associated ignitions.

[37] When RAMP was developed, Remote-Controlled Automatic Recloser (RAR) / Circuit Breaker (CB) Fast Curve settings were expected to mitigate against all drivers. However, these settings would only be in place during 'Red Flag' conditions. Due to the constraints of the RAMP model, this mitigation could not be modeled to only affect certain outcomes (*i.e.* an outcome percentage shift). Therefore, due to the model limitations, this mitigation was modeled as a consequence reduction only for Red Flag specific outcomes.

(a) Reconciliation Between RAMP and GRC

Table II-11
HFRA Sectionalizing Devices Mitigations
RAMP vs GRC O&M Forecast Comparison
(Total company Nominal $000)

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021
Wildfire	M2	Remote-Controlled Automatic Reclosers and Fast Curve Settings	RAMP	$ 285	$ -	$ -
			GRC	$ 1,260	$ 158	$ -
			Variance	**$ 975**	**$ 158**	**$ -**

Table II-12
HFRA Sectionalizing Devices Mitigations
RAMP vs GRC Capital Forecast Comparison
(Total Company Nominal $000)

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021	2022	2023
Wildfire	M2	(M2) Remote-Controlled Automatic Reclosers and Fast Curve Settings	RAMP	$ 9,090	$ 19,288	$ -	$ -	$ -
			GRC	$ 6,292	$ 28,452	$ 5,209	$ 5,360	$ -
			Variance	**$ (2,798)**	**$ 9,164**	**$ 5,209**	**$ 5,360**	**$ -**

In RAMP, only 98 RARs were identified for inclusion and were all considered capital. Since then, SCE identified an additional 92 locations that would require a sectionalizing device. SCE also identified, in some cases, that alternative mitigations would be appropriate for use under specific conditions. This means SCE could use RCSs, PSs, or RAR relocations instead of adding a brand new RAR.

The increase between RAMP and GRC for O&M is driven by the inclusion of RAR relocations. The increase between RAMP and GRC for capital is driven by the addition of needed devices. This increase was counteracted by a change of RARs to RCSs or PSs, which both have a lower unit cost than RARs.

c) Fusing Mitigation

(1) Work Description

Fuses are safety devices consisting of a filament that melts and breaks an electric circuit if the current exceeds the fuses rating. SCE has traditionally used conventional expulsion type fuses (conventional fuses) for Branch Line Fuse (BLF) applications. For this program, SCE intends to utilize Current Limiting Fuses (CLFs) for most applications in the HFRA. CLFs are selected for this application because they can provide faster fault clearing for most faults and a reduction in fault energy,[38] compared to a conventional fuse. This fault energy reduction is expected to reduce the size and quantity of molten metal particles created by the fault which then reduces the likelihood of igniting dry brush, or other combustible materials, that those particles may land on. Fuses are placed on branch lines to increase fault clearing speed and minimize number of the customers affected by resulting outages.

SCE has considered various fusing technologies and interrupting devices that have the potential to further reduce the risk of ignitions in HFRA. In assessing the options, SCE took into consideration energy reduction capabilities, maintenance requirements, and cost. SCE's proposed fusing approach allows for rapid deployment across all of SCE's HFRA distribution circuits with relatively minimal costs to alternate strategies. Specifically, the BLFs work in conjunction with other SCE mitigation programs such as Fast Curve operating settings, reclose relay blocking, and covered conductor. SCE is also piloting substation-class electronic fuses in 2019 that would be deployed on overhead feeders just outside of the substations to provide energy reduction capabilities to main line circuitry.

(2) Need for Activity

CLFs are selected for this application because they can provide faster fault clearing for most faults and a reduction in fault energy, compared to a conventional fuse. In addition to the fault energy reduction, the placement of BLFs is expected to improve electric circuit reliability by segmenting faulted circuits to smaller line sections.

De-energizing lines that experience faults due to vegetation contact, animal contact, or contact with other objects, is critical to mitigating fire ignition risk. In addition, the ability to limit the amount of energy associated with a fault is expected to further minimize the ignition

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[38] Various vendor and industry documentation suggest the CLF energy reduction is typically up to twenty-five (25) times compared to a conventional fuse for high magnitude fault currents. Refer to WP SCE-04 Vol. 05, Part 1 pp. 299 - 308 – IEEE Fusing Support.

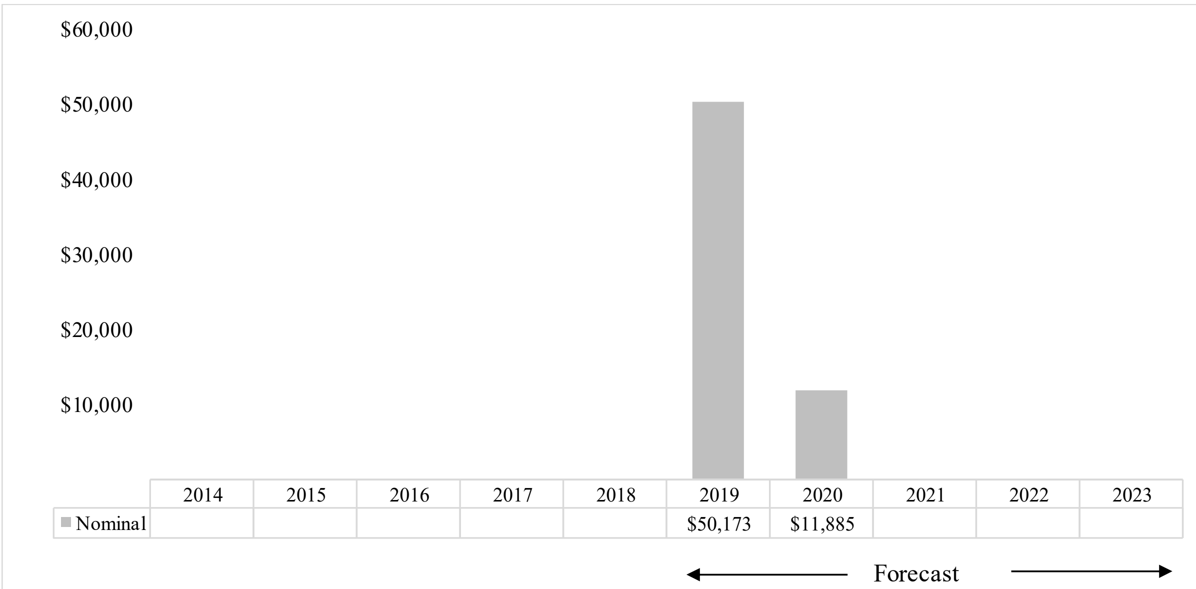
potential. Given that SCE's HFRA circuits have approximately 9,000 branch lines,[39] a substantial reduction in high fault energy events can be realized with CLF applications for these locations. Furthermore, replacement of conventional BLFs with CLFs can further aid in reducing fault energy on branch circuits. SCE's substation-class electronic CLF pilot is aimed at evaluating the expansion of fault energy reduction to main line circuitry as well as branch lines to further mitigate fire ignition risk.

It is important to note that CLFs and covered conductor work together in terms of their respective strategic purposes for mitigating wildfire risk. Covered conductor is preventative in nature and is intended to reduce the number of "contact from object" faults experienced such as wire-to-wire, vegetation, animal, and other debris. While covered conductor is highly effective at reducing faults it is not fool proof. Additionally, equipment failures (transformer, capacitors, potheads, etc.) can also cause fault current to flow and covered conductor doesn't mitigate mechanical failures caused by car hit pole events or trees/large limbs falling into the lines that can cause wire downs. It is in these situations that the CLFs SCE is deploying help to minimize ignition risk by significantly reducing energy delivered to faults. This energy reduction also reduces collateral damage to upstream conductor and equipment in the fault path from the substation. Furthermore, due to the significantly shorter deployment timelines associated with CLFs, they will be in place to provide the energy reduction benefits in most locations in advance of covered conductor deployment.

[39] Approximately 2,000 un-fused branch lines were fused in 2018 under the GSRP program.

(3) Fusing Mitigation Capital Expenditure Forecast

Figure II-13
Fusing Mitigation
2019-2023 Forecast
(Total Company Nominal $000)[40]



(a) Basis for Capital Expenditure Forecast

This forecast is primarily driven by the number of fuse locations SCE plans to install or replace during the 2019-2023 time period. SCE will install new fuses at all 7,473 branch lines in the HFRA that were not fused at the start of 2019. SCE will also replace all fuses at locations where convention fuses exist without compatible fuses holders, which equates to 1,254 locations. SCE estimates the unit cost for these locations to be $6k per location. This unit cost was estimated using planned average project costs.

Additionally, SCE will install 11 substation class electronically controlled fuses as a pilot in 2020. The unit cost is based on a detailed project estimate.

The units and unit costs are presented in Table II-13 below.[41]

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[40] Refer to WP SCE-04 Vol. 05, Part 1 pp. 309 - 311 – Capital Detail by WBS Element for Fusing Mitigation.

[41] Refer to WP SCE-04 Vol. 05, Part 1 pp. 312 - 318 – Fusing Mitigation (Capital).

Table II-13
Fusing Mitigation Unit Forecast
(Total Company Constant 2018 $000; Converted to Total Company Nominal $000)

Description		2019	2020	2021	2022	2023
Current Limiting Fuses	Locations	7,473	1,254	-	-	-
	Unit Cost	6	6	6	6	6
	Sub-Total	$ 48,310	$ 8,104	$ -	$ -	$ -
Substation Class Electronically -	Locations	-	11	-	-	-
Controlled Fuses	Unit Cost	$ -	$ 265	$ -	$ -	$ -
	Sub-Total	$ -	$ 2,913	$ -	$ -	$ -
Total Company Constant (2018 000's $)		**$ 48,310**	**$ 11,017**	**$ -**	**$ -**	**$ -**
Escalation		*$ 1,863*	*$ 868*	*$ -*	*$ -*	*$ -*
Total Company Nominal (000's $)		*$ 50,173*	*$ 11,885*	*$ -*	*$ -*	*$ -*

(4) <u>Fusing Mitigation O&M Cost Forecast</u>

Figure II-14
Fusing Mitigation
2019-2023 Forecast
(Constant 2018 $000)[42]

	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor						$33	$4,900	$705
Non-Labor						$19	$2,901	$417
Other								
Total Expenses						**$52**	**$7,801**	**$1,122**
Ratio of Labor to Total	-	-	-	-	-	63%	63%	63%

[42] Refer to WP SCE-04 Vol. 05, Part 1 pp. 319 - 325 – O&M Detail for Fusing Mitigation.

(a) **Basis for O&M Forecast**

This forecast is driven by the number of fuse locations where SCE plans to replace fuses with CLFs during the 2019-2023 time period. SCE will also replace all fuses at locations where conventional fuses exist with compatible fuses holders, this equates to 3,862 locations. SCE estimates the unit cost for these locations to be $4k per location in 2019-2020 and $2.5k per location in 2021-2023. This unit cost was estimated using planned average project costs. The units and unit costs are presented in this forecast are based on a forecast of units and associated unit costs for replacement of current limiting fuses as presented in Table II-14 below.[43]

The forecast also includes costs for SCE to perform a pilot to evaluate Rapid Earth Fault Current Limiters (REFCL), which are a group of technologies which can be installed to rapidly reduce fault current should a phase to ground fault event occur, such as a wire down, which will reduce the likelihood of fire ignitions associated with these events.

Table II-14
Fusing Mitigation Unit Forecast
(Constant 2018 $000)

Description		2019	2020	2021	2022	2023
Current Limiting Fuses	Locations	-	1,931	434	496	588
	Unit Cost	4	4	3	3	3
	Sub-Total	$ -	$ 7,801	$ 1,122	$ 1,282	$ 1,523
REFCL	Pilot Estimate	$ 52	$ -	$ -	$ -	$ -
Total Company Constant (2018 000's $)		**$ 52**	**$ 7,801**	**$ 1,122**	**$ 1,282**	**$ 1,523**

(5) **RAMP Integration**

SCE's Fusing Mitigation was modeled in SCE's RAMP Wildfire chapter. SCE modeled Fusing Mitigation to reduce the ignition driver frequency of Equipment/Facility Failure by de-energizing branch lines that experience faults and reducing the fault energy that can damage conductors, insulators, or connectors.

(a) **Reconciliation Between RAMP and GRC**

Table II-15 and Table II-16 compare the RAMP and GRC O&M and Capital forecasts for Fusing Mitigation.

[43] Refer to WP SCE-04 Vol. 05, Part 1 pp. 326 - 330 – Fusing Mitigation (O&M).

Table II-15
Fusing Mitigations
RAMP vs GRC O&M Forecast Comparison
(Total Company Nominal $000)

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021
Wildfire	M8	Fusing Mitigation	RAMP	$ 1,735	$ 21,675	$ -
			GRC	$ 53	$ 8,230	$ 1,214
			Variance	**$ (1,682)**	**$ (13,445)**	**$ 1,214**

Table II-16
Fusing Mitigations
RAMP vs GRC Capital Forecast Comparison
(Total Company Nominal $000)

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021	2022	2023
Wildfire	M8	Fusing Mitigation	RAMP	$ 46,490	$ 9,990	$ -	$ -	$ -
			GRC	$ 50,173	$ 8,743	$ -	$ -	$ -
			Variance	**$ 3,683**	**$ (1,248)**	**$ -**	**$ -**	**$ -**

The O&M forecast for Fusing Mitigation in this GRC is lower than in RAMP due to a decrease in units needing to be completed, as SCE expecting to remove a substantial portion of the non-CPUC HFRA.

The increase between RAMP and GRC for capital is primarily driven by the addition of expected complexity and increase to the unit cost as observed in recently installed fuses. This increase was counteracted by a decrease of units needing to be completed due to the expected reduction of removing a substantial portion of the non-CPUC HFRA from forecasts after 2019.

d) <u>Distribution Fault Anticipation (DFA)</u>

(1) <u>Work Description</u>

Distribution Fault Anticipation (DFA) is a technology that utilizes devices with a predictive algorithm that leverages electrical system measurements to recognize current and voltage signatures indicative of potential incipient equipment failures. DFA allows for continuously monitoring circuit current and voltage waveforms from utility substation current and potential transformers (CT's and PT's, respectively) and applying digital signal processing, pattern matching, along with other software techniques to report ongoing and developing circuit events and conditions. DFA alerts SCE of potential equipment weaknesses/failures to allow for proactive remediation, thus avoiding faults and minimizing ignition risks. SCE is investigating the use of DFA to predict failures based on voltage and current signatures for proactive mitigation during its 2019-2020 pilot. In 2019, SCE will install 60 DFA devices inside existing Mechanical-Electrical Equipment Room (MEER) buildings at 7 substations and will study their performance. In 2020, SCE will determine how to best utilize DFA as a tool for identifying anomalies on distribution circuits to better guide proactive maintenance, which reduces in-service failures of equipment, serving to reduce potential ignitions. From 2021 through 2023, SCE will begin installing DFA across HFRA circuits.

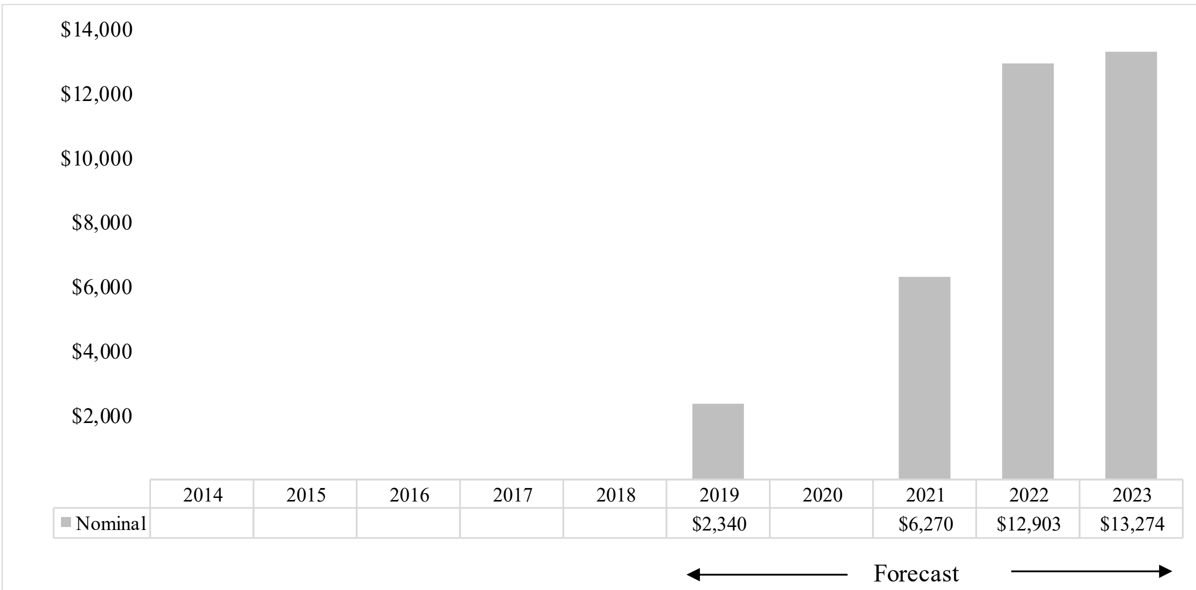
(2) Need for Activity

This technology was developed collaboratively by Texas A&M Engineering and the Electric Power Research Institute, Inc. (EPRI). SCE currently receives line circuit data from monitoring and protection systems and performs utility preventive maintenance accordingly. Data gained from the DFA deployment could be used to further assist with the diagnosis of potential system failures in support of equipment repair/replacement and reduction of potential fire ignition risks and reliability impacts. This is achieved by preventing faults that may occur due to failing equipment, which can result in expulsion of hot particles or in downed wires. DFA can also serve to identify locations where conductor slapping occurs. If left unmitigated, conductor slapping emits a shower of hot, possibly burning particles with each episode.

DFA allows for continuously monitoring circuit current and voltage waveforms to report ongoing and developing circuit events and conditions that could be used in support of maintenance decisions as appropriate. The DFA devices will be located within the substation and monitoring circuits impacts as the circuits leave the station. SCE intends to study the information received from the DFA program study in determining future deployment decisions to further assist in support of equipment maintenance reviews.

(3) **DFA Capital Expenditures**

Figure II-15
Distribution Fault Anticipation
2019-2023 Forecast
(Total Company Nominal $000)[44]



(a) **Basis for Capital Expenditure Forecast**

SCE estimates the forecast for this activity to include 810 devices at the cost of $38k per device during 2018-2023. There will be a pilot in 2019 that will include the installation of 60 devices. After analysis of the pilot, based on the results of the pilot, SCE forecasts that it will install another 750 devices between 2021 – 2023 as a part of the program roll out. The unit cost is based on the estimate for the 60-device pilot, which includes 7 substations. SCE notes that it has proposed the establishment of a two-way wildfire-related balancing account in this proceeding. If the Commission adopts this proposal, it should obviate any potential concerns related to the implementation of new wildfire-mitigation technologies and other related issues underlying potential forecast uncertainties for wildfire-mitigation-related spend.[45]

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[44] Refer to WP SCE-04 Vol. 05, Part 1 pp. 331 - 332 – Capital Detail for WBS Element for Distribution Fault Anticipation.

[45] Refer to WP SCE-04 Vol. 05, Part 1 pp. 333 - 336 – Distribution Fault Anticipation (Capital).

Table II-17
DFA Unit Forecast
(Total Company Constant 2018 $000; Converted to Total Company Nominal $000)

Description			2019		2020		2021		2022		2023
Distribution Fault Anticipation	Devices		60		-		150		300		300
	Unit Cost		38		38		38		38		38
Total Company Constant (2018 000's $)		**$**	**2,253**	**$**	**-**	**$**	**5,633**	**$**	**11,266**	**$**	**11,266**
Escalation		*$*	*87*	*$*	*-*	*$*	*637*	*$*	*1,637*	*$*	*2,008*
Total Company Nominal (000's $)		*$*	*2,340*	*$*	*-*	*$*	*6,270*	*$*	*12,903*	*$*	*13,274*

(4) DFA O&M Forecast

(a) Need for Activity

This activity is required for SCE to manage the large quantity of data that will be collected from DFA devices during the study period 2019-2020 as well as 2021 for continued support of the pilot locations as SCE transitions to from pilot to broad implementation. Texas A&M will provide SCE with data storage, software to remotely access data, software to automatically interpret DFA data, and also provide support in the form of researchers who will work with SCE personnel to identify how to integrate DFA with other SCE tools and systems.

(b) **Scope and Forecast Analysis**

Figure II-16
Distribution Fault Anticipation O&M Expenses
(Constant 2018 $000)[46]

	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor								
Non-Labor						$729	$205	$68
Other								
Total Expenses						**$729**	**$205**	**$68**
Ratio of Labor to Total	-	-	-	-	-	0%	0%	0%

(c) **Basis for O&M Cost Forecast**

This forecast is based on a negotiated contract with Texas A&M University to provide software/service, data interpretation, and integration services.[47]

e) **Targeted Undergrounding Program**

(1) **Work Description**

As part of its continued efforts to reduce wildfire risk, in 2019, SCE will conduct an assessment to determine if certain areas should be considered for undergrounding. Construction for areas identified for undergrounding will begin in 2021.

Undergrounding of existing overhead power lines consists of digging a continuous trench approximately 24" wide and anywhere from 36" to 62" deep depending on number of conduits required. Vaults and manholes will be required at regular intervals along this trench to

[46] Refer to WP SCE-04 Vol. 05, Part 1, WP, pp. 337 - 343 – O&M Detail for Distribution Fault Anticipation.

[47] Refer to WP SCE-04 Vol. 05, Part 1, WP, pp. 344 - 345 – Distribution Fault Anticipation (O&M).

accommodate cable pulling and electrical connections as well as any underground equipment being relocated from the overhead system. These structures vary in size from 7’x18’x8’ for the largest vaults to 5’x10’-6”x7’ for the smallest standard manhole. Since the Targeted Undergrounding Program is focused on reducing wildfire risk, SCE will only be addressing energized electric conductors and will not be including any communications infrastructure in the program. Following the installation of the new equipment, overhead primary and secondary conductors as well as any SCE only poles (*i.e.* not associated with a joint owner) will be removed.

Generally, when converting existing overhead lines to underground facilities, a line route needs to be determined. Often times in urbanized areas this route can be the same as the existing overhead line assuming pre-existing underground utilities (e.g. natural gas, water, sewer, etc.) do not preclude the addition of a new duct and structure system. Routes may also need to be altered to avoid obstructions. For example, this may involve moving a rear property pole line to curbside to avoid swimming pools, block walls, etc. In coastal, mountainous, or more rural communities topography can present additional challenges to those already mentioned above. Lines may need to be moved to the road to avoid steep terrain, heavy vegetation, water crossings, erosion concerns, and to generally avoid environmental considerations associated with heavy equipment access to construct and/or maintain lines. Because of these topographical challenges with some existing overhead lines, vehicle access required for installing underground cable is not available, which makes undergrounding along the same route impractical. Therefore, overhead lines may need to be brought out to the public right-of-way for undergrounding, increasing the length of the undergrounding needed and significantly increasing the cost as well as the construction timeline. Additionally, traffic control plans need to be developed, permits secured, and finally, each service panel currently taking overhead service along the conversion route will need to be evaluated to determine upgrades needed to accommodate an underground electric service.

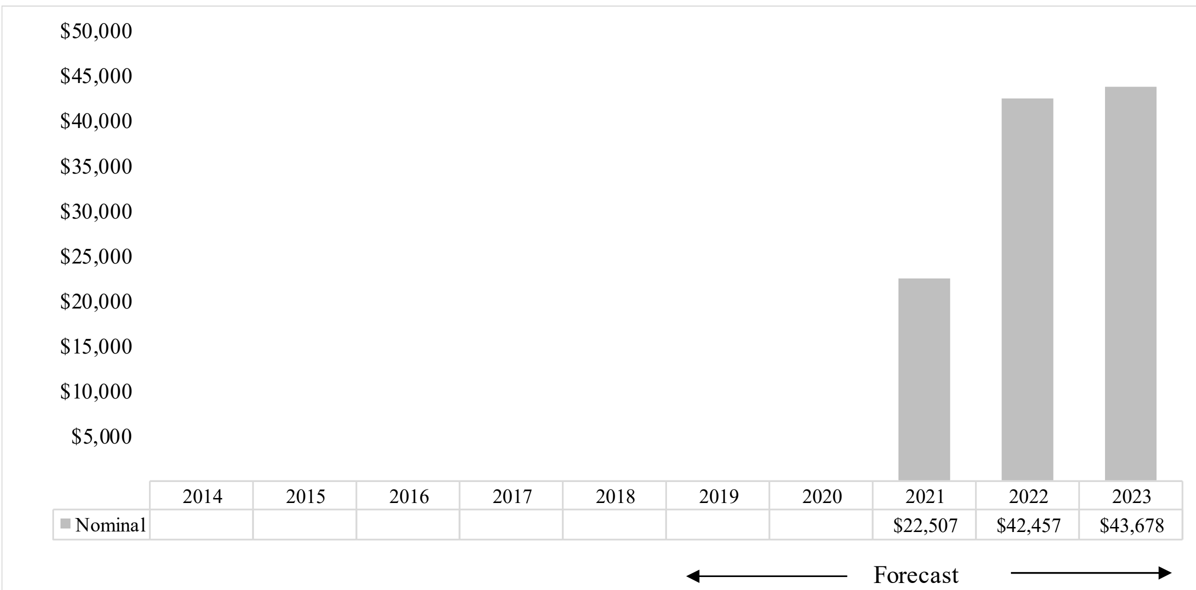
(2) Need for Activity

In 2019, SCE will conduct an evaluation to determine portions of its HFRA where the need to mitigate ignitions exceeds that which can be delivered by an overhead system, for targeted undergrounding.

Placing lines underground is typically less cost-effective at reducing risk than installing covered conductor. However, under certain circumstances where covered conductor would not sufficiently mitigate wildfire risk and certain sections of line cannot be moved, it may be appropriate to underground. Pursuant to SCE's procedural proposal to update its wildfire-related forecast in this GRC, SCE will report on any updates from analyses evaluating undergrounding overhead conductor.[48]

(3) Targeted Undergrounding Capital Expenditures

Figure II-17
Targeted Undergrounding
2019-2023 Forecast
(Total Company – Nominal $000)[49]



(a) Basis for Capital Expenditure Forecast

This forecast is based on the number of miles SCE expects to be able to underground during the 2019-2023 time period. Given the long cycle times for undergrounding circuitry SCE intends to underground six circuit miles in 2021 and 11 circuit miles per year in 2022-2023. SCE estimates the unit cost for undergrounding to be $3,370k per mile. This unit cost was estimated by unitizing 2018 Rule 20A undergrounding projects. The units and unit costs are presented in Table II-18 below.[50]

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[48] *See* Chapter IV.A of the Application.

[49] Refer to WP SCE-04 Vol. 05, Part 1 pp. 346 - 347 – Capital Detail by WBS Element for Targeted Undergrounding.

[50] Refer to WP SCE-04 Vol. 05, Part 1 pp. 348 - 350 – Targeted Undergrounding.

Table II-18
Targeted Undergrounding Unit Forecast
(Total Company Constant 2018 and Nominal $000)

Description		2019	2020	2021	2022	2023
Targeted Undergrounding	Miles	0	0	6	11	11
	Unit Cost	$ 3,370	$ 3,370	$ 3,370	$ 3,370	$ 3,370
Total Company Constant (2018 000's $)		**$ -**	**$ -**	**$ 20,220**	**$ 37,071**	**$ 37,071**
Escalation		*$ -*	*$ -*	*$ 2,287*	*$ 5,386*	*$ 6,608*
Total Company Nominal (000's $)		*$ -*	*$ -*	*$ 22,507*	*$ 42,457*	*$ 43,678*

2. Organizational Support

a) Organizational Change Management

(1) Work Description

Organizational Change Management (OCM) is a program focused on helping to identify and manage the effect of necessary changes to business processes, systems and tools, job roles, policies and procedures, and other areas that may have a corresponding impact to resources.

SCE's OCM efforts primarily support its wildfire mitigation programs and is embedded both at the program level to oversee and coordinate across work streams, and at the work stream level to address more targeted/localized OCM efforts. OCM efforts include employee and other stakeholder communications, engagement, training, coaching, development, feedback, monitoring, and advocacy.

(2) Need for Activity

For SCE's wildfire mitigation efforts, the OCM work is needed to facilitate internal and external awareness, understanding, and knowledge of the many and varied changes resulting from the increased hardening and resiliency of our grid and the safety of our employees, customers, and communities. Given the scope, scale, and complexity of change inherent in the wildfire mitigation programs, it is critical to embed OCM efforts into these activities and solutions to increase the likelihood of success of the programs' intended outcomes.

(3) Organizational Change Management O&M Forecast

Figure II-18
OCM Development and Delivery O&M Expenses
(Constant 2018 $000)[51]

	Recorded					Forecast		
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Labor								
Non-Labor						$2,171	$3,354	$3,354
Other								
Total Expenses						**$2,171**	**$3,354**	**$3,354**
Ratio of Labor to Total	-	-	-	-	-	0%	0%	0%

(a) Basis for O&M Cost Forecast

This forecast was calculated by estimating the amount of effort and resources required to effectively drive the amount of organizational change needed for SCE's wildfire management efforts. These costs include third party support for helping to drive these changes in planning, engineering, operational practices, communications, etc.[52]

b) Program Management Office (PMO) Support

(1) Work Description

In early 2018, SCE created a program management office (PMO) aggregating SCE's wildfire mitigation efforts and focused on bolstering public safety and system resiliency. From a high level, SCE charged the PMO with the following overarching objectives: (1) executing near-term actions to further mitigate increased wildfire risk; (2) developing enhancements

[51] Refer to WP SCE-04 Vol. 05, Part 1 pp. 351 - 357 – O&M Detail for Organizational Change Management.

[52] Refer to WP SCE-04 Vol. 05, Part 1 pp. 358 - 359 – Organizational Change Management.

to its operational plans for long-term wildfire, public safety, and related resiliency strategies; and (3) integrating SCE's wildfire mitigation strategies with existing programs, such as long-term capital planning, the Risk Assessment and Mitigation Phase (RAMP), and the GRC. Over the course of this past year, the PMO's core responsibilities have evolved to provide oversight for all wildfire mitigation activities. In order to support these objectives, SCE will augment its current staff to provide additional overall Program Management Office support. Additionally, SCE will focus on risk analysis to provide additional analysis and expertise regarding program selection, sizing and prioritization.

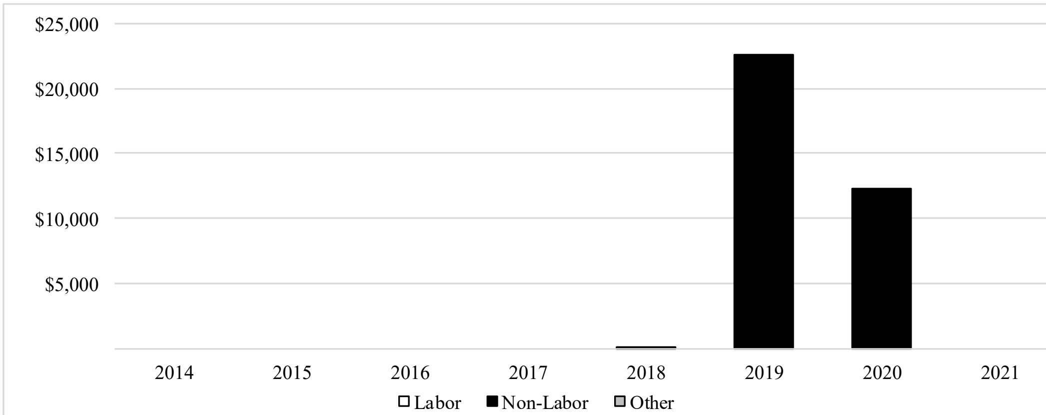
(2) <u>Need for Activity</u>

The recent increase in wildfire risk drives an even stronger need to find means to reduce the cause of wildfires and enhance methods to detect and suppress them more quickly. In order to operationalize the most effective suite of mitigations, SCE is contracting with vendors that have specific expertise. The PMO requires additional skills and resources that will be responsible for oversight of the entire portfolio. These resources will ensure the overall strategy gets integrated into the overall company's long-term plans, drive completion of regulatory requirements, and report on the overall status of the program.

SCE requires additional risk analysis expertise which will help shape the overall portfolio of mitigations. An overall system risk assessment and corresponding analysis on how mitigations affect this risk will help SCE select effective mitigations for its wildfire mitigation programs. Additionally, risk analysis that focuses on prioritization will allow for SCE to further improve the targeting of programs.

(3) **PMO Support O&M Forecast**

Figure II-19
PMO Support O&M Expenses
(Constant 2018 $000)[53]



	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor					$5			
Non-Labor					$53	$22,655	$12,271	
Other								
Total Expenses					**$57**	**$22,655**	**$12,271**	
Ratio of Labor to Total	-	-	-	-	8%	0%	0%	-

(a) **Basis for O&M Cost Forecast**

SCE estimated the forecast by extrapolating existing vendor purchase orders for 2019 through 2020. SCE currently has four primary vendors performing this activity in developing this forecast, SCE assumed the effort experienced over the first half of 2019 will continue through 2019 and will decline linearly over 2020 until ongoing efforts can be managed by SCE labor.[54]

3. **Enhanced Operational Practices**

a) **Enhanced Overhead Inspections (EOI) and Remediation**

(1) **Work Description**

SCE plans to conduct inspections of all overhead transmission and distribution structures and equipment in HFRA with a focus on potential ignition risk conditions. These inspections started in late 2018 and were substantially completed by June 2019. The ongoing

[53] Refer to WP SCE-04 Vol. 05, Part 1 pp. 360 - 366 – O&M Detail for Grid Resiliency PMO.

[54] Refer to WP SCE-04 Vol. 05, Part 1 pp. 367 - 368 – Grid Resiliency PMO.

inspection program for distribution assets in HFRA is currently forecasted to take place on a two-year cycle, inspecting approximately half of the HFRA each year. Inspections will include both ground and aerial components. Ground-based inspections involve inspectors inspecting overhead facilities from the ground in order to identify potential ignition sources. Aerial inspections employ high resolution photographs to identify problems that are not visible from the ground.

Additional internal and external resources have been added to support the aerial inspections of distribution and transmission assets. Engineers, GIS analysts, and inspection staff are all members of the aerial inspection team. This team correlates digital imagery with GIS locations for structures and documents the inspection findings. GIS analysts are required to geo-locate all assets based on inspection records. Analysts then take this information to create SAP work order notifications. For an additional detailed description of how EOI differs from SCE's traditional inspection programs, please see SCE's July 5, 2019 Advice Letter 4031-E.

SCE will also remediate necessary issues identified during inspections. Remediation activities likely will include, but will not be limited to, vegetation pruning/removals and the repair or replacement of overhead structures and equipment, such as conductors, poles, cross arms, insulators, and transformers. As part of the EOI effort, SCE will also assess and deploy additional system hardening measures to reduce ignition risk or increase grid resiliency, as appropriate, based on conditions observed. These measures may include, but are not limited to, wildlife protection (e.g., critter guards), and long span mitigations (e.g., installation of line spacers, reconductoring, cross arm replacement).

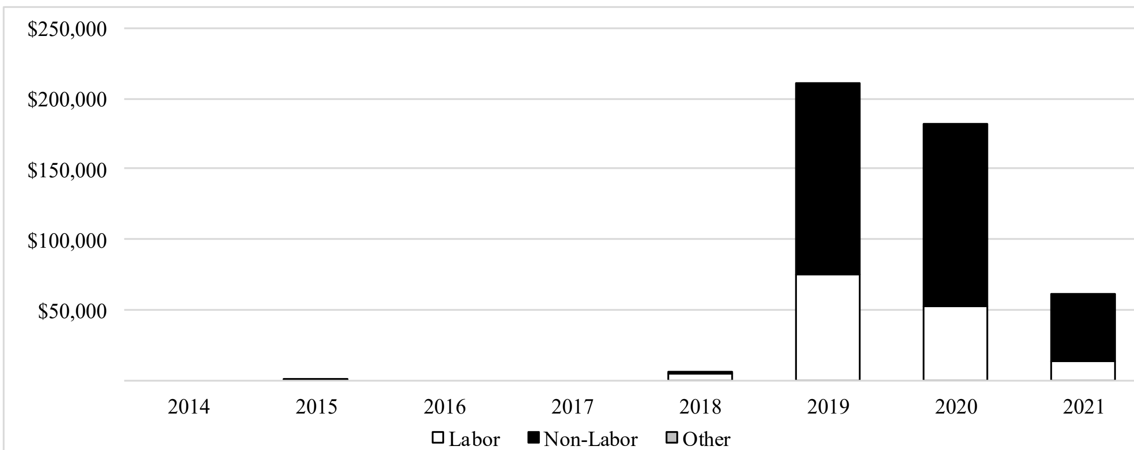
(2) <u>Need for Activity</u>

Due to the rapidly evolving wildfire risks, SCE continues to review and assess its inspection and maintenance programs to get ahead of the evolving wildfire threat. The EOI initiative is building on SCE's desire to evolve beyond a compliance-based approach to a risk-based approach (that still achieves compliance requirements). Inspection results will be analyzed in light of SCE's existing inspection, maintenance and capital programs, a risk-based inspection and remediation model will be explored, and lessons learned from the EOI initiative will be studied. The results of these analyses will serve as a foundation for a risk-based inspection and maintenance strategy that is likely to impact the objectives, design, and tactics of existing inspection and maintenance programs moving forward. Furthermore, SCE anticipates that these findings may also influence future design, engineering, construction, and operational standards/procedures to assess wildfire risks throughout the asset lifecycle.

CPUC General Order 95 Rule 18 has designated adjusted compliance timeframes for issues identified in HFRA. In addition to the need to meet state compliance regulations, remediation is intended to minimize wildfire risk, increase public safety, and ensure optimal electrical reliability to SCE customers. Remediation efforts have been vetted through multiple subject matter experts and external consultants to ensure SCE's approach to wildfire mitigation takes into account risk associated to the tier level of a notification, types of notification found in the inspection process, and consequence of a wildfire threat as prioritized using latest wildfire modeling data.

(3) EOI O&M Forecast

Figure II-20
Enhanced Overhead Inspections O&M Expenses
(Constant 2018 $000)[55]



	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor					$4,533	$75,347	$52,703	$13,493
Non-Labor		$1			$330	$135,913	$129,627	$48,044
Other								
Total Expenses		**$1**			**$4,863**	**$211,260**	**$182,329**	**$61,537**
Ratio of Labor to Total	-	0%	-	-	93%	36%	29%	22%

(a) Basis for O&M Cost Forecast

This forecast is composed of Transmission EOI, Distribution EOI, and Aerial inspections; Transmission and Distribution EOI repairs; long span mitigation; vertical switch

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[55] Refer to WP SCE-04 Vol. 05, Part 1 pp. 370 - 376 – O&M Detail for Enhanced Overhead Inspections and Remediation.

bypasses; and EOI PMO. SCE summarizes the individual methods used to forecast each of these components below, and provides further detail in workpapers:[56]

- The Transmission EOI inspection forecast ends in 2019 is based on actual costs.
- The Distribution EOI Inspection forecast is based on actual inspection results for 2019, while subsequent years are forecast based on the number of inspections needed for HFRA and a reduced cost per inspection due to increased inspection efficiency.
- The aerial inspections forecast is based on the number of poles to be inspected as well as a bottoms-up forecast of labor to review aerial inspection data.
- Transmission and Distribution EOI repairs are based on a forecast of notifications identified by EOI inspections and unit costs for repairs based on past completed notifications.
- The long span mitigation forecast is a bottoms-up forecast based on needed material and labor to implement these mitigations.
- Vertical switch costs are estimated based on an estimated 75 bypasses required for switch replacements while cost per bypass is estimated based on an assumed one crew-day of labor.
- EOI PMO costs are composed of project forecasts for various IT activities needed to support EOI implementation.

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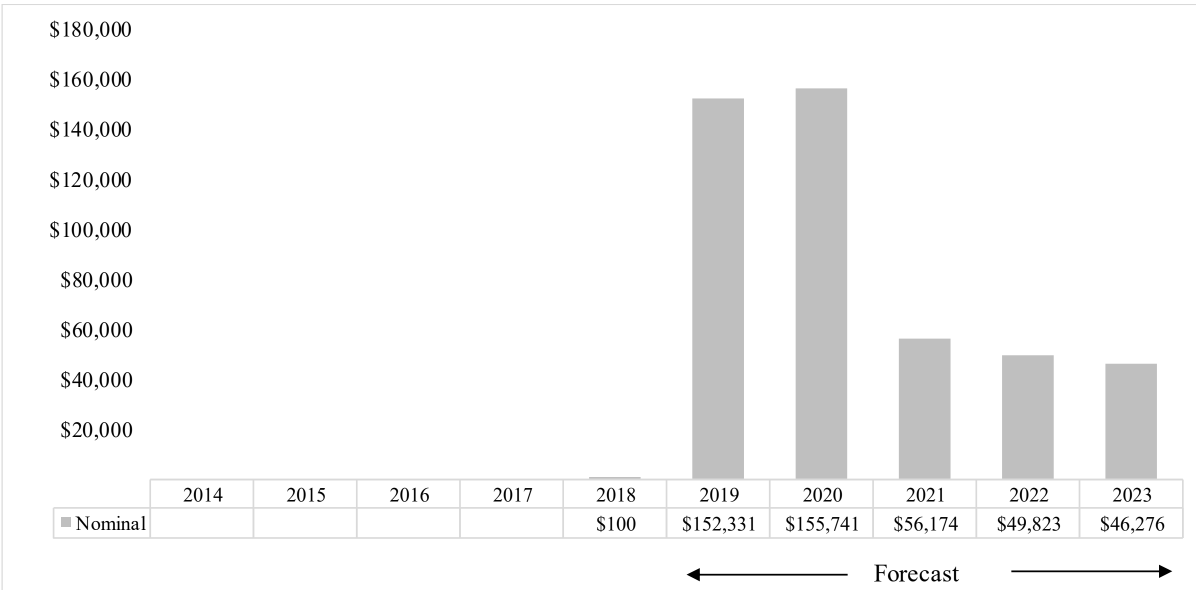
[56] Refer to WP SCE-04 Vol. 05, Part 1 pp. 377 - 389 – Enhanced Overhead Inspections (O&M).

(4) EOI Capital Expenditures

Figure II-21
Enhanced Overhead Inspections
2019-2023 Forecast
(Total Company – Nominal $000)[57]



(a) Basis for Capital Expenditure Forecast

This forecast is composed of transmission EOI replacements, distribution EOI replacements, long span mitigations, vertical switch replacements, and EOI PMO. SCE summarizes the individual methods used to forecast each of these components below, and provides further detail in workpapers:[58]

- Transmission and distribution EOI replacement expenditures are based on a forecast of capital notifications identified from EOI inspections that require capital remediation, while cost per notification is based on previously completed notifications.

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57 Refer to WP SCE-04 Vol. 05, Part 1 pp. 390 - 396 – Capital Detail by WBS Element for Enhanced Overhead Inspections and Remediation.

58 Refer to WP SCE-04 Vol. 05, Part 1 pp. 397 - 405 – Enhanced Overhead Inspections (Capital).

- Long span mitigation expenditures are based on a bottoms-up forecast of needed material and labor to implement these mitigations.
- Vertical switch replacement expenditures are based on 300 switch replacements with a unit cost based on a bottoms-up estimate to replace the switch, reconfigure cross arms, and install automation.
- EOI PMO costs are composed of projects forecasts for various IT support needed to support EOI implementation.

b) Infrared and Corona Inspection Program

(1) Work Description

The Infrared (IR) Inspection Program is a biennial program to inspect overhead distribution circuits within HFRA. Inspections will be prioritized based on SCE consequence risk categorization; prioritizing and sequentially scanning highest to lowest consequence risk. Inspection findings will be prioritized given appropriate system remediation timeframes.

SCE's distribution IR Inspection program will be conducted at the circuit level and will include all circuit infrastructure located within HFRA. SCE will conduct the majority of inspections by truck; however, a small percentage of the system requires hiking or scanning from a helicopter. Truck inspections will use a two-person crew, with the passenger aiming an infrared camera at overhead facilities as the driver follows the inspection route. The IR scan detects temperature differences and heat signatures of components, which may be indicative of degradation not visible during traditional inspections and could result in component/conductor failure. When the crew discovers a potential issue, they will stop and determine if there is a Hot Spot.[59] If confirmed, SCE will record relevant data (location, equipment, temperature reading, and pictures (infrared and optical)) and schedule the equipment for remediation. Inspection findings would be prioritized based on a risk-informed methodology and given appropriate remediation timeframes.

Additionally, SCE seeks to perform annual IR and Corona scans of all overhead transmission facilities and equipment located in HFRA. Specialized infrared and ultraviolet (Corona) light cameras are typically mounted to helicopters and the line is flown, with special attention

[59] A temperature difference between similar component/equipment under similar loading.

paid to splices, conductor connection/attachment points, and insulators. Corona scanning is a technology that is being used on Transmission circuits in HFRA. This technology was deployed during Enhanced Overhead Inspections performed to-date in 2019 to capture system degradation not visible to the naked eye or IR. Corona identification is neither visual nor thermal. Corona detection is accomplished by identifying ultraviolet energy that is generated by leaking high voltage current, which indicates the degree of electric discharge or 'leakage' due to the ionization of air surrounding high voltage electric components. In some cases, the 'leakage' is substantial enough that they may result in an arc flash and potential ignition.

(2) <u>Need for Activity</u>

SCE believes that infrared and corona inspections are an important complement to standard visual inspections by adding a layer of detection into potential failures that are not visually detectable. IR inspections will help increase safety by enhancing critical circuit inspections and identifying fire safety hazards caused by potential equipment failures. Reliability benefits will also be recognized by the identification and remediation of system degradation via these inspections.

In 2017, SCE conducted an IR inspection program study involving a statistically random sample of its overhead distribution system. This program study identified "Hot Spots," *i.e.*, areas where there is a temperature difference between either two phases, or two pieces of metal on one phase. These Hot Spots are not visible to the naked eye and can only be detected by a trained thermographer using an IR camera. SCE removed and analyzed these Hot Spots and determined they are reliable predictors of future component failures.

In 2018, SCE conducted an IR inspection of all remaining HFRA circuits, identifying 199 findings. These findings were not visible during a visual inspection or other testing.

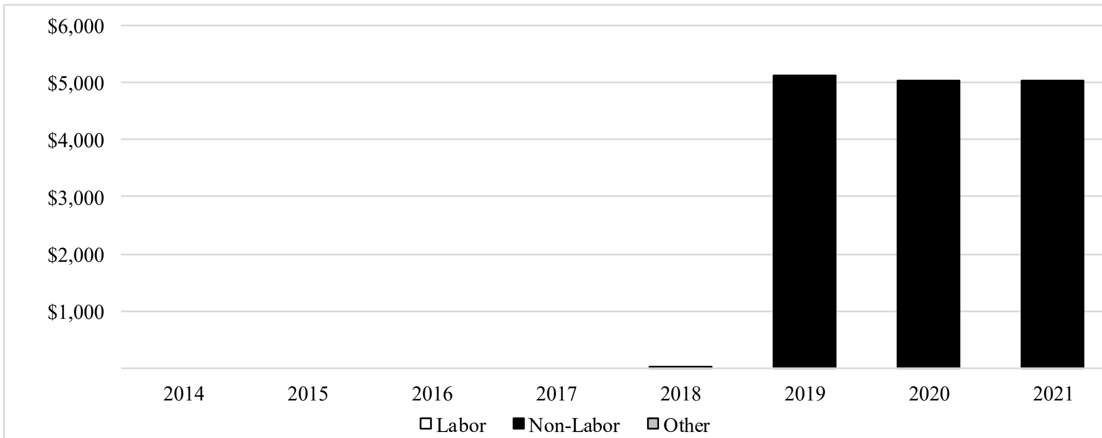
Performing Corona inspections on overhead conductors, insulators, hardware, and attachment/connection points can detect maintenance issues that are not visible before they become failures. Common anomalies detected through Corona Scanning are frayed/broken strands in the conductor and aging insulators.

Transmission Corona inspections and IR inspections are currently being done using the same helicopter. These two inspection methods complement each other in that one searches for thermal anomalies while the other searches for ultraviolet anomalies. Failing components can be an early indication of potential ignition threats. By identifying these issues ahead of failure, SCE can effectively remediate them and reduce the risk of equipment failure.

(3) <u>Infrared and Corona Inspection Program O&M Forecast</u>

(a) <u>Scope and Forecast Analysis</u>

Figure II-22
Infrared Inspection Program O&M Expenses
(Constant 2018 $000)[60]



	Recorded					Forecast		
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Labor					$0			
Non-Labor						$5,122	$5,018	$5,018
Other								
Total Expenses					**$0**	**$5,122**	**$5,018**	**$5,018**
Ratio of Labor to Total	-	-	-	-	100%	0%	0%	0%

(b) <u>Basis for O&M Cost Forecast</u>

This forecast is primarily driven by the number of miles SCE plans to inspect with IR and corona scans. For distribution, SCE intends to inspect approximately 5,000 miles per year at a cost of approximately $79 per mile based on subject matter expert judgment. SCE will also inspect approximately 5,300 miles of transmission lines at a cost of $583 per mile based on subject matter expert judgment.[61] In addition to the cost of performing the transmission inspections, additional labor is required for sensor operation at $57k per year as well as additional aerial inspection data support for approximately $1.6M per year.[62]

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[60] Refer to WP SCE-04 Vol. 05, Part 1 pp. 406 - 412 – O&M Detail for Infrared and Corona Inspection Program.

[61] *See* Chapter IV.A of the Application.

[62] Refer to WP SCE-04 Vol. 05, Part 1 pp. 413-416 – Infrared and Corona Inspection Program.

(4) RAMP Integration

IR inspections will help increase safety by enhancing critical circuit inspections and reducing fire safety hazards caused by potential equipment failures. These IR inspections will also improve reliability. IR inspections will reduce the frequency of Equipment / Facility Failure by detecting in advance certain types of equipment failure before it occurs.

(a) Reconciliation Between RAMP and GRC

Table II-19
Infrared Inspection Program
RAMP vs GRC O&M Forecast Comparison
(Nominal $000)

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021
Wildfire	M4	Infrared Inspections	RAMP	466	475	481
			GRC	406	411	416
			Variance	**$ (59)**	**$ (63)**	**$ (65)**

In Chapter 10 of SCE's 2018 RAMP report, SCE evaluated wildfire risk. This risk analysis identified and evaluated the ability for IR inspections to mitigate the Equipment / Facility Failure driver of wildfire ignitions. The costs presented in RAMP and those requested in this GRC for IR Inspections are generally aligned.

4. Public Safety Power Shutoff (PSPS)

As the new normal of year-round exposure to catastrophic wildfires threatens the communities SCE serves, it is now more important than ever to develop programs and protocols to minimize the potential threat of wildfire from electrical infrastructure. In support of this, SCE has developed processes and procedures for three programs specifically targeted to reduce this risk and mitigate the impacts of outages, (1) PSPS Execution, which outlines the processes for activating an Incident Management Team (IMT) to manage a potential PSPS event, (2) PSPS Customer Support that provides support to customers and communities in the event of an actual PSPS event, and (3) Community Resiliency Equipment Incentives Program.

SCE employs guidelines to proactively de-energize circuits within HFRAs if data sources indicate that elevated local weather conditions pose an imminent and significant threat to public safety. The significant variability of weather and environmental conditions across the service territory, coupled with the effects of climate change and the State's severe drought and bark beetle issues, demand flexible de-energization guidelines that can be used under a variety of circumstances and electrical system operating conditions. SCE's protocol,[63] officially titled Public Safety Power Shut-Off (PSPS), consists of a set of criteria and guidelines with a wide variety of factors to be considered for appropriate use.

a) Regulatory Background/Policies Driving SCE's Request

The Commission's Electrical Standards and Reliability Branch (ESRB) recently established standards under Resolution 8 (ESRB-8) for notifications to public safety agencies and customers' in the event pro-active de-energization is necessary due to the threat of existing or impending wildfire. In a series of recent Decisions (D. 12-04-024 and D.19-05-042), the Commission adopted reporting requirements for all investor owned utilities with regard to pro-active de-energization. Requirements include meeting with local communities that may be impacted by a future de-energization event, customer notifications prior to a de-energization event, notification to the Safety and Enforcement Division (SED) with an explanation of de-energization processes as soon as practicable after a decision to de-energize facilities. SCE complies with these requirements by creating and executing a hazard-specific Wildfire Response Plan outlining actions required by the IMTs leading up to and during wildfires and includes reporting requirements pursuant to ESRB-8.

(1) RAMP Integration

A PSPS event represents the mitigation of last resort in a line of defenses against fire risk. This practice is aimed at keeping the public, SCE customers, and SCE workers safe. SCE currently considers many factors before de-energizing, including:

- Input from in-house meteorologists and fire scientist about current and forecast fire weather conditions;
- Wildfire fuel characteristics and moisture levels of vegetation surrounding utility infrastructure; and
- Input from first responders and emergency management personnel regarding the potential impacts to ongoing evacuations, essential facilities/services, and at-risk customers.

[63] Given the tradeoffs inherent in a decision to preemptively shutoff power, and the complex nature of events and potential existence of other factors, execution of the PSPS protocol is ultimately based on the judgment of the PSPS IMT and the protocol is intended to provide a framework to assist the IMT in exercising this discretion.

- SCE will deploy line patrol crews to assess circuit conditions before de-energizing and prior to re-energizing.

(a) Reconciliation between RAMP & GRC

Table II-20
PSPS Protocol Support Functions Mitigations (O&M)
RAMP vs. GRC O&M Forecast Comparison
Nominal 2018 $000

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021
Wildfire	M3	PSPS Protocol and Support Functions	RAMP	$ 3,704	$ 3,769	$ 3,475
			GRC	$ 26,583	$ 27,079	$ 31,292
			Variance	**$ 22,879**	**$ 23,310**	**$ 27,817**

As shown in Table II-20, there are significant differences from 2019 - 2021 between the forecast for PSPS as estimated in SCE's 2018 RAMP report and the forecast requested in this GRC. The cost variance for PSPS is mainly driven by the revised cost for PSPS sub-activities that are dependent on the number of PSPS events forecasted per year. SCE updated its number of forecasted PSPS events to 30 events per year, based on subject matter expertise in meteorology and fire science.

Table II-21
PSPS Protocol Support Functions Mitigations (Capital)
RAMP vs. GRC O&M Forecast Comparison
Nominal 2018 $000

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021	2022	2023
Wildfire	M3	PSPS Protocol and Support Functions	RAMP	$ -	$ -	$ -	$ -	$ -
			GRC	$ 180	$ 1,212	$ 738	$ -	$ -
			Variance	**$ 180**	**$ 1,212**	**$ 738**	**$ -**	**$ -**

From Table II-21, SCE forecasts capital related costs for PSPS from 2019 – 2021. These capital costs are required for the procurement and installation of transfer switches at the Community Resource Centers (CRCs). Transfer switches will allow SCE to expediently and safely deploy backup generation to the CRCs. The installation of transfer switches is consistent with the practice of other utilities for this purpose. SCE intends to install one transfer switch per CRC in the backcountry

b) <u>PSPS Execution</u>

SCE has developed and implemented several programs/sub-activities in support of PSPS that are discussed in detail in subsequent sections. These sub-activities are (1) PSPS IMT (2) Line Patrols (3) Mobile Generator Deployment (4) Community Outreach Vehicles (4) Community Resource Centers and (5) Advanced Unmanned Aerial Study.

(1) <u>PSPS IMT</u>

(a) <u>Work Description</u>

Execution of the PSPS protocol is overseen by a specialized Task Force in the Incident Command Structure (ICS) overseen by the PSPS IMT. The Task Force reports to the Operations Section Chief and includes representatives from key internal stakeholders to manage the necessary public safety notifications to critical care, essential use, residential and business customers and local governments potentially affected by its use. The PSPS IMT is responsible for monitoring and considering conditions and relevant information before recommending the de-energization of any SCE circuit(s).

Considerations may include, but are not limited to, the following:

- Red Flag Warnings issued by the NWS for fire weather zones that contain SCE circuits in HFRAs
- Ongoing assessments from the SCE in-house meteorologists of local conditions including wind speed (sustained and gust), humidity and temperature, fuel moisture, fuel loading and data from weather stations
- Real-time situational awareness information from personnel positioned locally in HFRAs identified as at risk of being subject to elevated weather conditions
- Input from SCE Fire Management experts
- Input from SCE's Vegetation Management as appropriate
- Input regarding specific concerns from local and state fire authorities regarding the potential consequences of power outage and wildfires in select locations

- Alternative ways to reroute power to affected areas
- Awareness of mandatory or voluntary evacuation orders in place
- Expected impact of de-energizing circuits on essential services
- Other operational considerations to minimize potential wildfire ignitions, including the blocking of re-closers on the identified circuit(s)
- On-going fire activity throughout SCE territory and California
- Progress of customer notification processes
- Ongoing notifications to local governments and public officials
- Potential impacts to communities and customers

When the PSPS IMT makes the decision to activate, the team begins executing the PSPS protocol, and mitigations such as coordinating with counties to deploy Community Outreach Vehicles (COVs) and/or activate Community Resource Centers (CRCs), deploying mobile generation to essential customers for life safety emergencies (where appropriate) and initiating pre-patrol activities to assess safety hazards on impacted circuits. These PSPS execution activities are critical for minimizing impacts and public safety risks to customers and communities before and during a PSPS event. Once the elevated fire weather abates, PSPS execution activities continue as the PSPS IMT deploys line patrols to identify potential safety hazards prior to turning the electricity back on, minimizing the risk of an ignition. Additionally, PSPS execution includes an Advanced Unmanned Aerial Study which is intended to reduce the time it takes to patrol circuits (both pre-patrol and post patrols) by leveraging UAV's (drones) to patrol the lines. Use of this technology may have incremental benefits as regulations and technology continue to advance and support the use of drone equipment without requiring an operator to maintain visual line of sight on the UAV.

When fire risk conditions subside to safe levels and safe conditions are validated by field resources, SCE will begin patrolling impacted circuits to check for any condition that could potentially present a public safety hazard when re-energizing circuits. Once field resources confirm that it is safe to re-energize the circuit(s), power will be restored, and local government and customers will be notified of re-energization. The order in which circuits are re-energized will depend on many factors including, but not limited to, customer safety and well-being, consideration of affected essential services, damage to electrical and other infrastructure, and circuit design/topology.

(2) **Line Patrols**

(a) **Work Description**

A critical component of SCE's PSPS protocols is to assess potential for fire risk conditions with the help of line patrols and field observation functions (including trouble men and supporting crews) in the field prior to making the decision to de-energize. In addition, SCE will utilize line patrols to assess the condition of each circuit prior to re-energizing after the extreme conditions have subsided as well in order to assist with assessing ignition risks and ensuring public safety prior to re-energizing.

SCE intends to deploy crews upon alert of a potential PSPS event to assess elevated fire conditions as part of factors to be considered in making the decision to de-energize. In addition, these crews will be needed to visually inspect primary conductors and associated assets to determine that circuits have not sustained damage and are safe to re-energize.

(3) **Mobile Generator Deployment**

(a) **Work Description**

Because PSPS may disrupt electric services to critical electrical loads and essential customers, SCE may contract the deployment of temporary mobile generators for critical facilities to assist maintaining electric service for essential life safety, and public services emergencies on a case-by-case basis. These case-by-case decisions will be made by the IMT, based on the unique circumstances associated with each event. SCE's supply chain organization performed a competitive solicitation for regional vendors who could support mobile generator deployment and will keep a list of generator vendors assigned to different regions.

Under the plan, SCE would begin to assess emergency generator deployment once the PSPS IMT is activated and emergent public safety needs are identified.

(4) **Community Outreach Vehicles (COVs)**

(a) **Work Description**

During emergencies, SCE's customers may be without power for extended periods of time. These extended outages will likely be exacerbated by PSPS activations and/or planned outages associated with hardening the grid and installing technologies that reduce wildfire. SCE understands how important electric service is to our customers and works to minimize the impacts and disruptions associated with power outages. During outages some customers will need assistance in receiving critical messages from SCE, public agencies, first responders, news agencies, social media, etc. To address these needs, during PSPS events and other extended outages, SCE will coordinate with impacted local emergency management agencies (when possible) to deploy community response vans to impacted locations to provide customers with access to basic amenities such as water, snacks and portable charging devices as well as access to trained staff who are able to provide real-time information on PSPS events. This program directly aligns with requirements set forth in Resolution ESRB-8, which states, "Increased coordination, communication and public education can be effective measures to increase public safety and minimize adverse impact from de-energization."

In support of this, SCE will design and outfit five cargo transit vans as Community Outreach Vehicles (COV's) with the required equipment and technology to enable SCE staff to transport water, snacks, portable charging devices, lights and other amenities to community locations where trained staff will interact with customers to provide information and updates on the PSPS event in real-time. Five COVs will provide SCE with the minimum number of resources required to support typical PSPS activations where multiple counties are impacted. This scope is consistent with past activations in 2018 when there were multiple counties impacted simultaneously. Five COVs will also allow us to deploy an asset to each of the impacted counties individually as needed and work with the local emergency management agency to determine a location where the vehicle will be most accessible to the community. Additionally, as an interim solution, SCE will retrofit existing SCE vehicles to augment the COVs fleet. These SCE vehicles will provide the same amenities as the COVs to customers. The COVs will be configured to withstand the high winds that will be typical during this type of events and will contain a fire extinguisher, first aid kit, a place to store and display informational brochures/resources and have ample storage for water and/or snacks.

(5) <u>Community Resource Centers (CRCs)</u>

(a) <u>Work Description</u>

To complement its COVs, SCE will partner with existing community facilities and retailers to host customers indoors to improve comfort and safety by creating, Community Resource Centers (CRCs). Both COVs and CRCs will be activated by the Incident Management Team during PSPS activation depending on the scale and expected duration of the outage.

SCE's approach to establishing CRCs will balance coverage and cost by using a combination of COVs and CRCs. For those customers living at the wild/urban interface (approx. 5-10 miles of the boundary of a high-fire risk area (HFRA), SCE will encourage those customers to visit a center that is not in an HFRA, and thus more likely to still have power (an "Urban

CRC"). Customers further than 5-10 miles within the HFRA (*i.e.*-in the backcountry) will be able to access COVs in the short term, and later, CRCs supplied with backup generation ("backcountry CRCs").

SCE will staff the CRCs with a vendor that has a history of providing services to SCE, is well versed in SCE programs and will be able to provide in-language support at SCE's request for the five most common spoken languages in SCE's customer base. Staff will facilitate services, help customers obtain resources, keep customers up to date on the outage, educate customers about SCE offerings, and encourage them to update their outage information. SCE will also arrange security personnel to support potential conflict de-escalation and keep occupants safe. These are all in addition to the staff provided by the CRC. SCE will only occupy the facilities if facility staff are also on site.

SCE will work with county & local governments, community-based organizations, retailers, and existing relationships (e.g., cooling centers) to identify locations that are safe, comfortable, and easily accessible to communities. Once sites have been identified and onboarded, nearby demographics will be studied to ensure languages served accordingly. Siting criteria may include:

- Availability of on-site generation
- Hosting capacity
- Ease of public access
- Opening hours (8am-6pm, available 7 days/week). SCE will consider adjusting hours after each fire season based on customer feedback.
- Proximity to emergency services
- Services provided (air conditioning, refrigeration, outlets, charging stations, restrooms, Wi-Fi, seating, children's play area, televisions)
- Limited presence of existing populations that may create liability concerns for host facility (e.g., hospitals and schools may not be desirable due to presence of medical patients, children, etc.)

- Pre-existing use as informal / natural gathering place for other reasons (e.g., SCE cooling center, landmark, municipal building)
- Site resiliency (e.g., not in debris flow zone)
- Ease of onboarding host facility
- History of providing services to the public

SCE plans to build up its CRC offering over time according to the following schedule:

Table II-22
Community Resource Center Offering Over Time

Fire season (6/1 – 12/31)	Customer Offering
2019	3 COVs are main response mechanism, with 10 urban CRCs (mostly through Transform Holding Company on high fire risk area boundaries) supporting deployment where geography happens to make sense. Target 3 backcountry CRCs located in high fire risk areas as well.
2020	35 CRCs likely to serve most PSPS events. 20 backcountry CRCs + 15 urban CRCs. 5 COVs for areas not covered by CRCs.
2021 (and on)	50 CRCs likely to serve nearly all PSPS events. 35 backcountry CRCs + 15 urban CRCs. 5 COVs for areas not covered by CRCs.

(6) Advanced Unmanned Aerial Study

(a) Work Description

The Advanced Unmanned Aerial Systems (UAS) study provided preliminary results that will inform, advance and operationalize SCE's existing UAS program by exploring the capabilities of Beyond Visual Line of Sight (BVLOS) flight. SCE's UAS program is developing the capability to expedite patrolling utility lines following a PSPS event or other extended outage, to more quickly and safely restore power to its customers. SCE plans to contract with an approved UAS vendor with significant experience in BVLOS flight in order to explore these capabilities, better understand how to successfully navigate the restrictive Federal Aviation Administration (FAA) regulations governing BVLOS flight and lay the foundation to establish an internal BVLOS UAS program.

Today, SCE's Aircraft Operations department currently owns and operates three UAVs, in addition to a small fleet of helicopters, for conducting a wide variety of operations (e.g., pole sets, inspections, line patrols, etc.) across the utility. Aircraft Operations is routinely called upon to conduct circuit patrols of utility lines that are particularly long, traverse mountainous or heavily vegetated terrain, and/or traverse terrain that is difficult to access via the ground. SCE currently utilizes helicopters to conduct select circuit patrols following extreme weather conditions when called upon by SCE's Grid Operations department, who may have difficulty accessing these lines for a visual inspection or may otherwise be resource constrained. It is particularly important to patrol lines prior to re-energization following an extreme wind or weather event in case foreign objects have come into contact with electrical lines (which could ignite fires upon re-energization), or lines have been knocked to the ground due to extreme weather. UAVs are currently not used for circuit patrols due to FAA regulations that generally require the UAV to be within line of sight of the operator or pilot.

SCE will leverage the PSPS protocol to address wildfire risk. In some cases, SCE estimates that PSPS outages could last up to 72 hours. Therefore, it is important to restore power to customers quickly and safely following elevated fire and weather conditions. The ability to conduct circuit patrols via UAV operating BVLOS is expected to be a more expedient, efficient and cost-effective means to inspect electrical assets, especially for large-scale outages when resources may already be constrained. Moreover, the preliminary report will be applied in the future for developing an in-house BVLOS program to conduct other important utility work (e.g., equipment inspections, asset mapping, etc.).

Since the areas or circuits SCE wishes to patrol are already difficult to access, this currently precludes the use of drones as an efficient means of conducting a circuit patrol. Additionally, while traditional aircraft can be an efficient means of inspecting assets, it is relatively expensive (compared to a UAV) and helicopters are much better suited to fully utilize their additional payload capability for more heavy-duty restoration efforts. UAVs take advantage of the efficiency of traditional manned aircraft inspections but at a much lower cost due to the lower cost of the resources required to operate and maintain them. Exploring, and ultimately achieving, the ability to perform BVLOS flights via UAS would be a more efficient and affordable way to conduct circuit patrols following a PSPS event or extended outage in an effort to safely expedite the restoration of power to SCE customers. The ability to perform BVLOS UAV flights could provide a valuable new tool given the diverse geography of SCE's service area.

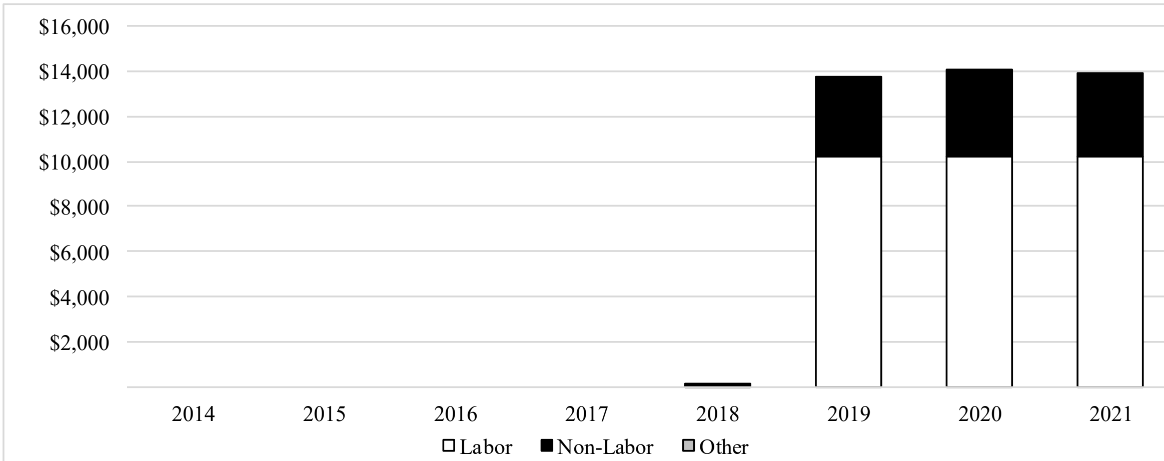
(7) Need for Activity

Although disruptive for customers, preemptively shutting off power to the lines may be necessary to ensure the safety of communities and employees when extreme weather conditions present danger to the community and customers that SCE serves. SCE has employed a number of mitigations in its PSPS Execution toolkit to help mitigate and minimize disruptions to customers during PSPS events.

These activities help to avoid potential risk to the communities we serve by providing essential amenities to customers (to include mobile generation where life safety emergencies exist) while the power is out and by equipping SCE with trained and qualified personnel and appropriate equipment to efficiently and effectively manage PSPS events. This includes standing up CRCs and deploying COVs to impacted areas to provide customers with essential information as well as snacks and water. This also includes staffing SCE's EOC with ICS qualified personnel who are charged with effective management of PSPS incidents with a focus on public safety and risk mitigation. Additionally, this activity directly reduces risk by appropriately resourcing SCE with personnel and equipment to quickly and effectively patrol electrical lines with the goal of identifying potential safety hazards that may pose a risk to customers and communities.

(8) Forecast for PSPS Execution

Figure II-23
PSPS Execution O&M Expenses
(Total Company Constant 2018 $000)



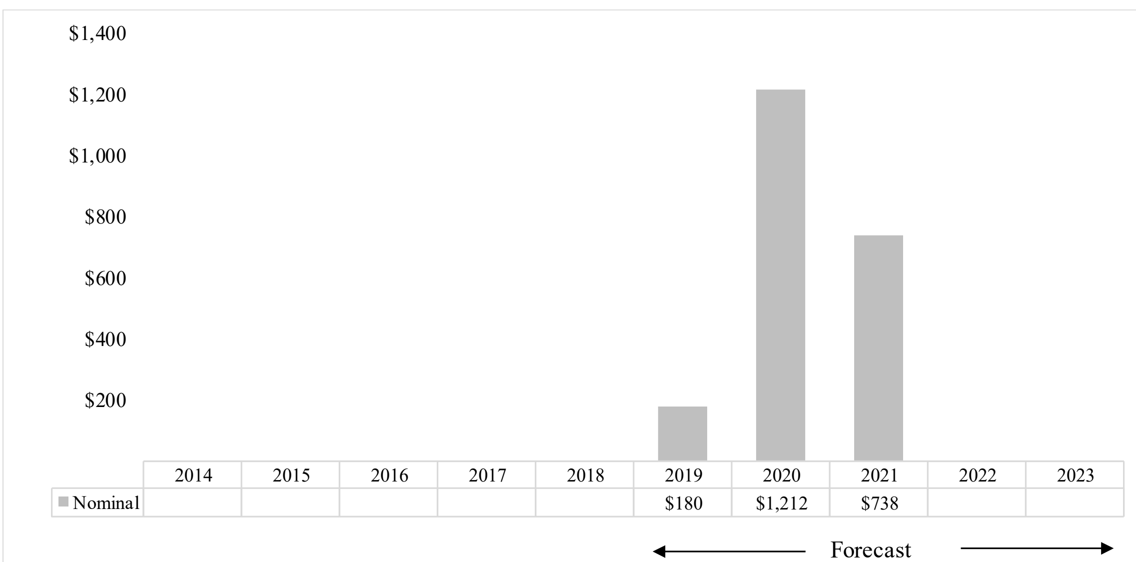
	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor					$1	$10,196	$10,196	$10,196
Non-Labor					$168	$3,531	$3,834	$3,726
Other								
Total Expenses					**$169**	**$13,727**	**$14,030**	**$13,922**
Ratio of Labor to Total	-	-	-	-	1%	74%	73%	73%

	Recorded			Forecast
	2018	2019	2020	2021
Advanced Unmanned Aerial Systems Study		$516	$395	$101
Community Outreach	$169	$421	$421	$342
Community Resource Centers		$589	$1,013	$1,278
Line Patrols		$10,196	$10,196	$10,196
Mobile Generator Deployment		$1,724	$1,724	$1,724
PSPS Execution IMT		$282	$282	$282
Totals	**$169**	**$13,727**	**$14,030**	**$13,922**

SCE has developed detailed forecasts for each of the above work activities to minimize costs while appropriately equipping the company with the needed personnel and resources to manage PSPS execution. Forecasts for the advanced unmanned aerial system study are based on pricing information that was provided to SCE by a specialized UAV vendor based on 30 activations per year. Cost projections were developed by estimating the number of times per year UAV support is expected to be needed, to include the estimated number of circuits in scope for each event.
Cost projections also account for reduction in the number of PSPS events driven by grid hardening activities. For community outreach, SCE identified the need for five vehicles to adequately support a

PSPS event that impacts up to five counties simultaneously. Forecasts for this activity include vehicle acquisition costs as well as funding for amenities (water and snacks) and event staffing to include both customer service representatives and security personnel. Cost projections for CRC's include center activation and setup costs, staffing, security, additional services, and incidentals. SCE will require incremental labor to manage this program. For centers requiring backup generation, the forecast includes non-labor costs for generator rental costs and fuel. Forecasts for line patrols include average times to conduct patrols and the estimated number of 30 activations per year. Forecasts for the mobile generator deployment are based on the estimated number of generators (by output capacity) required for each event multiplied by the vendor cost for the rental of the units. PSPS IMT costs include the supplemental pay (hours work outside of normal business day) for personnel activated to support the PSPS execution. This forecast also includes meal and lodging costs (where required) for personnel deployed to the EOC on extended shifts during the event.[64]

Figure II-24
PSPS Execution Capital Expenses
(Total Company Constant $000)



SCE's capital forecast for Community Resource Centers includes the cost for a transfer switch at each Community Resource Center requiring backup generation.[65]

[64] Refer to WP SCE-04 Vol. 05, Part 2 pp. 36 -5 4 – Forecast Summary – PSPS Execution (O&M).

[65] Refer to WP SCE-04 Vol. 05, Part 2 pp. 57 - 58 – Forecast Summary – PSPS Execution (Capital).

c) PSPS Customer Support

SCE's customers have historically enjoyed the benefits of strong energy reliability, and most have not experienced power outages with the potential to last multiple days. Planning and knowing how to prepare for power outages that may be initiated due to extreme weather conditions is a new concept that will require consistent and frequent messaging designed to build customer awareness and understanding of what a PSPS event means, heighten attention that such an event could potentially impact them and encourage and aid customers in building their own resiliency plans for de-energization events.

SCE's PSPS Customer Support strategy will leverage an integrated mix of communications channels that deliver the right message and in the right moment to stand out in an environment that can be extremely "noisy."

Aside from the challenges inherent in educating customers about a new and complex concept, in order to be successful, SCE will need to break through other barriers too. For instance, in today's always-connected, information-rich world, we face fierce competition to capture a finite amount of the consumers' attention and must do so through various channels that align with the preferences of the audience. To achieve this a one-size fit option for raising awareness and supporting customer needs does not exist and therefor SCE's plan requires multiple tactics and technology enhancements in order to be successful. Absent such a detailed and robust strategy, customers could be at risk due to lack of preparedness during de-energization events such as PSPS.

Our plan was designed with emphasis on five critical elements:

- Awareness leads to preparedness and preparedness leads to resiliency;
- Meaningful information that makes a connection with customers (*i.e.*, from the customer's point of view, what does this mean to me);
- Providing the right information at the right time is imperative;
- California's new normal environment needs to be talked about;
- Successful resiliency will come through partnerships with SCE, our customers, local governments and agencies.

Our plan relies both on leveraging existing processes as well as building new platforms and campaigns that will bring awareness to our customers. As we build our plans, it is important that we acknowledge that our customers today wish to communicate with us through convenient channels. They want to receive and seek out information via a method of their choice.

This plan will take these preferences into consideration and deliver what our customers expect from their utilities provider.

Among the most critical components of our plan is the technical capabilities that we have in order to reach our customers during public safety events. SCE has made substantial investments in new technology with its Emergency Outage Notification System (EONS) so SCE can deliver the magnitude of notifications under tight time constraints when notifying customers about PSPS events. Our Community Engagement plan is a comprehensive and robust plan today but will continuously evolve as we learn more from our customers through our targeted outreach efforts.

(1) IOU Customer Engagement

(a) Work Description

It is important that SCE's localized outreach campaign be in alignment with campaigns airing Statewide and created in conjunction with the other two electric IOUs, California Governor's Office of Emergency Services (CalOES) and California Department of Forestry and Fire Protection (Cal Fire), so that messages do not conflict and attention is focused appropriately on safety imperatives, information and resources.

While residential and business customers in high fire-threat areas are the primary target, the purpose of the campaign is to inform all residents and those who may be visiting within our service territory so that they better understand the PSPS program and how to prepare. Since people move and travel across California, it's important that there is consistency in how PSPS events are communicated and that is why there is alignment with Statewide campaign messaging.

Special emphasis will be placed on difficult to reach customers such as those on Medical Baseline, those with disabilities, low-income, the elderly and non-English speaking including those with Access and Functional Needs.

Most communications materials will be created in multiple languages such as those spoken most prominently in our service territory: English, Spanish, Cantonese, Mandarin, Vietnamese and Korean. For other language preferences, SCE offers translation services through a third party which is available through SCE's contact center.

SCE's plan uses a multi-channel, integrated mix which may include the following:

Bill Insert: Bill Inserts will be utilized for PSPS awareness and understanding particularly during the high-heat, summer season.

Direct Mail / Email: Direct mail and email will be used to provide personalized communications and preparedness tips to residential and business customers.

Social Media Posts: SCE's main social media channels (Twitter and Facebook) will be leveraged as an interactive and targeted way to engage with customers, monitor the conversation, and respond to feedback.

Digital and Social Media Ads: SCE will use digital ads on targeted web sites and social media channels. Ads will be used to drive awareness and understanding of PSPS and will be used opportunistically to target customers geographically who may be impacted before, during and after event activation.

Search Engine Marketing (SEM): SCE will use SEM should a customer query specific key word or subject to drive traffic to the landing page on SCE.com.

Radio Ads: Radio ads will be created to provide mass awareness to customers throughout SCE's service territory.

(2) Annual Wildfire Customer Direct Mailer

(a) Work Description

The annual wildfire awareness direct mailer is a proactive communication solution that allows SCE to target specific areas of its territory with important customer information. SCE began its campaign in 2018 to raise awareness with its customers about the expansive work SCE has done and continues to do in support of wildfire mitigation while educating customers about new advancements in operational activities, situational awareness, system hardening efforts and advances in customer notifications to those customers who reside in HFRA. Approximately 1.5 million customers in HFRA received this letter via direct mail. SCE’s customer support strategy will continue to leverage direct mailing in 2019 but will be targeting all SCE customers. SCE’s two direct mailings will be tailored specifically to those in a HFRA and those in non HFRAs, recognizing that the information needed and the call to action differs between these two demographics.

(3) PSPS Website Improvements

(a) Work Description

SCE.com is a place for customers to organically search for content regarding important utility information and specifics about their individual SCE account. With our new normal and the inevitability of executing a PSPS, we must design an experience our customers look for when they are seeking immediate information without having to call their utility. Additionally, SCE’s website is a rich source of information for customers to learn about the wildfire mitigation activity in SCE's territory and has a dedicated page for PSPS.

SCE has created a dedicated, interactive, and informative landing page where customers can increase their awareness about the program, learn techniques and considerations that prepare them to be more resilient during events, and receive up to date information regarding events in their area and learn when an event is impacting their area. The landing page design is leveraged to link to other pertinent and existing sites on sce.com such as the Outage Map where PSPS specific event information is available as well as links to emergency operation centers in their communities. SCE.com allows for agile and quick content updates in response to events or circumstances. SCE continues to enhance its website as customer feedback is gathered.

(4) Customer Research and Education

(a) Work Description

SCE's customer research and education strategy will align with the Statewide Campaign mentioned above in the IOU Customer Engagement section but will expand into other vital activities such as focus groups and customer surveys that will provide a framework for when and how SCE can best educate customers at the right time and through the right channels regarding wildfire mitigation activities and in particular PSPS

Focus Groups are designed with the purpose of gaining insights into what customers understand or think about SCE's PSPS wildfire mitigation program and how they evaluate the messaging associated with an actual experience (or the prospect) of their power being shut off. Additionally, the results from these focus groups will aid SCE is its commitment to continuous improvement around communication, awareness and preparedness of its customers about this new normal in SCE's territory. Specifically, the research will address: impressions of / experiences with the program, recall and effectiveness of communications, expectations of SCE, usefulness / impact of the communications, and preferred delivery channels, among other things. SCE's focus groups include a mix of all customer types from Residential, in-language, small to medium business and large business customers.

As discussed above SCE intends to use a multi-channel, integrated mix which may include the following:

- bill inserts and onserts, which are intended to target specific times of the year when consistent messaging to all audiences can be utilized for PSPS awareness and understanding particularly during the high-heat, summer season;

- direct mail and/or email campaigns to provide personalized communications and preparedness tips to residential and business customers;
- social media channels (Twitter, Facebook and Instagram) which provide a targeted way to engage with customers, monitor the conversation, and respond to feedback and will also leverage digital and social media ads to opportunistically target customers geographically who may be impacted before, during and after event activation.

Additionally, we are ensuring that content developed through these outreach efforts are available on SCE's website or other sites through strategic partnerships so that all customers have the ability to educate themselves when convenient.

(5) <u>Community Meetings</u>

(a) <u>Work Description</u>

Community meetings are designed to provide our customers who reside in High Fire Areas (HFA) and are likely to be impacted by a Public Safety Power Shut-off (PSPS), an opportunity to hear firsthand from appropriate SCE staff, and other community leaders or agencies, about the new normal in California and what that means to them; how to be prepared and remain resilient.

These forums serve a dual purpose and allow SCE an opportunity to obtain up-to-date customer information that is critical for outreach notifications during events. Additionally, these events reflect the partnerships with local governments and other agencies, such as the Red Cross and local emergency first responders and allow these agencies the opportunity to also address the community about their own wildfire activities and resiliency plans.

These meetings are designed to with the following objectives in mind:

- Provide residents/customers an overview of SCE's wildfire mitigation measures including the Public Safety Power Shut-off (PSPS) process.

- Provide customers an opportunity to update contact information and receive information on SCE programs and services.

(6) <u>Emergency Outage Notification System (EONS)</u>

(a) <u>Work Description</u>

Prior to a de-energization event, SCE will utilize its Emergency Outage Notification System (EONS) to quickly create and deliver customized outage communications in the customers' digital channel(s) of preference (smartphone, SMS text, email, TTY and social media) regarding de-energization events to customers in the following order:

1. Local government and public safety agencies
2. Critical care customers
3. Essential service providers
4. Business and residential customers

(7) <u>Customer Contact Support Center</u>

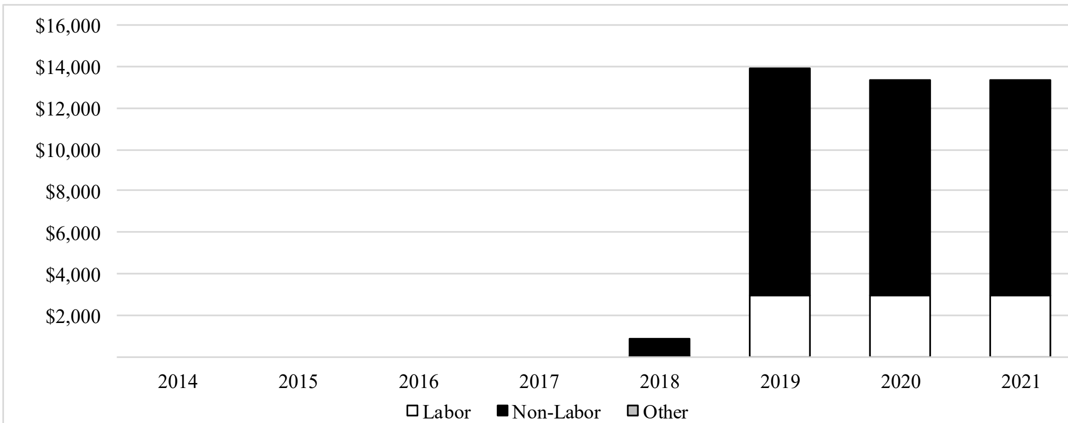
(a) <u>Work Description</u>

The Customer Contact Center and outsource partner (GCS) handles all inbound customer calls for SCE. The CCC handles approx. 17 million inbound calls a year, 24/7/365 and is the voice of SCE for the general public. Our energy advisors will need to be trained and prepared to respond to all customers inquiries regarding SCE's wildfire mitigation activities, specifically responding to customers regarding PSPS events.

SCE's contact center must be available to respond to its customers as events are unfolding and will require extended scheduled work hours for staff in order to ensure response times are reasonable. Resource availability and staffing needs during these events is incremental to historic forecasts. Taking historical service and staffing levels during storm situations determine which areas are most likely to be impacted by a wind related event so we could determine the potential customer's impact in order to base forecasts which supported expected call per customer ratios during PSPS events. SCE also took into account call patterns observed from Summer Discount Plan (SDP) events, where a large volume of calls came in during the first hour and were followed by another spike a few hours later. For PSPS we assumed a large portion of calls from our customers in the first hour and then every 8 hours after where inquiries about status updates would be sought and using these forecasts determined that SCE would require normal scheduled work times for resources as well as the need for staff on extended schedules, or overtime at a forecasted average of approximately nineteen full time resources per event working extended durations.

(8) PSPS Customer Support O&M

Figure II-25
PSPS Customer Support Functions O&M Expenses
(Total Company Constant $000)



	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor					$3	$2,997	$2,997	$2,997
Non-Labor					$849	$10,880	$10,368	$10,314
Other								
Total Expenses					**$852**	**$13,877**	**$13,365**	**$13,311**
Ratio of Labor to Total	-	-	-	-	0%	22%	22%	23%

	Recorded	Forecast		
	2018	**2019**	**2020**	**2021**
Customer Contact Center Support	$3	$2,997	$2,997	$2,997
Customer Research and Education	$27	$899	$813	$759
Direct Customer Mailings	$607	$3,604	$3,604	$3,604
Emergency Outage Notification System	$215	$1,091	$847	$847
IOU Customer Engagement		$5,000	$5,000	$5,000
PSPS Website Improvements		$181		
Town Hall Community Meetings		$105	$105	$105
Totals	**$852**	**$13,877**	**$13,365**	**$13,311**

SCE has developed detailed forecasts for each of the above work activities based on a combination of historical data, input from Subject Matter Experts, and key assumptions.[66] Our forecast for IOU Customer Engagement is based on cost of our contribution to the statewide

[66] Refer to WP SCE-04, Vol. 05, Part 2 pp. 9 - 18 – PSPS Customer Support.

campaign. Our forecast for the Direct Mailings is based on the average per unit cost of different types of mailings and the number of mailings we will have to do. Some mailings go to the entire service territory, some mailings go only to customers in the HFTD, and additional mailings are made to invite customers to attend the Community Meetings we are also sponsoring. The costs of the website improvement are based on a vendor quote to design an effective website for our customers. Our forecast for Customer Research and Education is based on estimated costs by different media we plan to use, either for engagement or research. This includes cost estimates for Search Engine Marketing and the use of the big social networking sites (Facebook, Twitter, Instagram). Our forecast for Community Meetings is based on an assumed average of 18 town hall meetings per year, and the recorded costs from 2018 when we conducted a number of Community Meetings. The forecast for Emergency Outage Notification Systems is based on a vendor quote of the cost of subscription, along with an estimate from our IT department of the cost of implementing the software.

Finally, our Customer Contact Support costs are based on several different factors. First the average handling time for a call from a customer requesting information or support during an activation is based on the average handling time from our experience with similar calls from 2016 and 2017. The hold time is then translated into labor costs, based on the average cost of straight and premium time. The final step is an assumed 30 activations per year.

d) Community Resiliency Equipment Incentive Program

(1) Work Description and Need for Program

SCE's new Community Resiliency Equipment Incentive Program will facilitate increased resiliency within the communities in its service territory. Through the Community Resiliency Equipment Incentive Program, customers with behind-the-meter distributed generation and energy storage may obtain an incentive for a portion of the qualifying cost to enable the supply of power during an outage from their on-site distributed generation and energy storage device. This Program differs from the Community Resource Centers described in II.B.4.b)(5) in that the Community Resiliency Equipment Incentive Program supports a customer's ability to ride through an outage using energy storage, whereas Community Resource Centers will open to the community during a Public Safety Power Shutoff (PSPS) event. The Program will target customers capable of providing resiliency services to the communities they serve, and rebates will be commensurate with the extent of the service provided and the vulnerability of the community served. Eligible customers for the Community Resiliency Equipment Incentive Program include:

- Customers supplying critical services to the community (police, fire, water, telecommunications, emergency operations, medical services)
- Customers designated as a Community Resource Center

SCE's Community Resiliency Equipment Incentives complements the work SCE is performing to increase the resilience of its grid infrastructure. SCE uses its PSPS protocol to de-energize portions of its system to ensure public safety during extreme weather conditions. The increased frequency of such conditions drives the need for greater resilience of the communities we serve. Moreover, as more customers install distributed generation and energy storage, the opportunity for customers to extract some degree of resilience presents itself.

However, most non-residential SCE customers with distributed generation and energy storage are only capable of self-generation in a grid-tied configuration; when the grid goes down, these customer resources do not provide power to the customer's premise.
The technology for self-generation while islanded from the grid is maturing, although the market is quite nascent. Many of SCE's non-residential customers with distributed generation and energy storage do not have dedicated backup generation facilities, and the Community Resilience Equipment Incentive would enable some degree of resilience for this segment of customers. Some of SCE's customers, particularly those providing critical services, have dedicated backup generation facilities. SCE does not intend to supplant the necessity of these facilities; however, where possible, distributed generation & energy storage can displace the need for the use of these facilities which may be costlier to operate and create undesirable audible and gaseous emissions. Such a plan is consistent with the state's long-term decarbonization goals.

SCE's Community Resiliency Equipment Incentive will lower the net cost to enable resilience with a distributed generation and energy storage system for non-residential customers. Customers will receive rebates for a portion of the qualifying system cost associated with microgrid controls, transfer switches, and other equipment necessary to enable islanded operation, which may include engineering & design services, equipment, construction and installation, configuration, and commissioning. Funds are forecast to be disbursed according to the schedule in the table below, however, funds allocated for this program will be distributed on a first-come first-serve basis, until funds are disbursed, or the program expires, whichever comes first. Customer rebates available are detailed in Table II-23.

As part of its Community Resiliency Equipment Incentive Program, SCE also intends to serve its low income, critical care customers who have at least one piece of critical medical equipment through a rebate program for on-site backup generation using a battery backup system. SCE intends to initially supply qualifying customers with a $500 rebate for a battery backup system, and, may request, via a Tier 2 Advice Letter, to adjust the rebate amount and number of customers treated based on battery sizing and medical equipment needs. SCE will cap rebate disbursements for this program at 2 (two) million dollars (serving up to 4,000 customers at a rebate of $500 / qualified customer). Funds used for behind-the-meter energy storage incentives for community resource centers and critical services customers will be pooled with funds used for battery backup rebates and will disbursed on a first-come first-serve basis.

Table II-23
Community Resiliency Equipment Incentives by Customer Segment

Customer Segment	Potential Rebate Available	Maximum Rebate Per Customer	Minimum Annual Allocation of Funding
Community Resource Center	$0.15 / Wh	$100,000	25%
Critical Services	$0.10 / Wh	$25,000	25%
Low Income Critical Care	$500	$500	10%

In light of the CPUC Assigned Commissioner Ruling[67] (ACR) seeking comments around a resiliency adder through SB 700, SCE may modify its request for the Community Resiliency Equipment Incentive Program in the future, depending on the outcome of the ACR.

Once the Program has been established, SCE intends to use a Tier 2 Advice Letter for changes to program requirements, design, process, and budget, or other program details.

[67] Assigned Commissioner's Ruling Seeking Comment on Implementation of Senate Bill 700 and Other Program Modifications. April 15, 2019. Proceeding R.12-11-005.

(a) SED / Intervenor Comments On Vulnerable Communities

In its comments on SCE's RAMP report, SED recommends that SCE should submit a Vulnerable Communities Program plan that describes an ongoing utility program that performs a vast set of activities related to wildfire risk and mitigation, vulnerable communities, community grants and outreach, etc. in this 2021 GRC.[68]

SED's recommendation is largely comprised of the following list:

- Assessment of High Fire Threat Areas: As discussed above in Section IIA, SCE has engaged in an extensive assessment of the risks in HFTD and continues to refine and develop its methodologies.
- Assessment of Strategic LTE network, covered conductor, and Undergrounding Opportunities: Wildfire Covered. Conductor and Undergrounding are discussed above in sections II.B.1 SCE did not put a priority on conducting a risk evaluation of a telecommunications network (LTE) that is does not own.
- Regional Fire Potential Indices program: As discussed below in the section on our Enhanced Situational Awareness project, SCE's Situational Awareness center that is closely monitoring conditions in fire prone areas and is enhancing our capabilities to do that monitoring.
- Community Resource Centers: this is discussed above in Section II.B.4.b.
- Report on 2018 De-energization program; SCE files the ESRB-8 report following any PSPS activation, whether or not there is a de-energization.
- De-energization protocols: these are discussed above in Section II.B.4.

[68] *See* SED's "A Regulatory Review of the Southern California Edison's Risk Assessment Mitigation Phase Report for the Test Case 2021 General Rate Case," dated May 24, 2019, I.18-11-006, p. 63.

- Flooding/Mudflow Impact Assessments: SCE's response to this issue is discussed in SCE-01, Volume 2.
- Restoration and Recovery Plans: SCE's Restoration and Recovery plans are covered in SCE-04, Volume 1 Business Continuation and SCE-04, Volume 2, Emergency Management.
- Community Grants, Outreach and Public Engagement Plans: this is discussed above in Section II.B.4.c.

In D.19-05-042, the Commission adopted a definition of vulnerable populations for the purposes of PSPS as "populations with access and functional needs (AFN populations)". (p. 77) As described above, we intend to focus our efforts for raising awareness and outreach on the needs of this population as part of both SCE's own outreach campaigns as well as the statewide outreach campaign. These efforts will include partnerships with expert organizations that understand and serve the needs of this population of customers to develop programs that best serve the AFN population.

In the context of wildfire risk, SCE treats all communities the same. It is not whether a community is poor or has a largely ethnic population that defines it for wildfire purposes, it is the risk that ignition would cause a fire that would affect the community. It is that risk of ignition and the subsequent consequences that sets priorities for SCE's decision on mitigation.

(b) <u>Forecast (L & NL)</u>

All funds allocated for this Program are classified as O&M expenses.

Figure II-26
Community Resiliency Equipment Incentives O&M Expenses
(Total Company Constant $000)

	Recorded					Forecast		
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Labor								$191
Non-Labor								$3,259
Other								
Total Expenses								**$3,450**
Ratio of Labor to Total	-	-	-	-	-	-	-	6%

(i) **Basis for O&M Cost Forecast**

The non-labor allocation of these funds incorporates the forecast rebate payout over time. The labor costs consist of two (2) full-time employees for program administration, including program design and implementation, customer enrollment support, budget management and oversight, and customer and regulatory outreach.

5. Enhanced Situational Awareness

a) Work Description

Comprehensive situational awareness is fundamental to SCE's operational decision-making, service delivery and all-hazards emergency response. Better understanding of the nuances associated with critical system operations, including granular weather conditions across the system and other external factors that affect the daily operation of the grid increases the company's ability to effectively respond to emergencies.

To increase situational awareness, SCE has created The Situational Awareness Center (SA Center) which houses five meteorologists who provide weather forecasts, analytics, and hazard advisories to support the execution of core business functions as outlined in SCE-04, Vol. 2, Emergency Management. SCE has recently added a fire scientist, to expand and enhance existing wildfire mitigation capabilities. The SA Center is equipped with additional situational awareness tools, including access to high resolution weather and fire modeling products made possible through high-performance computing cluster (HPCC) technology. These tools increase the company's capacity to better forecast elevated weather conditions and potential wildfire activity to better inform decision-making during regular operations and emergencies. Our request in this case is for additional equipment to build out our capabilities in the SA Center.

(1) <u>Weather Stations</u>

Weather stations are equipment containing sensors that capture and transmit weather data, including wind speed, humidity, etc. This real-time weather information will be used to monitor weather and improve/validate weather models.

SCE evaluated existing weather forecasting and assessment products and services offered by vendors, as alternatives to the deployment of this mitigation. However, the weather forecasting and assessment models available through these existing tools rely on limited reliable weather sensor data in HFRAs, and thus do not meet SCE's requirement to enhance accuracy and specificity of weather data to support PSPS decisions and other all-hazard emergency response activities. Therefore, there is a strong case for installing additional weather stations to enable circuit-level detail to provide more granular information that is not achievable through other off-the-shelf weather forecasting products and services.

SCE's pre-existing weather stations were installed over twenty years ago, and while still in use, lack the precision and capabilities of modern-day technologies. These legacy weather stations were deployed in substations and not or near circuitry in high fire risk areas. They do not directly support SCE's objective to forecast and assess high fire conditions that may warrant preemptive de-energization, as well as other all-hazards type weather events that may impact the service territory.

As of December 31, 2018, SCE has installed 125 weather stations in high fire risk areas. SCE plans on installing up to an additional 725 weather stations from 2019 – 2020. This results in a total network of up to 850 weather stations throughout the SCE HFRAs. SCE has established an installation standard, which is being used by qualified electrical workers to install these units. Once we reach the desired level of deployed weather stations, we will have sufficient granularity in weather data to effectively monitor weather conditions at the circuit level and inform critical operational decisions during elevated weather conditions, such as deploying the PSPS protocol.

(a) **High Definition Cameras**

To minimize the growth and propagation of incipient stage fires and help with fire suppression efforts, SCE is partnering with the University of California, San Diego (UCSD) and the University of Nevada, Reno (UNR) to procure, install and maintain pan-tilt-zoom High Definition (HD) Cameras at up to 80 locations. These cameras provide 911 confirmation for fires from up to a 100-mile radius which helps fire agencies determine the size and approximate location of the fire. SCE is targeting these cameras to provide up to 90 percent coverage of CPUC T2 and T3 HFRA's. UCSD and UNR are serving as a technical, research, and execution partners for deploying the HD cameras. SCE is working with local and state fire agency personnel to support deployment and will continue incorporating impacted fire agencies throughout SCE's high fire risk area to provide HD Camera live feeds. This information is critical to fire agencies for effectively deploying air and ground resources to limit and contain fires in the early stages.

(2) **Need for Activity and Risk Avoided**

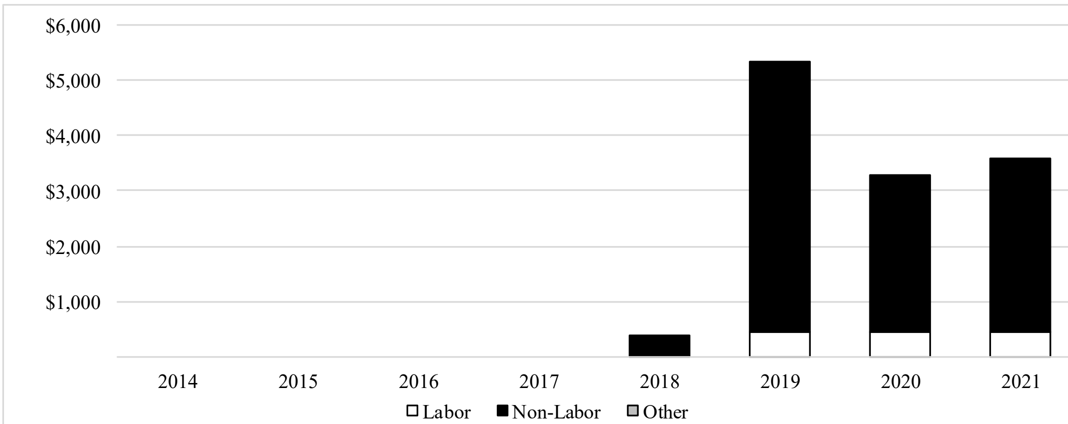
The SA Center forecasts assist in monitoring the risk and gives SCE the ability to forecast, track and monitor any threat to the grid which could cause issues to both public safety and power reliability. SCE meteorologist forecast a storm event impacting the SCE territory three to five days in advance to accurately identify what area of the SCE territory would be at risk to give field resources adequate time to stage and respond to an incoming storm threat. By providing the resources and access to critical system operations, weather conditions across the system at different degrees of granularity, and other externalities that affect the daily operation of the grid, the IMTs are better equipped to make decisions.

The weather stations provide a granular real-time observational reading of weather variables associated with fire risk. These observational readings provide SCE with the ability to detect real-time threats based on weather station observations. SCE weather stations improve the models being developed, which improves the ability to accurately and precisely predict weather related threats to SCE assets and infrastructure. Weather stations establish a program and network of sensors that actively help SCE reduce the wildfire threat within its service territory.

HD cameras provide the ability for both SCE and fire agency resources to monitor the service territory for possible fire ignition, which allows SCE and Fire agencies to avoid the risk of late fire detection, therefore fire agencies can quickly respond to a new fire and increase their ability to suppress a fire before it turns into a larger fire that could cause significant damage.

(3) Enhanced Situational Awareness O&M Forecast

Figure II-27
Enhanced Situational Awareness O&M
Recorded 2014-2018/Forecast 2019-2021
(Total Company Constant 2018 $000)



	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor					$28	$460	$460	$460
Non-Labor					$354	$4,876	$2,812	$3,134
Other								
Total Expenses					**$382**	**$5,336**	**$3,272**	**$3,594**
Ratio of Labor to Total	-	-	-	-	7%	9%	14%	13%

	Recorded 2018	2019	Forecast 2020	2021
HD Cameras		$4,216	$1,553	$1,651
Weather Stations	($278)	$640	$1,240	$1,463
Wildfire Response, Modeling, Analysis, & Weather Forecasting	$660	$480	$480	$480
Totals	**$382**	**$5,336**	**$3,272**	**$3,594**

(a) Basis for O&M Expenditure Forecast

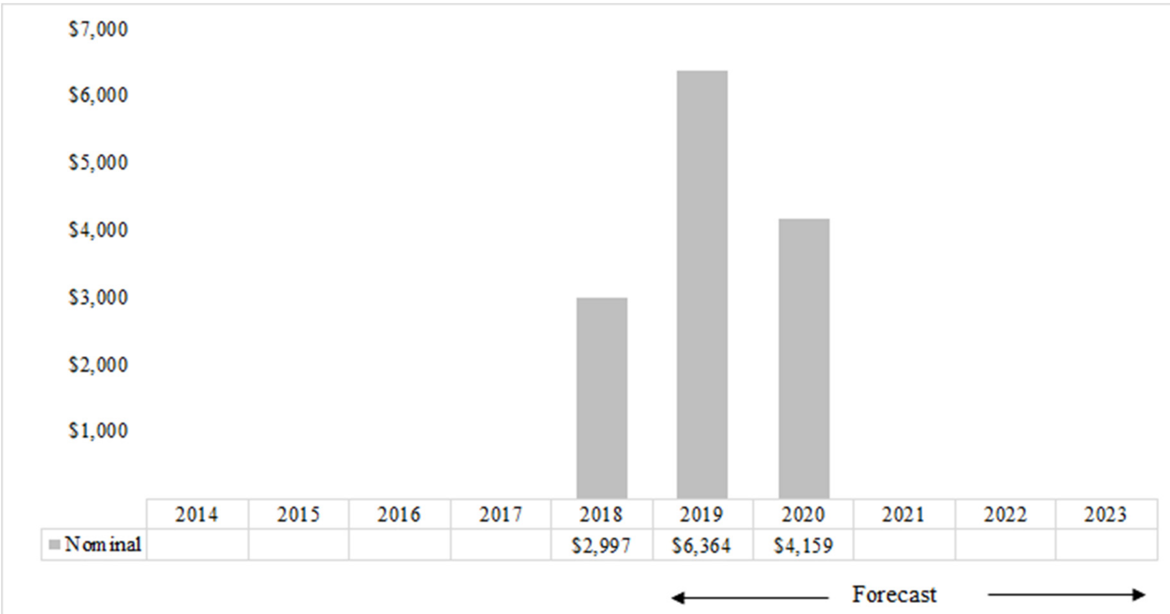
The Enhanced Situational Awareness forecast was developed using an itemized approach taking into consideration vendor contracts for HD Cameras, Weather Station maintenance and service fees as well as labor costs for related sub-work activities.[69,70]

[69] Refer to WP SCE-04 Vol. 05, Part 2 pp. 66 - 70 – Enhanced Situational Awareness (O&M).

[70] Negative charge in 2018 is due to weather station capital cost that was incorrectly booked to O&M and subsequently transferred to Capital.

(4) Enhanced Situational Awareness Capital Forecasts

Figure II-28
Enhanced Situational Awareness Capital Forecast
(Total Company Nominal $000)



	Recorded 2018	Forecast 2019	2020
HD Cameras	$656	$2,888	$220
Weather Stations	$2,341	$3,476	$3,939
Totals	**$2,997**	**$6,364**	**$4,159**

(a) Basis for Capital Expenditure Forecast

SCE requires capital investments to implement the Situational Awareness work activity for Weather Stations and HD Cameras. These projects help SCE prepare, prevent, and mitigate effects of potential wildfires. For the 2019 – 2023 period, SCE forecasts $7.4 million for the purchase and installation of 350 weather stations. These costs include the purchase of both cellular and satellite weather stations, siting of those weather stations and finally the installation of those weather stations. The forecast is based on the location of the weather station as some locations may be more difficult to access in rural or mountainous areas and hazardous conditions making areas inaccessible. These weather stations will provide real time information for operational decision making.

For the 2019 – 2023 period, SCE forecasts $3.1 million for the deployment and installation of 160 HD cameras in SCE's service territory. These costs include technical support and fabrication of tower camera systems, camera kits, and network/routing devices.[71]

(5) RAMP Integration

Situational Awareness is essential for SCE's operational decision-making and service delivery. Situational awareness gives SCE visibility to critical system operations, weather and hazardous conditions across the service territory at different degrees of granularity, and other externalities that affect the daily operation of the grid. Situational Awareness allows SCE improve response time before and during emergencies such as wildfires, which in turn allows for reduction in customer minutes of interruption. Greater awareness of emerging wildfire potential will allow us to plan proactively and appropriately modify work procedures to improve the safety of our workers and the communities we serve.

Note that the Situational Awareness, Monitoring & Analytics RAMP forecast for the Climate Change risk includes all Situational Awareness scope (shown in Table II-24). The Enhanced Situational Awareness RAMP forecast for the Wildfire risk includes a subset of Situational Awareness work. The same mitigation was forecasted to mitigate multiple risks in the RAMP report. The GRC forecast for this work will only appear in this volume.

Table II-24
Situational Awareness Mitigations (O&M)
RAMP vs. GRC O&M Forecast Comparison
Nominal 2018 $000

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021
Climate Change / Wildfire[1]	M2a / M7	Situational Awareness, Monitoring & Analytics / Enhanced Situational Awareness	RAMP	$ 4,761	$ 6,121	$ 4,841
			GRC	$ 5,350	$ 3,303	$ 3,641
			Variance	$ 589	$ (2,818)	$ (1,200)

[1] The same mitigation was used to mitigate multiple risks in the RAMP report. The funding for this work will be entirely requested in this volume

[71] Refer to WP SCE-04 Vol. 05, Part 2 pp. 74 - 77 – Forecast Summary - Enhanced Situational Awareness (Capital).

(a) Reconciliation Between RAMP and GRC: O&M

As shown in Table II-24, there are material differences from 2019 - 2021 between the forecast for Situational Awareness, Monitoring & Analytics mitigation as estimated in SCE's 2018 RAMP report and the forecast requested in this GRC. The cost variance for Enhanced Situational Awareness is mainly driven by the need to accelerate the project schedule for HD Cameras and complete installation in 2019. The 2020 decrease is as a result of the accelerated costs that will be incurred in 2019. For 2021 the decreased total cost is primarily due to movement of the forecast for certain sub-activities (Advanced Modeling Computer Hardware and Fuel Sampling Program) from Enhanced Situational Awareness to the newly integrated activity for Fire Science & Advanced Modeling.

Table II-25
Enhanced Situational Awareness Mitigations (Capital)
RAMP vs. GRC Capital Forecast Comparison
Nominal 2018 $000

RAMP Risk	RAMP ID	RAMP Mitigation Name	Filing Name	2019	2020	2021	2022	2023
Climate Change / Wildfire[1]	M2a / M7	Situational Awareness, Monitoring & Analytics / Enhanced Situational Awareness	RAMP	$ 12,483	$ 8,500	$ 22	$ -	$ -
			GRC	$ 6,364	$ 4,159	$ -	$ -	$ -
			Variance	$ (6,119)	$ (4,341)	$ (22)	$ -	$ -

[1] The same mitigation was used to mitigate multiple risks in the RAMP report. The funding for this work will be entirely requested in this volume

(b) Reconciliation Between RAMP and GRC: Capital

As shown in Table II-25, there are material differences in 2019 and 2020 between the forecast for Enhanced Situational Awareness as estimated in SCE's 2018 RAMP report and the forecast requested in this GRC. There are two main reasons for the reduction in forecast from 2019 – 2021:

- The forecast for Advanced Modeling Computer Hardware was moved from Enhanced Situational Awareness to the newly integrated work activity for Fire Science & Advanced Modeling, in order to appropriately group related projects in the same portfolio.
- The identification of operational efficiencies allowing the per unit cost per weather station installation to decrease by $7,000

for the 725 weather station installations planned for 2019 and 2020.

6. Fire Science & Advanced Modeling

a) Work Description

(1) Fire Science

Fire Science is a broad term that involves the gathering and integration of science and technology to help with wildfire mitigation across the SCE service territory. By taking a collective approach, Fire Sciences seeks to inform the process of wildfire mitigation through grid hardening, vegetation management, and situational awareness. Fire Sciences will also help inform policy makers in developing initiatives that reduce the risk of wildfires to the communities. Analytics will be one of the tools that Fire Science will use to help understand antecedent conditions that lead to the initiation, spread, and behavior of wildfire activity, all of which will help with situational awareness and daily operations. In addition to analytics, Fire Sciences will build new partnerships, and leverage existing relationships with government, academia, and the private sector to further the understanding of wildfires. One of Fire Sciences' priorities in the coming years will be to help understand and to model fuel conditions in greater detail across the service territory.

(a) Vegetation (fuels) modeling

The vegetation characteristics that contribute most to the initiation and spread of wildfires are moisture, continuity, loading, and type. Some of these characteristics can be remotely sensed, while others can be modeled. The moisture content and the amount of the vegetation will be one of the focuses of Fire Sciences going forward. Currently SCE can model the moisture content within the dead vegetation by using pre-established, standardized mathematical algorithms. However, modeling the moisture content in the living vegetation is much more difficult, so SCE is using a new model to estimate this for the service territory. This model uses random forest machine learning techniques to approximate live fuel moisture values. This model has been trained on historical live fuel moisture sampling observations that have been taken over the years by fire agencies. Future improvements in the model's performance will be dependent on more observational data, some of which will come from SCE's own fuel moisture sampling program.

(b) Fuels Sampling Program

For decades, fire agencies have measured moisture levels in the living vegetation every two weeks at sporadic locations throughout the state by physically collecting samples of the dominant plants. However, due to gaps in both sampling times and locations, SCE has started a fuels sampling program to help assess fuel moisture where these gaps exist. This is necessary for increasing situational awareness and assessing the antecedent conditions that lead to significant fire activity across the service territory. This information will also be assimilated into existing fuel moisture models periodically for the improvement and verification of model performance. Output from SCE's fuel sampling will be shared with the fire community for the benefit of all who engage in wildfire prevention and suppression.

(c) Remote Sensing Satellite

For the purpose of increasing situational awareness specifically related to wildfires, SCE is pursuing the use of remote sensing technology provided by satellite imagery. SCE will acquire vendor services or satellite services to provide hyperspectral imagery to be used for situational awareness and super computer model improvement. Services will also provide processing of imagery into vegetation indexes specifically designed for SCE territory to monitor the health of the environment. Including the dry fuel monitoring program, this will be accomplished through the high resolution and high temporal frequency provide values like Normalized Difference Vegetation Index (NDVI) which is a measurement of vegetation greenness. Acquiring this information will give SCE the awareness of the health of vegetation across the entire service territory with a focus on HFRAs.
In addition, this information will provide imagery that is frequently updated compared to current imagery, this will provide SCE the ability to see changes in the territory over a weekly basis, which will assist with restoration efforts in areas affected by fires/natural events.

(d) Surface Canopy and Fuels Mapping

Surface fuels and canopy information is a necessary and vital input into all fire spread modeling. Currently, SCE (through our vendor) is using the latest available land surface data which is coarse in resolution and does not include recent landscape disturbances. Therefore, in order to improve SCE's fire spread modeling results, an extensive and detailed mapping of the surface fuels and canopy is required. This process employs a blend of LIDAR and non-LIDAR technology to more accurately map fuel conditions across the HFRAs that are within the SCE service territory. In addition, careful attention will be paid to address fuel conditions around powerlines and to more accurately map the urban wildland interface regions which would help with risk analysis.

(e) **Advanced Modeling Computer Hardware**

SCE has acquired two High Performance Computing Clusters (HPCC) for the purpose of modeling the atmosphere, vegetation conditions, and fires. Publicly made available weather models from the National Center for Environmental Prediction will be downscaled to 1 and 2 km horizontal resolutions which will allow SCE meteorologists to view atmospheric conditions and fuel conditions in a high level of detail out to five days. This information will help to determine where and when significant fire activity may occur within the SCE service territory. Outputs from these HPCCs will help to drive the inputs for the fire spread models which will be run by an SCE vendor within their cloud environment. In addition to these two HPCCs, a third HPCC will be acquired for the purpose of climate modeling which will allow for the generation of temperature and precipitation forecasts for the medium range period (5-10 years). These Advanced Modeling capabilities will continue to be improved upon based on the Fire Science Enhancements introduced in the section below.

(f) **Fire Science Enhancements**

Based on the continuous technological advances that are available, Fire Sciences will be enhancing much of the modeling applications and procedures that directly affect wildfire mitigation. SCE will be consistently building upon these continuous process improvements to advance our overall capabilities. Some of the enhancements include, but are not limited to the following:

1. Seasonal forecasts of Santa Ana Winds - Improving the 1- and 3-month outlooks of Santa Ana winds can help SCE be more proactive in preparing for conditions that can lead to potential catastrophic wildfire activity.
2. Fuels Modeling - Modeling live fuel moisture is important in understanding fuel dryness for the determination of wildfire potential. Using Artificial Intelligence technology such as machine learning to provide more accurate forecasts is desired.
3. PSPS wind thresholds (wind gust parameterization) – Using a more robust historical dataset to help correct for biases in wind gusts will allow for more accurate forecast of winds across the SCE service territory.
4. Migration to higher resolution model output – Evaluate the feasibility and benefit of modeling weather and fuel conditions

at a 1 km horizontal resolution. Metrics will be established to determine accuracy vs model run time.

5. Using ensemble approach to modeling weather and fuel conditions – Using a perturbed ensemble model approach by configuring the model for optimized performance for individual parameters.
6. Fire Potential Index (FPI) – Calibrate the FPI to historical fire data and improve the FPI so that it can account for other types of fuel regimes.
7. Real-time validation of the WRF model – Incorporate SCE weather station information in conjunction with machine learning to validate the WRF model in real-time.

(g) Asset Risk Modeling

Asset Risk Modeling is focused on developing risk models that create composite risk scores based on asset, environmental and operational data. This will provide guidance on ignition risks to prioritize asset maintenance, upgrades and replacement work to decrease the risk of wildfires. As such, the key objectives and elements of Asset Risk Modeling are as follows:

- Enhance public safety by identifying and prioritizing assets for ignition risk mitigation in HFRA by creating composite risk indexes for those assets based on their characteristics (splices, fusing, conductor type, fault risk, maintenance and operational data, and fire simulation data from the "super computer" platform)
- Integrate relevant SCE and public domain data to enable risk modelling
- Develop and implement risk models associated with SCE Assets, surrounding vegetation, weather and operational data that then result in a consolidated Risk Score
- Integrate risk model events, data and scores for ingestion into the machine learning and analytics environment to operationalize the asset risk modelling capability

- Display geospatial visualization of the risk model events and scores along with appropriate notifications and alerts to the situational awareness center, distribution planning, engineering, and SCE work and asset management teams
- Conduct exploratory analysis using machine learning techniques to gain greater insights into the data and improve model accuracy by searching for anomalies or extremes and improving spatial and temporal fidelity of major data sources as new sensors and simulation data becomes available

(h) <u>Operational Analytics</u>

Operational Analytics is focused on using analytics to develop advanced fault detection. Specifically, the program is designed to develop and improve energized wire down detection algorithms using streaming data from meters, SCADA, remote fault indicators and other sensors to shorten the duration of Energized Downed Conductor (EDC) events and reduce ignition risks. Key elements and objectives of operational analytics for energized downed conductor detection are as follows:

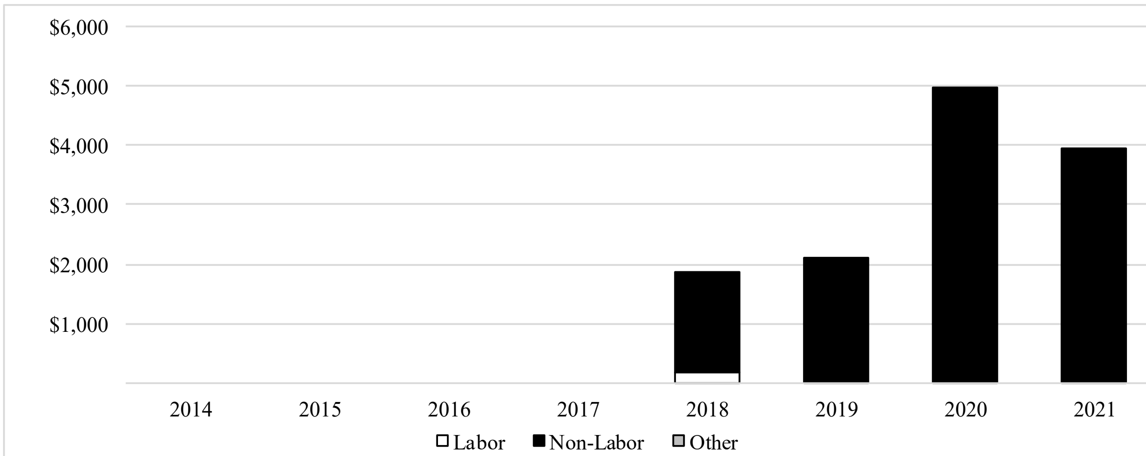
- Identify many EDC events within approximately fifteen minutes and to be able to mitigate public danger as fast as possible;
- Determine the confidence, location, and risk factor of an EDC and respond appropriately;
- Provide first responder notification of an EDC in faulted conditions that pose a public safety risk;
- Use the information from events to tune continue to fast curve settings on RARs (where available) to further diminish risks to public safety from EDCs; and
- Use data analytics tools to create a platform capable of improving existing operational analytics and algorithms to detect infrastructure in faulted conditions and predict assets more prone to faults.

(2) Need for Activity

The generation of high-resolution model data will allow SCE meteorologists to forecast weather and fuel conditions in greater detail, exposing the unique meteorological nuances that can occur across the SCE service territory. Microclimates that are common throughout Southern and Central California are typically not handled well at course resolutions due to the prevailing complex topography. Therefore, the demand for higher resolution model data is needed in order to resolve surface terrain complexities that can alter model performance. Numerical weather models that run at higher resolutions provide more accurate forecasts which will help SCE decision making. As a result, risk avoided can ultimately be tied to the prevention of utility caused wildfires. This avoided risk would be rooted in more proactive decision making during the pre-stages of potential PSPS events and having a better understanding of detailed wind and fire potential information which will help target assets needing immediate repair The Fire Science Program provides overarching support for the advanced modeling efforts as well as all the integration of the latest science and technology into daily operations. This affects the wildfire mitigating strategies and plans, including grid hardening and PSPS. Longer term efforts centered around climate change also fall under this program. This program helps to orchestrate all these efforts and to guide the future of wildfire mitigation for SCE. Risks avoided include utility caused wildfires as well as loss of various SCE assets due to wildfires and other environmental influences such as climate change. Increased situational awareness along with a greater understanding of wildfires, climate, fuels, and fire behavior will help SCE to make more proactive decisions in wildfire mitigation in the near-term. This is also true for long-term mitigation strategies, standards, and practices as the latest science on climate change and prediction is incorporated into future planning.

(3) Fire Science and Advanced Modeling O&M Forecast

Figure II-29
Fire Science & Advanced Modeling (O&M) Forecast
Recorded 2014-2018/Forecast 2019-2021
(Constant 2018 $000)



	Recorded					Forecast		
	2014	2015	2016	2017	2018	2019	2020	2021
Labor					$186			
Non-Labor					$1,687	$2,110	$4,974	$3,948
Other								
Total Expenses					**$1,873**	**$2,110**	**$4,974**	**$3,948**
Ratio of Labor to Total	-	-	-	-	10%	0%	0%	0%

	Recorded 2018	Forecast 2019	2020	2021
Fire Science and Advanced Modeling	$1,873	$2,110	$4,974	$3,948
Totals	**$1,873**	**$2,110**	**$4,974**	**$3,948**

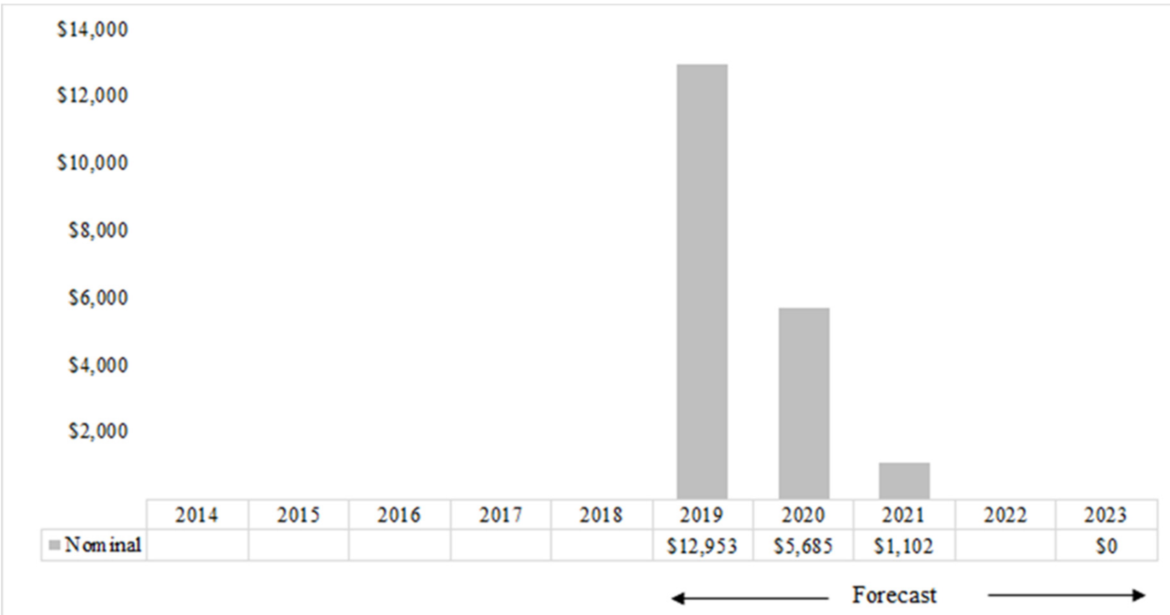
(a) Basis for O&M Forecast

SCE developed the O&M forecast by utilizing vendor quotes and itemized forecasting for the sub-work activities. For the remote sensing sub-activity, SCE estimated the unit cost to acquire hyperspectral imagery to assess vegetation health and fuel conditions in HFRAs.[72]

[72] Refer to WP SCE-04 Vol. 05, Part 2 pp. 85-92 – Forecast Summary – Fire Science & Advanced Modeling (O&M).

(4) Fire Science & Advanced Modeling Capital Forecast

Figure II-30
Fire Science & Advanced Modeling Capital Forecast
Recorded 2014-2018/Forecast 2019-2021
(Nominal $000)



	Forecast 2019	2020	2021
Advanced Modeling Computer Hardware	$6,783	$800	$1,102
Asset Risk Modeling	$3,370	$3,926	
Operational Analytics	$2,800	$960	
Totals	**$12,953**	**$5,685**	**$1,102**

(a) Basis for Capital Expenditure

SCE requires capital investments to implement and support the Fire Science & Advanced Modeling work activity detailed above. These capital costs are in support of projects grouped under (1) Advanced Modeling Computer Hardware, (2) Asset Risk Modeling, and (3) Operational Analytics. These projects help SCE prepare, prevent, and mitigate effects of potential wildfires. More specifically, Advanced Modeling provides detailed projected weather and fuels information for all hazard situations, while Asset Risk Modeling provides information to help with grid hardening prioritization. Finally, Operational Analytics involves a series of enhancements that allow for the investment and use of new technology to further Fire Sciences in order for SCE to be better prepared for wildfires.

SCE conducted benchmarking with SDG&E, as they have successfully installed these new technologies (HPPCs, modeling capabilities and analytics). SCE considered alternative vendors for the different technologies; however, made the decision to obtain quotes and contract with the same vendors based on their actual implementation at SDG&E that will meet SCE's operational needs.

In 2019 based on the quote from the vendor benchmarked at SDG&E, $6.7 million is forecast for the purchase of two High Performance Computer Clusters (HPCCs) and the software to be able to perform high resolution fuels and weather modeling across the SCE service territory. This funding covers the cost for SCE to run fire spread models for both risk modeling and consequence as well as to model current incidents in real-time.[73]

[73] Refer to WP SCE-04 Vol. 05, Part 2 pp. 97-101 – Forecast Summary – Fire Science & Advanced Modeling (Capital).