



Enabling High Penetration Renewables with Synchronous Condenser Conversion Technology

TECHNICAL VOLUME

Project Title: **Enabling High Penetration Renewables with Synchronous Condenser Conversion Technology (SCCT)**
Funding Opportunity Announcement (FOA) Number: DE-FOA-0002740
Grid Resilience and Innovation Partnerships (GRIP)
Topic Area 3 (40103(b)): “Grid Program Upgrading Our Electric Grid and Ensuring Reliability and Resiliency (Grid Innovation Program)”
Area of Interest 3: Combination System Applications
Concept Paper Identification Code: TA3-050-E

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Confidentiality: No Confidentiality Restrictions

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1.0 PROJECT OVERVIEW

1.1 Background

Hawai'i is a national leader in climate and renewable energy policy. With the passage of Act 15 in 2018 Hawai'i set a statutory zero emissions clean economy target in **§225P-5 (a)** "..., a statewide target is hereby established to sequester more atmospheric carbon and greenhouse gases than emitted within the State as quickly as practicable, but no later than 2045." §225P-5 (a) builds upon Hawai'i renewable national energy leadership being the first state to adopt a one hundred percent renewable portfolio standard by December 31, 2045¹ through Act 97 of 2015. The duties of the Hawai'i State Energy Office (HSEO) as stated in **HRS §196-71 (b) (3)** include "Provide renewable energy, energy efficiency, energy resiliency, and clean transportation project deployment facilitation to assist private sector project completion when aligned with state energy goals". Specific statutory responsibilities of the Chief Energy Officer under HRS §196-72 (d), that guide HSEO in the development and submittal of this application, "(5) Identify market gaps and innovation opportunities, collaborate with stakeholders, and facilitate public-private partnerships to develop projects, programs, and tools to encourage private and public exploration, research, and development of energy resources, distributed energy resources, and data analytics that will support the State's energy and decarbonization goals;"

Kaua'i has the highest adoption of renewable energy in Hawai'i reporting an RPS of just over 60% for 2022. Kaua'i Island Utility Cooperative (KIUC) is the exclusive provider of utility electric service to the residences and businesses on the island of Kaua'i, the fourth largest island of the state of Hawai'i. There are no interconnections to other electrical systems or other islands. KIUC produces and distributes power for 80,000 residents and an average daily census of 30,000 visitors, serving nearly 30,000 residences, 5,000 commercial consumers, and 118 large power consumers. The power system is comprised of solar and hydroelectric renewable resources, thermal power generation, and battery energy storage, providing for the electric energy requirements of the island that reached as high as 458,000 megawatt-hours (MWh) in 2022.

1.2 Project Goal

The goal of **Enabling High Penetration of Renewables with Synchronous Condenser Conversion Technology (SCCT)** on the island of Kaua'i is to increase the capability of the KIUC electrical system to effectively transition to 100% renewable energy. The high-priority SCCT project is a Combination Systems application that uses assets in one sector to provide services

¹ §269-92 (a) (6)

to the others in a manner that reduces upgrade or expansion requirements, improves communications across sectors and allows for more complete optimization of grid operations as further discussed in the *Statement of Project Objectives*². This project involves a technology application and activities to provide grid-forming capability of an existing generator to accommodate the operation of high penetration distributed renewable generation.

A project goal is to provide significant regional and community benefits by reducing the likelihood and consequence of disruptive events by enhancing renewable resource adequacy, reducing outages, and enabling grid reliability and resilience by assurance of continuity in the delivery of renewable energy and electrical service. It provides a specific improvement in system operations via an innovative approach to address the most consequential system need and challenge of increasing the supply of geographically and technologically diverse location-constrained energy resources. Another goal is to develop a replicable approach for local, regional, and interregional grid enhancement to obtaining grid-forming capability using an innovative technology while advancing electric system decarbonization through improved interconnected operation with renewable power sources.

To manage the Kaua'i grid effectively, KIUC must not only regulate system frequency, being accomplished by proper MW dispatch, but must manage the grid voltage. The SCCT project will convert an existing, but stand-by, generator at the Port Allen power station to use as a synchronous condenser providing grid voltage regulation service to further the capability of the system to accommodate 100% dispatch of renewable generation sources.

1.3 DOE Impact

DOE funding reduces barriers to deploy an innovative technology to support a grid that is moving in the near term to 100% renewable energy. KIUC qualifies as a small utility³ for which a significant portion of the DOE project funding is set-aside (see Addendum B) and is also a consumer-owned nonprofit electric cooperative in a high electric rate environment. As discussed in Section 2.7.2 below Hawai'i has the highest electricity rates, has the highest cost of living, and has the second highest cost of housing in the nation. Capital expenditures are therefore highly scrutinized. Although the SCCT is an appropriate system addition, moving forward with construction is a management decision of KIUC's consumer member cooperative board, and the availability of the DOE funding will help alleviate rate impact concerns. Furthermore, supplemental funding from DOE for the SCCT project will mitigate the need for regulatory approval from the Hawai'i Public Utilities Commission (HPUC). DOE funding would reduce KIUC's project costs below \$2.5 million, the threshold over which HPUC approval is required speeding up the deployment timeline. DOE support of this project will contribute to

² Application TA3-050-E, Statement of Project Objectives, SOPO.docx.

³ KIUC's retail sales to ultimate customers in 2022 were 458,054 MWh. That amounts to just 11% of the reference level of 4,000,000 MWh or less of electricity sales which defines small utility entities.

the advancement of cost-effective 100% renewable energy for the greatest benefit of the community, supporting KIUCs renewable energy leadership. DOE support to achieve 100% renewable energy, reducing price volatility and increasing energy security by mitigating exposure to the oil market, benefits consumers in disadvantaged communities, including those on Kauaʻi, to a greater degree than in other locations. Of note this is prior to 2022, 25% to 33% of foreign petroleum imports to Hawaiʻi were from Russia. The impact is shown in Section 2.2 Figure 2-4.

1.4 Community Benefits Plan: Job Quality and Equity

The Project will provide significant community benefits through enhanced utilization of existing renewable resources and the potential for additional renewables. The region will receive the benefit of reduced frequency and impact of power disruptions, and expand clean energy utilization. As a not-for-profit member-owned cooperative, KIUC regularly engages with government, community, labor, and business organizations to ensure the success of projects. The Project will contribute to the community employment through short-term construction jobs. Most of the work is expected to be contracted out, and KIUC would encourage contractors and subcontractors to recruit from the local Kauaʻi workforce whenever possible. KIUC recently completed an \$8.5 million construction project in Anahola, and both contractors who were engaged were Kauaʻi-owned and operated. KIUC also participates in the State of Hawaiʻi “Good Jobs Hawaiʻi” coalition. This is a coalition of businesses, educators, and community partners that will help people in Hawaiʻi get high quality jobs and careers, while ensuring employers meet their needs for a skilled, local workforce. The emphasis on job quality and equity is described further in the *Community Benefits Plan* ⁴.

1.5 Strategy for Sharing Benefits and Community Engagement

The SCCT system improvement provides a system-wide benefit through the expanded use of renewable energy resources insulating customers from oil market price volatility. The utilization of existing infrastructure reduces the incremental cost which lowers the overall cost of energy. This provides even greater value to disadvantaged communities by lowering the cost of electricity. Disadvantaged areas in particular have higher marginal value from reduced electricity costs than other areas. The County of Kauaʻi administration, along with communities, have routinely been involved in evaluation of options for enhanced infrastructure, recognizing the history of extended disruptions of service. To support the project, a Resiliency Advisory Committee, on which HSEO will be a participant, will be established to provide ongoing guidance and look for opportunities to enhance community benefits of the project.

⁴ Application TA3-050-E, Community Benefits Plan, [CBenefits.pdf](#)

1.6 No Long-Term Constraints on Access to Natural Resources

As a community-owned provider, natural resource stewardship is foundational to KIUC's progressive leadership in service standards. The SCCT furthers this stewardship by using existing infrastructure as the source of the project as opposed to new, greenfield, developments that impact the natural environment of Hawai'i.

1.7 Climate Resilience Strategy

The project supports achieving 100% renewable in the near term, directly supporting the states statutory 100% RPS and a net-negative carbon economy as soon as practicable but no later than 2045. The project serves to expand the use of renewable energy thereby reducing generation from fossil resources for Kaua'i and the state as a whole.

2.0 TECHNICAL DESCRIPTION, INNOVATION, AND IMPACT

The Technical Description identifies the character of the project in several ways.

2.1 Relevance to the FOA Goals of Grid Innovation

The SCCT Project is an innovative technical approach for enhancing the operability of systems with a high penetration of renewable resources. As a combination project, it affects both the transmission and distribution system and is a well-planned and economically supportable infrastructure development. The outcome will be improved electric service, and provide evidence of a method to fully integrate and effectively demonstrate the operation of a high-penetration renewable energy system. Planning for such improvements by KIUC has included several years of evaluating alternatives to system development⁵ to provide improved reliability, operability, flexibility in provision of electric service and enhanced system resilience.

The synchronous condenser conversion project will address both the transmission and distribution system of KIUC and provides a technological advancement that adds value to existing capacity that has been largely idled by renewable, distributed generation. The conversion technology will demonstrate a replicable opportunity for:

- improved utilization of distributed generation assets;
- load point flexibility enhancement;
- energy storage systems flexibility enhancements;
- grid sensing and control technology advancement;
- grid-forming power system electronics;

⁵ Long Range Engineering Plan, April 2015; and Construction Work Plan 2021-2024, November 2020.

- systems design for increasing renewables integration; and,
- innovative planning that provides for minimal environmental impact by use of brownfield locations.

While providing both transmission and distribution benefits, the SCCT project contributes significantly to the objectives of the Topic 3. The project demonstrates infrastructure utilization that enhances resiliency and reliability, and demonstrates an approach that may be replicated region-wide. The SCCT demonstration contributes to the Topic 3 objectives by:

- Ensuring reliable grid operations by increasing system inertia and reducing the frequency, scale, and duration of disruptions that otherwise destabilize the system;
- Improving overall grid resiliency through improved utilization of distributed and renewable resources across the transmission and distribution system;
- Enhancing collaboration among entities and private and public sector owners and operators on grid resilience by a statewide alliance and support for a regional strategy, and the establishment of a Kaua'i-based Resilience Advisory Committee (RAC);
- Contributing to the decarbonization of electricity and broader energy system by improved access to technologically and geographically diverse energy sources, including distributed sources, renewable resources, and electrification opportunities; and,
- Providing enhanced system value and delivering economic benefits to the residences and business of Kaua'i – the members of the cooperative – and other island communities and ratepayers of other utilities that can then make use of stranded or underutilized generation assets to provide for high levels of renewables penetration.

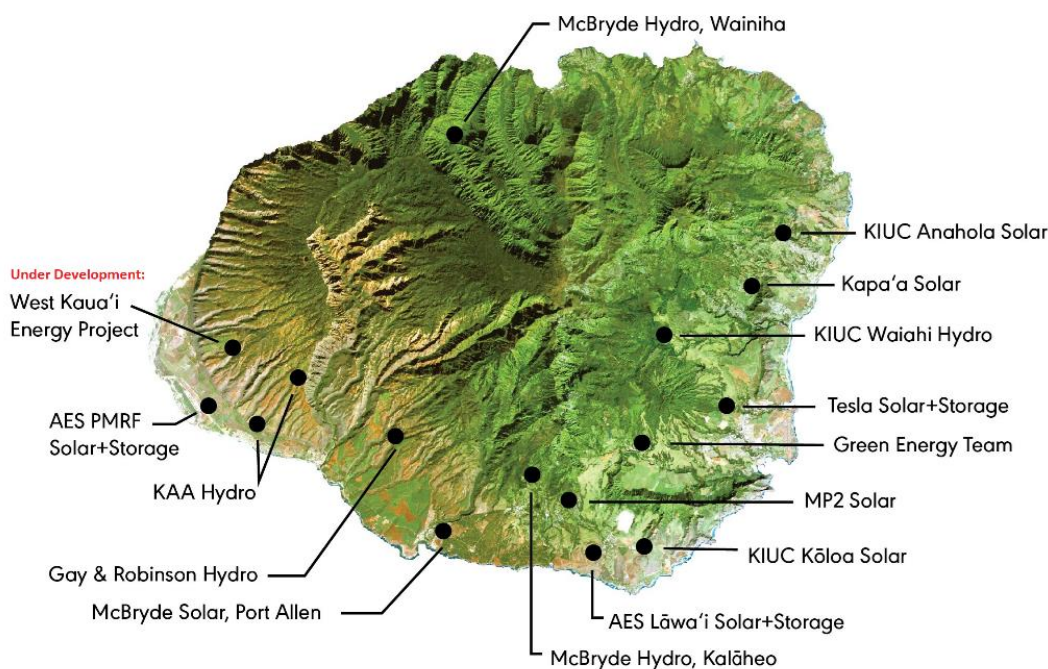
Specifically, the SCCT project will meet the requirements of the FOA Topic 3 area as an innovative approach with public benefits by offering a clear path to replication, improved ability to impact decarbonization, equitable access using existing facilities, and involvement of multiple communities currently served in part by fossil generation facilities. The SCCT project:

- Is of a scale (10 MVar of reactive power) that brings a differentiated value to the area;
- Demonstrates a replicable, scalable technology application that can be incorporated into utility planning and financing evaluations;
- Provides an estimated value in offsetting fossil fuel generation costs for inertial energy and relative values by advanced utilization of existing system assets;
- Measurable in impact by offsetting fossil resources, expanding the capability of distributed resources, contribution to reducing system losses and other grid outcomes (such as reduced outages or renewables displacement);
- Is readily deployable using assets for which local knowledge is established, and may be implemented within the operational framework of an existing grid;
- With federal funding contribution, reduces the regulatory hurdle associated with HPUC of approval for construction; and,

Kauaʻi's electrical generation has been transformed over the past decade or so. What used to be an island powered by over 90% conventional fossil fueled generation has morphed into an island powered by 60% renewable generation⁶. Advanced Metering Infrastructure was installed by KIUC in 2012 to help enable effective system monitoring and control of distributed generation, in association with the KIUC Supervisory Control and Data Acquisition system. This paradigm shift has resulted in lower rates and a substantial reduction in greenhouse gas emissions; it has also resulted in challenges like grid resiliency and resource intermittency.

Renewables Penetration: While KIUC has recorded the best reliability statistics of any island in the State of Hawaiʻi in 2020 and 2021, distributed renewable resources may be utilized to a larger extent by provision of grid-forming infrastructure that will be demonstrated by the SCCT project. Figure 2-3 shows the renewable resources available to KIUC in addition to residential and commercial rooftop or adjacent photovoltaic systems. Since 2012, seven new utility-scale renewable facilities have come on-line, and over 6,000 rooftop systems have been interconnected. The West Kauaʻi Energy Project currently under development, with expected operation by 2026 will take renewable penetration from 60% to over 80%.

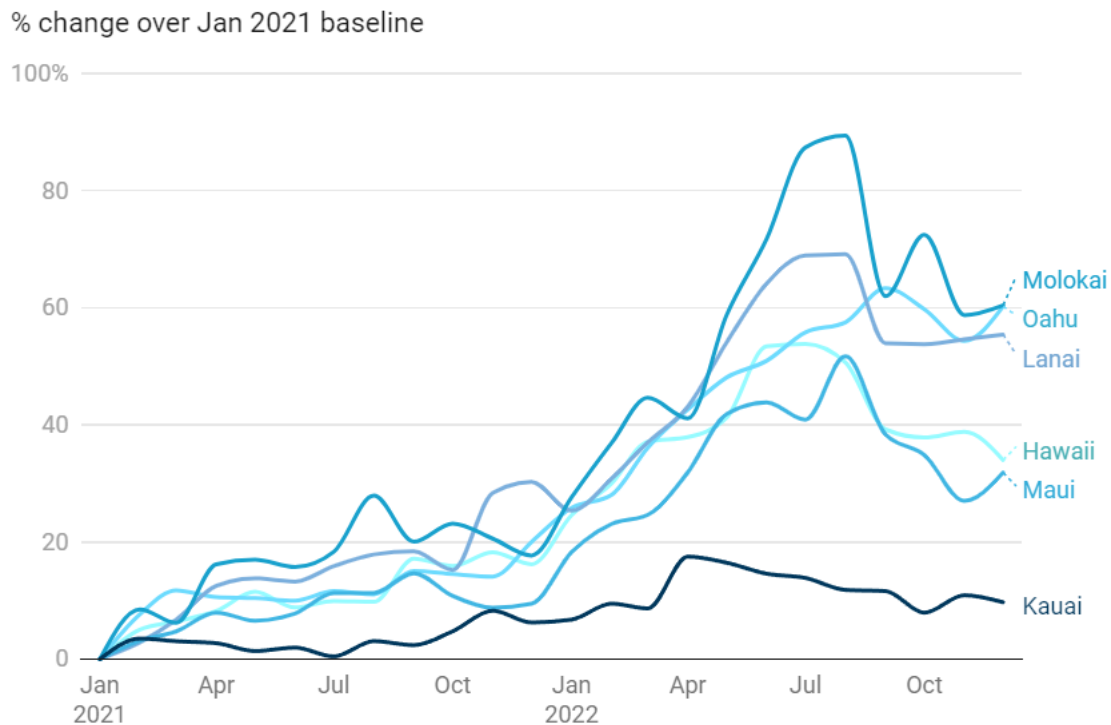
Figure 2-3 KIUC Renewable Resources



⁶ Kauaʻi Island Utility Cooperative Renewable Portfolio Standards (RPS) Status Report Year Ending December 31, 2022 <https://dms.puc.hawaii.gov/dms/DocumentViewer?pid=A1001001A23E05B02123D01458>

Increasing renewable energy penetration mitigates exposure to fossil fuel price volatility providing a material benefit to the Kauaʻi, the state as a whole, and other regions sensitive to the energy price shocks. As shown in Figure 2 – 4 below Kauaʻi's high levels of renewable penetration served to insulate KIUC members from the geopolitical induced price shock in the oil market in 2022. The exposure to volatility in electricity prices from the oil market was correlated to the level of renewable penetration.

Figure 2-4: Percent Change in Residential Electricity Price



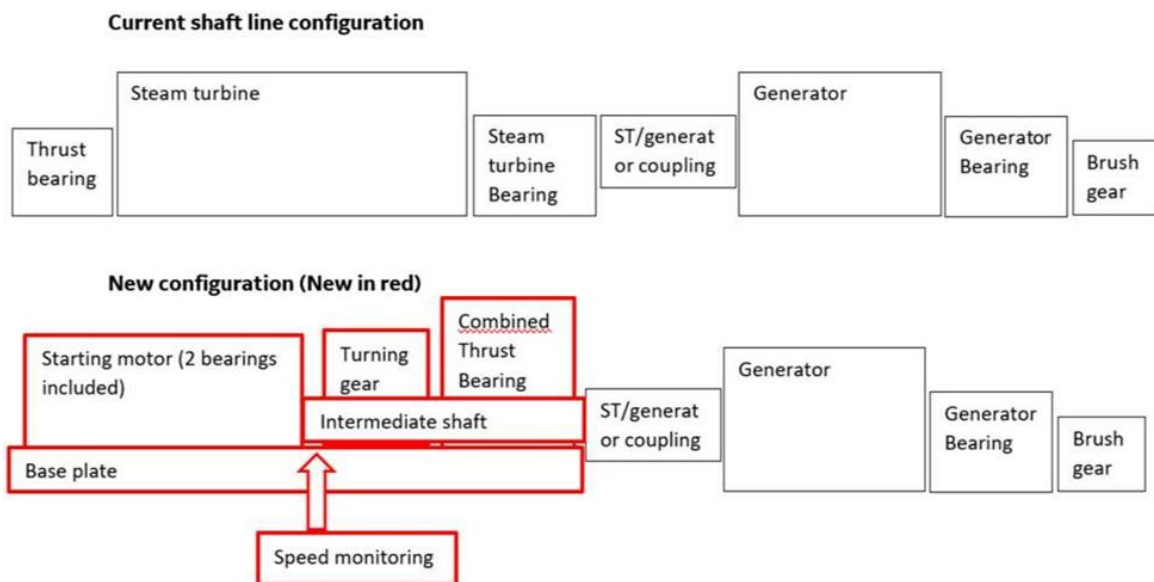
Conversion to Synchronous Condenser: The 12.5 MVA S1 steam turbine generator of Figure 2-5 was installed at Port Allen in 1968 as part of the 10 MW steam plant installation which included a boiler and other associated equipment. The boiler was taken out of service in 2019. Although the steam turbine can still be fed by a heat-recovery steam generator (HRSG) installed in 1977, the HRSG has not been needed to operate in over a year and has not run consistently in over a decade. The steam plant generator was rewound in 2007 and is in excellent condition. As a synchronous condenser, the unit will be capable of importing or exporting reactive power.

Figure 2-5: Port Allen S1 Steam Turbine



As depicted in Figure 2-6, the SCCT project will involve dismantling the steam turbine and installing a variable frequency drive motor to wind up the generator to 3,600 RPM, and a clutching mechanism to allow the motor to de-couple once the generator was synchronized to the grid. The project would also require oil piping modifications, electrical, instrumentation and control work. Upon conversion, the current exciter will be obsolete and replaced.

Figure 2-6 Configuration Change for Conversion to Synchronous Condenser



The cost of the conversion will be approximately \$3,350,000 and can be completed in one year following project approval and acquisition of the necessary parts and equipment. If approved for grant funding, KIUC may expeditiously proceed with project development.

The converted steam turbine unit will have a parasitic load of less than 0.1 MW, far less than the current 1.5 MW it takes to run a synchronous condenser associated with a combustion turbine located at Kapaia, saving roughly \$150 to \$300 per hour of operation. In 2020, the Kapaia unit ran as a synchronous condenser over 1,000 hours, and the conversion of the steam unit will allow operation of the island's electric grid at 100% renewable longer and more often.

KIUC progress to 100% renewable generation has resulted in running its fleet of conventional units less; this is most obvious with regard to the turbines at the Port Allen Generating Station (PAGS). As can be noted in Table 2-1 below, the Port Allen turbines (gas and steam) have been utilized less than 5% of the time over the past seven years and less than 1% the past two years.

Table 2-1 Port Allen Turbine Runtime Hours and Power Production

YEAR	2016	2017	2018	2019	2020	2021	2022
GT-1 Fired Hours	135	30	51	32	253	9	16
GT-1 kWh	547,890	110,090	341,320	249,280	3,531,753	55,420	200,910
GT-2 Fired Hours	415	349	288	192	51	7	33
GT-2 kWh	2,774,869	2,461,049	2,974,423	3,077,310	675,059	72,510	486,940
S1 Run Hours	312	624	528	0	96	0	0
S1 kWh	800,632	2,073,390	1,588,125	0	136,438	0	0

The significance of the data is to illustrate that the Port Allen station has a stranded asset in the S1 steam turbine generator and why it can now be utilized for the SCCT project. The data also shows that KIUC's steam plant system, which also includes an HRSG that can be fed by either GT-1 or GT-2 will not be utilized in the future. Conversion of unit S1 will result in the retirement of all steam systems at the Port Allen Generating Station.

2.3 Desired Grid Outcomes

One of the main obstacles for KIUC to run 100% renewable has been grid voltage and stability. SCCT will alleviate grid challenges resulting from solar resources in particular. All solar power comes to the grid via inverters. Inverters today, although advanced from even five years ago, are still limited by how much grid support they can provide during fault conditions and provide little to no inertia to the island system. Most inverters can achieve 110% of rated output during a fault, some even 150%, while a synchronous generator or condenser can achieve 600%. This fault current ability keeps the grid up in the split second between the fault occurring and

electrical protection engaging to isolate the fault. As Kauaʻi's grid transitions to 100% renewable this challenge has become more apparent.

The SCCT project will deliver grid-benefitting outcomes in a variety of ways. The project will provide reliability under a variety of operating and maintenance scenarios, provide resiliency to disturbances on the transmission and distribution system and increases the ability of KIUC's system to provide voltage stability to the island. The project provides:

- Additional opportunities island-wide for renewable resource contributions, and operation under conditions of 100% renewable energy sources;
- Decarbonization of the grid by fully displacing fossil fueled generation that would otherwise be deployed for system inertia;
- Better utilization of energy storage facilities and combination systems of solar/storage/pumped hydro and the pending West Kauaʻi Energy Project; and,
- Grid-forming control technology with a regionally located synchronous condenser.

The properly sized synchronous condenser of SCCT will provide a solution to the voltage stability and fault tolerance issues by offering the following solutions:

- Mitigation of frequency instability that occurs through balancing of renewable power;
- Support for the grid with inertia and offload reactive power;
- Combats phase-locked loop synchronization instability;
- Removes limitations in the power infeed caused by low short-circuit level;
- Provides short-circuit capacity to strengthen the grid and remedy voltage collapse; and,
- Provides dynamic voltage support, rather than from on-off switched reactive sources.

The SCCT will provide the means to deliver renewable energy throughout the island from various renewable facilities. The use of renewables reduces the island's (and the state's) reliance on fossil fuels, associated price volatility, export of funds out of the state for fuel imports, fuel supply reliability risk, and greenhouse gas emissions.⁷

2.4 Feasibility – Technical and Environmental

Technical Feasibility: There are no identifiable or preemptive technical risks associated with the SCCT project. The technical feasibility is founded upon the KIUC planning activities over the last several years and is a reasonable and appropriate use of available infrastructure. The mechanical processes are straightforward and KIUC has accomplished a combustion turbine conversion previously, as noted in Section 2.2. Stand-alone synchronous condensers are

⁷ HPUC Application Kilohana Switchyard Project, Docket 2022-0230, Nov. 15, 2022, p. 9

commercially available⁸. The technical significance of the SCCT project is that use of existing infrastructure that may be available to other system operators lowering costs and mitigating the need for green-field infrastructure. This is particularly true for system operators with retired or to-be retired generation facilities, as movement toward renewable energy increases. The SCCT project demonstrates the feasibility and attractiveness of the solution to achieve high-penetration of renewables.

Environmental Feasibility: There are no identifiable environmental **risks** in demonstrating the conversion of the KIUC S1 turbine to synchronous condensing service. This turbine location is a brownfield site, and all changes will take place within the exclusion zone of the powerplant facility. There will be no changes required outside of the turbine building and existing transmission and distribution facilities will be unaffected. There will, however, be **rewards** from the beneficial environmental impacts of offsetting thermal generation that would otherwise provide reactive power and enhancing the potential for expanded dispatch of renewables through the operation of the synchronous condenser.

2.5 Innovation, Impacts and Risk

Innovation: The electric grid development by KIUC has been ahead of the industry in promoting and implementing state-of-the art technology that provides energy security, reliability and resiliency for the island. It has been recognized for leadership in renewable power supply and battery energy storage,⁹ and KIUC has routinely met or exceeded the renewable energy goals set for the cooperative by the state of Hawai'i and its own board of directors. The SCCT project will continue that legacy of innovation and further advance technology on the utilization of renewable energy sources by demonstrating the ability to operate entirely on renewables to a greater extent and more economically. Success with the SCCT project will promote similar applications that can be scaled in accordance with the system development requirements in other regions and for other utilities.

Impacts: An advantage of the SCCT project over current and emerging technologies is the utilization of existing infrastructure that would otherwise be rendered obsolete and retired. The revitalization of a stand-by unit for longer-term use and beneficial system application reduces

⁸ https://www.gegridsolutions.com/products/brochures/powerd_vtf/synch_cond_web.pdf

⁹ KIUC earned its award in the category of Electric Cooperative of the Year for demonstrating industry leadership through unique innovation in an effort to significantly accelerate the transformation to a clean and modern energy system. In its award announcement, the Smart Electric Power Alliance (SEPA) said, "KIUC is unique in the world in achieving 100% renewable on nearly a daily basis." SEPA further noted, "KIUC's transition to renewables has resulted in more stable and lower rates, as members are increasingly buffered from the financial impacts of volatile oil pricing and benefit from a majority of their power being supplied via long-term power purchase agreements that are competitively- or lower-priced compared to fossil fuel."

<https://sepapower.org/knowledge/sepa-announces-2021-power-players-award-winners/>

waste, avoids acquisition of new materials and the associated environmental impacts of equipment production. The conversion adds value to a brownfield site and minimizes the potential loss of productive land and resources that may otherwise be required for an alternative such as battery storage for frequency regulation. Overall, by demonstrating the beneficial aspects of conversion technology, the project will promote wide-spread application of the option for high-penetration renewables among all utilities current undergoing transformation from fossil generation to renewable power supply.

The availability of a more secure renewable energy supply by the SCCT project will serve to promote economic well-being throughout Hawai'i and similarly situated locations with the potential for, or current high-level penetration of renewables. The improvement in electric service will help to advance private sector investments, not only in renewable energy resources, but beneficial electrification and general economic activities that support employment and workforce development. Community engagement will provide awareness of the incremental benefit in renewables integration and acceptance of the project as a model for others on the advantage of this approach to advance renewable energy penetration, provide economically feasible resource options, and advance energy security.

Risk: The primary risk to timely project completion is regulatory approval of the project if the cost should exceed \$2.5 million. However, partial funding by DOE will mitigate regulatory approval risk by lowering KIUC's cost below the \$2.5 million threshold as discussed in Section 1.3. Additional risk mitigation is demonstrated through KIUC's record of financial stability with management systems and standards to provide quality oversight of the project, history of performance in grant-funded project completion¹⁰, and recognized ability to effectively implement statutory, regulatory, or other requirements imposed on non-federal entities.

An advantage of the SCCT project over current and emerging technologies is the utilization of existing infrastructure that would otherwise be rendered obsolete and retired. The conversion adds value to a brownfield site and minimizes the potential loss of productive land and resources that may otherwise be required for an alternative such as battery storage for frequency regulation. Overall, by demonstrating the beneficial aspects of conversion technology, the project will promote wide-spread application of the option for high-penetration renewables among all utilities current undergoing transformation from fossil generation to renewable power supply.

¹⁰ An example includes successful installation of Advanced Metering Infrastructure under the DOE-funded Smart Grid Demonstration Project, DE-OE0000222. Project report Nov. 2013

2.6 Support of State, Local, Regional Resilience and Decarbonization

KIUC has a history of successful improvements in system operational reliability and resiliency, enhancing system operating facilities and equipment to improve island-wide service reliability, as indicated by roughly \$28 million in resiliency improvements from 2020-2022.

The SCCT project supports the State's statutory goals for a net-negative carbon economy and 100% renewable portfolio standard by filling an essential grid need traditionally provided through fossil fueled generation. A system improvement shown on Figure 2-3 that is currently under development is the West Kaua'i Energy Project (WKEP), a combination solar energy production and hydroelectric pumped storage project that will supplement the renewable energy portfolio of KIUC, offsetting fossil fuel generation currently produced at Kapaia and Port Allen which would increase Kaua'i's RPS to roughly 80%. The SCCT improves the capability of the entire Kaua'i grid to accommodate energy from WKEP. Additional renewables will be more readily accommodated to support 100% renewable power for KIUC by 2033.

HSEO can utilize the knowledge gained from the project to explore deployment throughout Hawai'i as well as share lessons learned on a national basis. HSEO participates in the resource planning proceedings at HPUC covering the other islands. HSEO is also an active member of the National Association of Energy Officials and serves as the Chair of NASEO's Electricity Committee positioning it to share Kaua'i's experience with the SCCT as a cost-effective technology to increase renewable energy adoption.

2.7 Topic Area 3 Specific Information

2.7.1 SCCT Addresses Innovative Approaches, Deployment Goals

As discussed in Section 2.1, The SCCT demonstration contributes to the Topic 3 objectives by:

- Ensuring reliable grid operations by increasing system inertia and reducing the frequency, scale, and duration of disruptions that would destabilize the system;
- Improving overall grid resiliency through improved utilization of distributed and renewable resources across the transmission and distribution system;
- Enhancing collaboration among entities and private and public sector owners and operators on grid resilience by a statewide alliance and support for a regional strategy, and the establishment of a Kaua'i-based Resiliency Advisory Committee (RAC);
- Contributing to the decarbonization of electricity and broader energy system by enhanced ability to integrate a broad range of technologically and geographically diverse energy sources, including distributed sources, renewable resources, and beneficial electrification opportunities; and,
- Providing enhanced system value and delivering economic benefits to the residences and business of Kaua'i – the members of the cooperative – and other island

communities and ratepayers of other utilities that can then make use of stranded or underutilized generation assets to provide for high levels of renewables penetration which help lower costs and mitigate price volatility from fossil fuel markets.

2.7.2 DOE Funding Increases Likelihood of Securing Additional Investment

DOE funding assists in alleviating project risk in approval of the capital investment by the KIUC consumer member cooperative board of directors by alleviating the concerns over rate impacts. Hawai'i has the highest electricity rates in the country at roughly three times the median electric rate and ~10 cents higher than the second highest rate.¹¹ There are minimal alternatives to electricity for residential consumers available to Kaua'i consumer such as natural gas distribution system making the sensitivity to electric rates even greater. In addition, Hawai'i has one of the highest costs of living in the country resulting in a highly cost-conscious consumer. According to the U.S. News in 2023 Hawai'i ranked 50th in Cost of Living and 49th in Housing Affordability nationally¹². All of this raises scrutiny for approval of capital investments, in particular innovative technologies. The ability to demonstrate to the KIUC board and electricity consumers that this is a viable low cost means by which to integrate renewables is all the more valuable.

DOE funding also mitigates concerns of regulatory approvals as discussed in Section 1.3 above. If KIUC's project costs were to exceed the \$2.5 million threshold it would be subject to HPUC for capital project approval. By helping enable the project to proceed, funds will be supplementally available through investment by USDA RUS, the National Utilities Cooperative Finance Corporation and CoBank. A successful SCCT project will further capital investment in other regions and for other utilities by demonstrating the beneficial use of existing infrastructure and avoiding the environmental impacts of new construction.

2.7.3 SCCT Provides Economic Benefits, Mitigating Impacts of Disruptions

Expanded utilization of distributed renewable resources has the impact of mitigating the impacts of disruptions by providing for localized power supply operation (e.g., a microgrid-type impact). While KIUC has been actively working on methods of enhancing resilience, investing roughly \$28 million in resilience initiatives from 2020-2022, the SCCT project furthers that goal of resilience. As discussed in the Community Benefits Plan, HSEO's engagement with DOE CESER on Clear Path XI includes a seminar to examine how emergency response requirements to all hazard events would change in a 100% renewable energy system. SCCT demonstrates the types of technologies that will be used in the future for recovery from all hazard events. Importantly,

¹¹ https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a

¹² <https://www.usnews.com/news/best-states/rankings/opportunity/affordability>

it also lends credence to the reality that 100% renewable energy is rapidly approaching. With projects such as the SCCT Kaua'i will be at 80% in the 2026 time frame and 100% by 2033.

2.7.4 SCCT Delivers Near-Term Economic Impacts

As reported in Section 2.2, the converted steam turbine unit will have a parasitic load of less than 0.1 MW, far less than the 1.5 MW it takes to run a previously installed synchronous condenser with a combustion turbine located at Kapaia, saving roughly \$150 to \$300 per hour of operation. In 2020, the Kapaia unit ran as a synchronous condenser over 1,000 hours, likely repeatable upon SCCT installation and amounting to \$300,000 in near-term economic impacts. Furthermore, the conversion of the steam unit will allow KIUC to operate the island's electric grid at 100% renewable longer and more often, avoiding the marginal cost of thermal generation and exposure to oil market price volatility highlighted in Section 2.7.2 above.

2.7.5 SCCT Readiness, Viability, and Expected Timing

The SCCT project is a well-planned and economically supportable infrastructure to provide improved electric service to the island of Kaua'i to support 100% renewable resources. Planning for the improvements has included several years of evaluating alternatives to system development¹³ to provide improved reliability, operability, flexibility in provision of electric service and enhanced system resilience. The SCCT project has been examined for viability and is subsequently under consideration for budgeting and work planning by KIUC and reflects KIUC's ongoing efforts to find ways to improve the system while taking advantage of incremental improvements through better use of stranded, brownfield resources. Consequently, the SCCT project is ripe for implementation on a schedule that could provide for construction to begin as early as 2023, with contemplated completion within one year.

3.0 WORKPLAN

3.1 Project Objectives

The objective of the SCCT project on the island of Kaua'i is to enable effective operation of the electric grid when dispatching a variety of electric generation sources and dispatchable loads. To manage the Kaua'i grid effectively, KIUC regulates system frequency, being accomplished by proper MW dispatch, and manages the grid voltage. A synchronous condenser is proposed at the Port Allen power station, through conversion of an existing, but essentially stand-by steam turbine generator. SCCT is a high-priority for KIUC. The conversion of an existing, but stand-by, generator to use as a synchronous condenser providing grid voltage regulation service will generate significant community benefit by furthering the capability to accommodate 100%

¹³ Long Range Engineering Plan, April 2015; and Construction Work Plan 2021-2024, November 2020.

dispatch of renewable generation sources safely, more economically and provide for a more reliable and resilient island grid.

The 12.5 megavolt-amperes (MVA) S1 steam turbine generator was installed at Port Allen in 1968 as part of the 10 MW steam plant installation which included a boiler and other associated equipment. The boiler was taken out of service in 2019. Although the steam turbine can still be fed by an HRSG installed in 1977, the HRSG has not been needed to operate in over a year and has not run consistently in over a decade. The steam plant generator was rewound in 2007 and is in excellent condition. The generator would be capable of importing or exporting reactive power as a synchronous condenser.

3.2 Technical Scope Summary

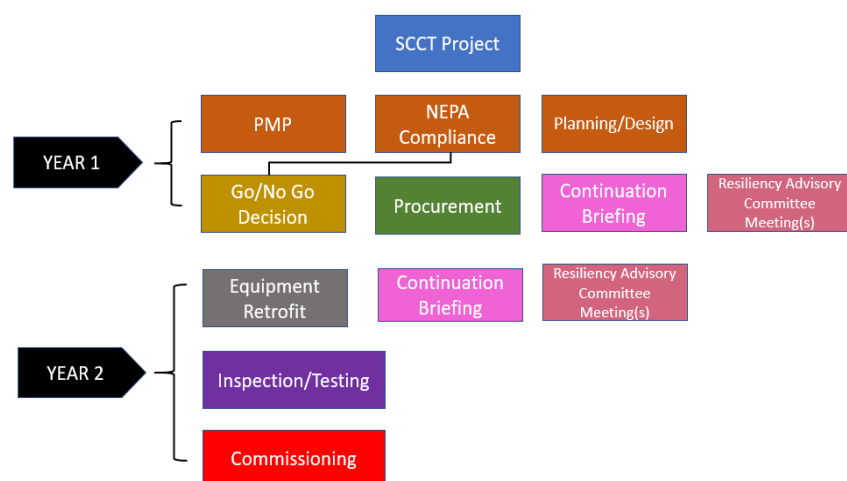
Performance Period 1 (Year 1):

- Hold meeting(s) of the Resiliency Advisory Committee
- Project Management and Planning
 - Submit Project Management Plan, Satisfy NEPA Compliance, Complete planning and design for the Project, Complete Go/No Go decision points
- Complete procurement activities for equipment, supplies, and contractual services

Performance Period 2 (Year 2):

- Hold meeting(s) of the Resiliency Advisory Committee
- Retrofit steam turbine and related site work
- Testing and Commissioning including inspection and acceptance tests on various elements of the Project
- Place Project into service

3.3 WBS and Task Description Summary



3.4 Milestone Summary

Year 1:

- Q1: Project Management Plan completed
- Q2: Resilience Advisory Committee (RAC) meeting held and appropriate recommendations incorporated into Project design/execution
- Q3: Results of NEPA compliance are identified for Project, and Go/No Go decision points are made; Necessary Project adjustments made based on Go/No Go decision points
- Q4: Complete procurement activities for equipment, supplies, and contractual services

Year 2:

- Q1: RAC meeting held to provide modifications or changes that were made during final planning, procurement, and contracting
- Q2: Retrofit of steam turbine and related site work
- Q3: Testing and Commissioning, including inspection and acceptance tests on various elements of the Project
- Q4: Place Project into service

3.5 Go/No Go Decision Points

This project contains three Go/No-Go Decision Points. Subtask 1.2 will require a Go/No-Go decision if the Project fails to complete NEPA compliance. Subtask 2.1 will require a Go/No-Go decision if an amended Project budget exceeds available financial resources.

3.6 End of Project Goal

The goal of the Project is to provide significant regional and community benefits by reducing the likelihood and consequence of disruptive events to the grid when operating on 100% renewable generation and increasing the period of time that the grid can operate with 100% renewables. The project will do this by providing reliability and continuity of service under a variety of operating and maintenance scenarios, providing resiliency to disturbances on the transmission and distribution system and increase the ability of KIUC's system to provide voltage stability to the island. Additionally, the project will demonstrate a novel approach to obtain grid-forming capability through an innovative technology, mitigating costs and environmental impacts through utilization of existing brown field infrastructure that could be replicated for local, regional, and interregional grid enhancement, while advancing electric system decarbonization through the benefits and capabilities described above.

3.7 Project Schedule

TASK	START	END	2024												2025						
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
Project Management	1/1/24	9/10/24																			
Submit PMP Report	1/1/24	2/9/24																			
PMP accepted by FPO	2/12/24	2/20/24																			
NEPA Compliance	1/1/24	2/9/24																			
DOE Go/No Go Briefing	2/12/24	2/12/24																			
Project Planning & Design	1/1/24	9/6/24																			
Annual DOE Briefing	9/10/24	9/10/24																			
Procurement & Delivery of Materials	9/11/24	3/27/25																			
Issue RFPs for elements of the Project	9/11/24	10/8/24																			
DOE Go/No-Go briefing	10/9/24	10/9/24																			
Contracts awarded	10/10/24	10/10/24																			
Material lead times	10/11/24	3/27/25																			
Retrofit of Steam Turbine & Related Site	3/28/25	6/19/25																			
Construction of SCC	3/28/25	6/19/25																			
Testing & Commissioning	6/20/25	7/17/25																			
Inspections & acceptance	6/20/25	7/17/25																			
Project in service	7/18/25	7/18/25																			
Annual DOE Briefing	7/1/25	7/1/25																			

3.8 Buy America Requirements for Infrastructure Projects

The Project will involve the construction and alteration of public critical infrastructure and KIUC intends to follow Buy American requirements for all aspects of the Project.

3.9 Project Management

The Project Team will handle various aspects of Project Management.

Administration of the grant will be provided by HSEO's Managing Director, Operations including responsibility for compliance with grant terms and conditions and overseeing procurement, contracting and fiscal operations for conducting a successful project. Technical oversight of the project will be provided by HSEO's Managing Director, Resilience, Clean Transportation, and Analytics to ensure that the project aligns with state energy policy objectives including decarbonization and resiliency.

Oversight of Project implementation will be provided by KIUC in coordination with HSEO. Project oversight for KIUC will be provided by the Member Services and Communications Manager (administration and reporting) and the Chief of Operations (all other activities). Five team members will contribute to oversight on various elements of the Project and their roles are defined in Section 4.1. Administration and reporting to HSEO to fulfill DOE requirements will be handled primarily by the Administrative Lead and the Finance Accounting Lead, with assistance from the Operations Lead. Other elements of the project as-needed include, planning/design, NEPA approvals, landowner agreements, procurement, construction, inspection/testing and commissioning, and will be a collaborative effort among the Operations Lead, Engineering Lead and Construction Lead, with the assistance of the Administrative Lead and Finance/Accounting Lead as necessary.

Currently KIUC utilizes National Information Solutions Cooperative (NISC) for project tracking. NISC is a cooperative specific software solution used by KIUC for accounting, billing, work order tracking, estimating, mapping and financial preparation. KIUC uses this integrated single platform solution to project manage every project from the beginning of the job starting with the estimate to the work order cost reconciliation and then to the final mapping of as-builts. NISC allows KIUC to track project specific expenses as they relate to direct payroll costs with fringe benefits, equipment expenditures, subcontractor expenses and other indirect costs.

The primary risk to timely project completion is associated with completion of NEPA requirements. Go/No Go decision points have been incorporated into the Project to account for these variables. There are no other environmental or technical risks identified, as the work will be completed within the Port Allen Generating Station. KIUC has successfully completed a similar conversion on its largest generating unit at the Kapaia Power Station. KIUC has a record of financial stability with management systems and standards to provide quality oversight of the project, as well as history of performance in grant-funded project completion, and a recognized ability to effectively implement statutory, regulatory, or other requirements imposed on non-federal entities.

KIUC tracks project changes through the NISC work order tracking system. Original estimates are input into the NISC system and tracked throughout the duration of the project. The estimates are input through a specific work order module and are tracked with meticulous detail which includes tracking specific equipment units, labor direct hours worked, fringe benefits, indirect labor, and subcontractor expense. As costs are incurred, they are matched and applied to the work order estimate and specific cost units. Variations from the original cost estimate are tracked and logged in the system and changes are captured and tracked. Changes occur when variances in original estimates and actual dollars, parts and direct labor are found. These changes are tracked and monitored through monthly reconciliation process. They are then timely communicated to the estimator and project manager.

In order to maintain effective communication, the HSEO and KIUC Project Team will hold monthly meetings to discuss Project status, next steps, current challenges and anticipated issues. However, HSEO has regular contact with KIUC to execute its statutory responsibilities and the KIUC Project Team works in close proximity with each other and are in contact on a daily basis for ongoing cooperative business and operations, so emerging issues will be discussed and addressed as they arise, without need to wait for monthly meetings. Documents related to the Project will be maintained to allow KIUC team members immediate access to Project information at all times and brief HSEO as required.

4.0 TECHNICAL QUALIFICATIONS AND RESOURCES

Section 4 includes descriptions of the technical qualifications and expertise, facilities, equipment, experience, and commitment to the SCCT Project.

4.1 Project Team Unique Qualifications and Expertise

The project team for the SCCT Project is comprised of seasoned professionals employed by HSEO and KIUC, including engineers, administrators, construction managers, project accountants, financial analysts, and general supervisory staff. Project planning, scheduling, construction planning, and construction oversight will be provided by HSEO and KIUC staff and, as necessary, contractors selected by KIUC staff for specific expertise and skills.

HSEO currently administers eight (8) federal grants and subawards including responsibility for compliance with terms and conditions and overseeing procurement, contracting and fiscal operations for conducting a successful project. HSEO subject matter experts have extensive experience in energy planning, project deployment facilitation, energy policy, and community engagement covering topics including renewable generation, system security, and resiliency.

KIUC has a history of successful system development in generation, transmission, distribution, renewable energy source development, and energy storage applications, including a previous successful SCCT project at the Kapaia Power Station. This includes component vendor and contractor selection, acquisition of materials, oversight of site preparation, construction and

erection, and functional and acceptance testing. After installation phases are completed, KIUC staff are responsible for and accomplish successful operation of existing and new plant and facilities with the circumstances and conditions of a remote, islanded electric grid. The principal team members include senior staff members with specific responsibilities:

- Administrative Lead: Donna Mau is responsible for the administration all federal grants and subawards including responsibility for compliance with grant terms and conditions and overseeing procurement, contracting and fiscal operations for projects.
- State Technical and Policy Lead: Chris Yunker has led HSEO energy system planning efforts including participation in resource planning dockets at the HPUC, administering Hawai'i's 40101(d) funds, and serving as an expert witness on finance, energy procurement, cost allocation, and rate design for San Diego Gas & Electric;
- HSEO Outreach and Community Engagement Lead: Parker Kushima leads HSEO's community engagement initiatives including the Clean Energy Wayfinders program to raise community awareness and increase participation in statewide energy planning.
- Operations Lead: Oversight and Project Management will be the responsibility of Brad Rockwell, Chief of Operations at KIUC. Mr. Rockwell has served in several capacities at KIUC, including Executive Manager, Operations and Production Manager, with power systems experience at General Electric;
- Engineering Lead: Engineering Management will be provided by Cameron Kruse;
- Construction Lead: Oversight of construction activity will be the responsibility of Richard Vetter, Port Allen Station Manager;
- Administration Lead: Project Administrative oversight will be provided by Beth Amaro, Member Services and Communications Manager for KIUC; and,
- Finance/Accounting Lead: Project accounting and financial reporting will be provided by Stacie Dellamano, KIUC's Chief Financial Officer.

4.2 Project Team Equipment and Facilities

Design/engineering, competitive bid development, contract management and other administrative functions will be conducted in the following facilities: 1. KIUC's headquarters at 4463 Pahe'e Street in Lihu'e, 2. Port Allen Generating Station, 261 Akaula Street in 'Ele'ele. Equipment/supply storage and field operations/construction will be conducted utilizing KIUC's warehouse facilities at the transmission and distribution offices in 'Ele'ele.

There are no unusual technological aspects to the SCCT Project that will require access to specialized or unavailable equipment and facilities to accomplish successful completion of the project. While Hawai'i is a remote location relative to the contiguous United States, equipment or facility availability has not hindered prior construction projects of a similar nature.

4.3 Project Team Relevant Work Experience

Prior projects completed at KIUC by staff have included substation upgrades and additions, utility-scale generation and transmission additions (including solar energy and battery energy storage facilities), and all aspects of projects necessary for continued successful operation of the island grid and system improvements. They have successfully overseen installation of facilities by contractors supplying facilities under purchased power agreements and contractors supplementing the KIUC workforce on isolated projects. To the extent team members are added to the project (as may be determined), KIUC has experience in contract management and construction oversight, evidenced by the successes to date in system development.

4.4 Time Commitment of Key Team Members

- Grant administration/Donna Mau, HSEO Managing Director, Operations: Anticipates spending 10 hours per quarter on compliance with grant terms and conditions.
- Technical and policy oversight/Chris Yunker, HSEO Managing Director, Resilience, Clean Transportation, and Analytics: Anticipates 10 hours per quarter on coordination and project review activities.
- HSEO community engagement and outreach/Parker Kushima: Anticipates 60 hours per quarter on community engagement activities.
- Implementation oversight and project management/Brad Rockwell, KIUC Chief of Operations: Anticipates spending 40 hours per quarter on Project activities.
- Engineering management/Cameron Kruse, KIUC Engineering Manager: 80 hours per quarter on activities related to the Project
- Oversight of construction activity/Richard Vetter, KIUC Port Allen Station Manager: 5 hours per week except during equipment installation (approximately three weeks), when 15 hours per week would be expected.
- Project administrative oversight/Beth Amaro, Member Services and Communications Manager: Anticipates commitment of 10-20 hours per quarter throughout the duration.
- Project accounting and financial reporting/Stacie Dellamano, Chief Financial Officer: Anticipates spending 10-15 hours per month on accounting and financial reporting.

4.5 Technical Services to be Provided by DOE/NNSA FFRDCs

HSEO and KIUC have successfully partnered with the National Renewable Energy Laboratory (NREL) in recent years, advancing statewide energy decarbonization planning and integrating a high percentage of renewable generation into the grid within a relatively short timeframe. The project partners relationship with NREL is strong, and they have a deep understanding of the state and utility's goals relating to grid resiliency and decarbonization. NREL has agreed to provide technical support and resources to KIUC relative to this Project in furtherance of its resiliency, reliability and equity goals. HSEO and KIUC have received a letter of support from NREL. The letter will be made available upon DOE's request.