Alliance for Sustainable Energy, LLC,
manager and operator of the
National Renewable Energy Laboratory

Strategic Partnership Projects
**Funds-In Agreement—Nonfederal Sponsor**

## Standard Agreement Face Page

| | |
|---|---|
| 1. Sponsor Name & Address<br>Riverside Public Utilities<br>3750 University Ave., 5th floor<br>Riverside, California 92501 | 4. Funds-In Agreement Number<br>FIA-22-22498 |
| | 5. Project Title<br>Riverside Accelerating Clean Energy by 2040 |
| 2. Estimated Performance Period (in months)<br>24 months | |
| 3. Financial<br>Contractor Cost $ 8,182,790<br>DOE Administrative Charge $ 000<br>Total Cost to Sponsor $ 8,182,790 | 6. Agreement Terms and Conditions<br>This agreement consists of (1) this Standard Agreement, (2) Terms and Conditions, and (3) the following:<br>a. Appendix A—Statement of Work<br>b. Appendix B—Patent Rights<br>c. Appendix C—Rights in Technical Data<br>d. Appendix D—Background Intellectual Property |
| Amount of first advance $ 2,040,000 | |

| 7. Sponsor—Representatives | 9. Contractor—Representatives |
|---|---|
| Technical representative<br>Tracy Sato<br>Riverside Public Utilities<br>3750 University Ave., 5th Floor<br>Riverside, CA 92501<br>(951) 231-8971 | Technical representative<br>David Palchak<br>National Renewable Energy Laboratory<br>15013 Denver West Parkway, MSRSF300<br>Golden, CO 80401<br>303-384-7456 |
| 8. Contract representative<br>Ruthann Salera<br>Riverside Public Utilities<br>3750 University Ave., 2nd Floor<br>Riverside, CA 92501<br>(951) 826-5691 | 10. Contract representative<br>Megan Ballweber<br>National Renewable Energy Laboratory<br>15013 Denver West Parkway, MSRSF056<br>Golden, CO 80401<br>303-275-4296 |

| 11. Sponsor Acceptance | | 12. Contractor Acceptance | |
|---|---|---|---|
| Michael Moore<br>Interim City Manager<br>City of Riverside<br>3900 Main St. 7th floor<br>Riverside, California 92501 | | Anne Miller, Director of Technology Transfer<br>Alliance for Sustainable Energy, LLC<br>Operator of the National Renewable Energy Laboratory<br>15013 Denver West Parkway<br>Golden, CO 80401 | |
| Signature: | Date: | Signature: | Date: |

Alliance for Sustainable Energy, LLC,
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## General Terms and Conditions

(together with the face page and appendices, hereinafter referred to as "Agreement")

**Article I. Parties to the Agreement.**

The U.S. Department of Energy facility contractor, Alliance for Sustainable Energy, LLC, manager of the National Renewable Energy Laboratory under Contract No. DE-AC36-08GO28308 ("Prime Contract") and hereinafter referred to as the "Contractor" or "NREL," has been requested by the "Sponsor," as identified in Block 1 on page 1 of this Agreement, to use best efforts to perform the work set forth in the Statement of Work, attached hereto as Appendix A. The Contractor and Sponsor are hereinafter collectively referred to as the "Parties" or individually as a "Party." It is understood by the Parties that the Contractor is obligated to comply with the terms and conditions of its facility Prime Contract with the United States Government (hereinafter called the "Government") represented by the United States Department of Energy (hereinafter called the "Department" or "DOE") when providing goods, services, products, materials, or information to the nonfederal Sponsor under this Agreement.

**Article II. Term of the Agreement.**

The Contractor's estimated period of performance for completion of the Statement of Work is included in Block 2 on page 1 of this Agreement. The term of this Agreement shall be effective as of the later date of (1) the date on which it is signed by the last of the Parties thereto or (2) the date on which funds are received and allocated to this Agreement.

**Article III. Costs.**

1. The Contractor estimated cost for the work to be performed under this Agreement is stated in Block 3 on page 1 of this Agreement.
2. The Contractor has no obligation to continue or complete performance of the work at a cost in excess of the original estimated cost or any subsequent amendment.
3. The Contractor agrees to provide at least thirty (30) days' notice to the Sponsor if the actual cost to complete performance will exceed its estimated cost.

**Article IV. Funding and Payment.**

The Sponsor shall provide sufficient funds in advance to reimburse the Contractor for costs to be incurred in performance of the work described in this Agreement, and the Contractor shall have no obligation to perform in the absence of adequate advance funds. Sponsor's payment to Contractor shall be made in accordance with the remittance instructions included on Contractor's Invoice. If the estimated period of performance exceeds 90 days and the estimated cost exceeds $25,000, the Sponsor may, with the Contractor's approval, advance funds incrementally. In such a case, the Sponsor shall provide to the Contractor, prior to any work being performed, an advance payment sufficient to cover anticipated work that will be performed for the first billing cycle. In addition, the Sponsor shall provide additional advance funding to ensure that funds remain available for work during subsequent billing cycles (collectively the advance payment amount of $2,040,000 as set forth in Block 3 on page 1 of this Agreement). Following Sponsor's remittance of the advance payment, the Contractor will invoice the Sponsor each billing cycle (or as necessary) to maintain a balance of funding sufficient to cover anticipated work. Sponsor's payment shall be due no later than thirty (30) days after receipt of Contractor's invoice. Payment shall be made directly to the Contractor who will then notify the

DOE as appropriate. Upon termination or completion, any excess funds shall be refunded by the Contractor to the Sponsor.

**Article V. Source of Funds.**
The Sponsor hereby represents that, if the funding it brings to this Agreement has been secured through other agreements, such other agreements do not have any terms and conditions (including intellectual property terms and conditions) that conflict with the terms and conditions of this Agreement.

**Article VI. Tangible Personal Property.**
Upon termination of this Agreement, tangible personal property or equipment produced or acquired in conducting work under this Agreement shall be owned by the Sponsor. Tangible personal property or equipment produced or acquired as part of this Agreement will be accounted for and maintained during the term of the Agreement in the same manner as DOE property or equipment. Costs incurred for disposition of property shall be the responsibility of the Sponsor and included in costs allocated in Article III or paid separately by the Sponsor.

**Article VII. Publication Matters.**
The publishing Party shall provide the other Party a 60-day period in which to review and comment on proposed publications that disclose any of the following: technical developments and/or research findings generated in the course of the Agreement or identify Proprietary Information (as defined in Appendix C). The publishing Party shall not publish or otherwise disclose Proprietary Information identified by the other Party, except as mandated by law.

The Sponsor will not use the name of Contractor, the Government, or their employees in any promotional activity, such as advertisements, with reference to any product or service resulting from this Agreement, without prior written approval of the Government and Contractor.

**Article VIII. Legal Notice.**
The Parties agree that the following legal notice shall be affixed to each report furnished to the Sponsor under this Agreement and to any report resulting from this Agreement which may be distributed by the Sponsor:

DISCLAIMER

This report may contain research results which are experimental in nature. Neither the United States Government, nor any agency thereof, nor Facility Contractor, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not constitute or imply an endorsement or recommendation by the United States Government or any agency thereof, or by the Facility Contractor. The United States Government reserves for itself a royalty-free, worldwide, irrevocable, non-exclusive license for Governmental purposes to publish, disclose, distribute, translate, duplicate, exhibit, prepare derivative works, and perform any such data included herein. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, or by the Facility Contractor and shall not be used for advertising or product endorsement purposes.

**Article IX. Disclaimer.**
THE GOVERNMENT AND THE CONTRACTOR MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE CONDITIONS OF THE RESEARCH OR ANY INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE OR DEVELOPED UNDER THIS AGREEMENT, OR THE OWNERSHIP, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE OF THE RESEARCH OR RESULTING PRODUCT; THAT THE GOODS, SERVICES, MATERIALS, PRODUCTS, PROCESSES, INFORMATION, OR DATA TO BE FURNISHED HEREUNDER WILL

ACCOMPLISH INTENDED RESULTS OR ARE SAFE FOR ANY PURPOSE INCLUDING THE INTENDED PURPOSE; OR THAT ANY OF THE ABOVE WILL NOT INTERFERE WITH PRIVATELY OWNED RIGHTS OF OTHERS. NEITHER THE GOVERNMENT NOR THE CONTRACTOR SHALL BE LIABLE FOR SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES ATTRIBUTED TO SUCH RESEARCH OR RESULTING PRODUCT, INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE OR DELIVERED UNDER THIS AGREEMENT.

**Article X. General Indemnity.**
Reserved.

**Article XI. Product Liability Indemnity.**
To the extent permitted by California State law and except for any loss, liability, or claim resulting from any willful misconduct or negligent acts or omissions of the Government, the Contractor, or persons acting on their behalf ("Indemnified Parties"), the Sponsor agrees to hold harmless and indemnify the Indemnified Parties against any losses, liabilities, and claims, including all damages, costs, and expenses, including attorney's fees, arising from personal injury or property damage occurring as a result of the making, using, or selling of a product, process, or service by or on behalf of the Sponsor, its assignees, or licensees, which was derived from the work performed under this Agreement.

For the purposes of this Article, neither the Government nor the Contractor shall be considered assignees or licensees of the Sponsor, as a result of reserved Government and Contractor rights. This Article shall apply only if the Sponsor was:

1. informed as soon and as completely as practical by the appropriate Indemnified Party of the allegation or claim;
2. afforded, to the maximum extent by applicable laws, rules, or regulations, an opportunity to participate in and control its defense; and
3. given all reasonably available information and reasonable assistance requested by the Sponsor.

No settlement for which the Sponsor would be responsible shall be made without the Sponsor's consent unless required by final decree of a court of competent jurisdiction.

**Article XII. Intellectual Property Indemnity—Limited.**
Reserved.

**Article XIII. Notice and Assistance Regarding Patent and Copyright Infringement.**
Each Party shall report to the other Party, promptly and in reasonable written detail, each claim or allegation of infringement of any patent, copyright, trade secret or other intellectual property right based on the performance of this Agreement of which a Party has knowledge. In the event of any claim or suit against a Party based on such alleged infringement, the other Party shall furnish to the Party, when requested by the Party, all evidence and information in the possession of the other Party pertaining to such suit or claim.

**Article XIV. Patent Rights.**
Terms and conditions regarding patent rights are set forth in Appendix B attached hereto and incorporated herein.

**Article XV. Rights in Technical Data.**
Terms and conditions regarding rights in technical data are set forth in Appendix C attached hereto and incorporated herein.

**Article XVI. Background Intellectual Property.**
Each Party may use the other Party's Background Intellectual Property identified in an appendix of this Agreement solely in performance of the Statement of Work. This Agreement does not grant to either Party any option, grant, or license to commercialize, or otherwise use the other Party's Background

Intellectual Property. Licensing of Background Intellectual Property, if agreed to by the Parties, shall be the subject of separate licensing agreements between the Parties.

Each Party shall use reasonable efforts to list all relevant Background Intellectual Property in the appendix titled “Background Intellectual Property;” however, neither Party shall be liable to the other Party because of failure to list its Background Intellectual Property.

**Article XVII. Assignment and Notification.**
Neither this Agreement nor any interest therein or claim thereunder shall be assigned or transferred by either Party, except as authorized in writing by the other Party to this Agreement, provided, however, the Contractor may transfer it to the Department, or its designee, with notice of such transfer to the Sponsor, and the Contractor shall have no further responsibilities except for the confidentiality, use, and/or non-disclosure obligations of this Agreement. The obligations of the Contractor set forth in this Agreement shall apply to any successor in interest continuing the operation of the National Renewable Energy Laboratory.

If the Sponsor intends to assign or transfer any interest in this Agreement to a third party or the Sponsor is merging or being acquired by a third party, the Sponsor shall notify the Contractor with details of the pending action for a determination. The Contractor shall reply in writing whether such transfer is acceptable or invoke the termination clause.

**Article XVIII. Similar or Identical Services.**
The Government and/or Contractor shall have the right to perform similar or identical services in the Statement of Work for other sponsors as long as the Sponsor's Proprietary Information is not utilized.

**Article XIX. Export Control.**
Each Party is responsible for its own compliance with laws and regulations governing export control.

**Article XX. Disputes.**
The Parties shall attempt to jointly resolve all disputes arising from this Agreement. In the event a dispute arises under this Agreement, the Sponsor is encouraged to contact Contractor’s Technology Partnerships Ombudsman in order to resolve such dispute before pursuing third-party mediation or other remedies. If the Parties are unable to jointly resolve a dispute within 60 days, the Parties agree to submit the dispute to a third-party mediation process that is mutually agreed upon by the Parties.

**Article XXI. Entire Agreement and Modifications.**
1. This Agreement with its appendices contains the entire agreement between the Parties with respect to the subject matter hereof, and all prior representations or agreements relating hereto have been merged into this document and are thus superseded in totality by this Agreement.
2. Any agreement to materially change any terms or conditions of this Agreement or the appendices shall be valid only if the change is made in writing, executed by the Parties hereto, and approved by DOE.

**Article XXII. Termination.**
This Agreement may be terminated by either Party, following thirty (30) days written notice to the other Party. If Article IV provides for advance funding, this Agreement may also be terminated by the Contractor in the event of failure by the Sponsor to provide the necessary advance funding. In the event of termination, either by the Sponsor or the Contractor (e.g. for lack of advance funding), the Sponsor shall be responsible for the Contractor's costs (including closeout costs), but in no event shall the Sponsor's cost responsibility exceed the total cost to the Sponsor as described in Article III, above.

It is agreed that any obligations of the Parties regarding Proprietary Information or other intellectual property will remain in effect, despite early termination of the Agreement.

Alliance for Sustainable Energy, LLC
operator of the
National Renewable Energy Laboratory

Strategic Partnership Projects
**Funds-In Agreement—FIA-22-22498**

# Appendix A – Statement of Work

**Notice**: By signing this Agreement, the Sponsor acknowledges in advance that its entity name and the title and non-proprietary description of the project are available for public release by the Contractor without further notice.

**I. Project Title:** Riverside Accelerating Clean Energy (RACE) by 2040

**II. Non-Proprietary Description of Project:**

This project is to provide support to the Riverside Public Utility (RPU) in the form of a stakeholder-informed technical research study that evaluates the technical challenges and solutions to meeting the City of Riverside's 2040 Carbon Neutral Energy target.

**III. Parties to this agreement:**

Contractor: Alliance for Sustainable Energy, operator of the National Renewable Energy Laboratory under Prime Contract No. DE-AC36-08GO28308 for the U.S. Department of Energy (DOE). Contractor has a facility at 15013 Denver West Parkway, Golden, CO 80401.

Sponsor: Riverside Public Utility

**IV. The following provides project background, statement of work, and timelines.**

## Contents

## Overview

The objective of this project is to provide support to the Riverside Public Utility (RPU) in the form of a stakeholder-informed technical research study that evaluates the technical challenges and solutions to meeting the City of Riverside's 2040 Carbon Neutral Energy target. This study will include an analysis of the transforming electrical load through detailed modeling of the building stock, the electrification of transportation, and distributed energy resources. These loads will be combined to create different potential futures for RPU, which will be integrated with power system models at both the bulk and distribution level to evaluate the impacts to generation and other infrastructure requirements to meet the 2040 target. Included in this analysis would be an assessment of direct emissions from power production, transportation, and building electrification programs and a comparison of other technical challenges to the power sector that may be faced in reaching the 2040 target.

### Impact

The impact of this study is an understanding for RPU and its stakeholders of the options and economic and technical tradeoffs to reaching the 2040 Carbon Neutrality target. The outcomes of the study will allow for informed decision-making on the energy strategy for Riverside.

## Work Structure

### Period of Performance

The project has been scoped for a period of performance consisting of 24 months (Year 1, months 1–12 and Year 2, months 13–24) from the completion of a signed contract and NREL receiving and allocating initial payment to this Agreement.

### Study Team

The study will be led by the NREL Project Team, working in close cooperation with RPU subject matter experts, and subcontractors, as determined by project scope. NREL will be the principal performer, leading the modeling and analysis efforts for each task, the advisory group engagement, and the final report. NREL efforts will be funded through the Agreement associated with this statement of work. Amendments to the scope and budget, if necessary, will be detailed in modification documents in accordance with Article XXI.

### NREL Project Team

The NREL project team will be made up of NREL researchers, subcontractors, project support staff, and communications support staff.

#### *Laboratory Program Manager*

The Laboratory Program Manager (LPM) is responsible for establishing and maintaining the client/lab relationship, ensuring the project charter is agreed to, and ensuring the project execution.

#### *Principal Investigator*

The principal investigator (PI) will be the project lead and main point of contact for the study. The PI will be responsible for approval authority, project success, planning, executing, and promoting activities that the project undertakes, task delegation, review of and completion of all work products, and all communication with RPU and city engagements.

### *Technical Lead*

The technical lead is responsible for ensuring that the technical vision for the project is achieved, that technical risks are identified and mitigated, and for ensuring technical quality.

### *Project Manager*

The project manager will be responsible for planning, initiating, and monitoring project progress and identifying risks to help determine what resources, processes, and changes are necessary to complete the project scope on time and within budget. The project manager will be responsible for monitoring and analysis of project financials and resources to ensure tasks remain within budget, track cash flow, invoice accuracy and submission, and receipt of payment. The project manager will manage the project schedule, deliverable tracking, preparing, and reviewing any scope changes or task order amendments, meeting coordination, reporting, and subcontract management.

### *Task Leads*

Task leads are subject matter experts and are responsible for overseeing the completion of project tasks/subtasks by supervising their task team and reporting progress and issues to the project leadership team. The task leads are responsible for timely and quality submission of deliverables, and communication of task progress and presentations, when deemed necessary.

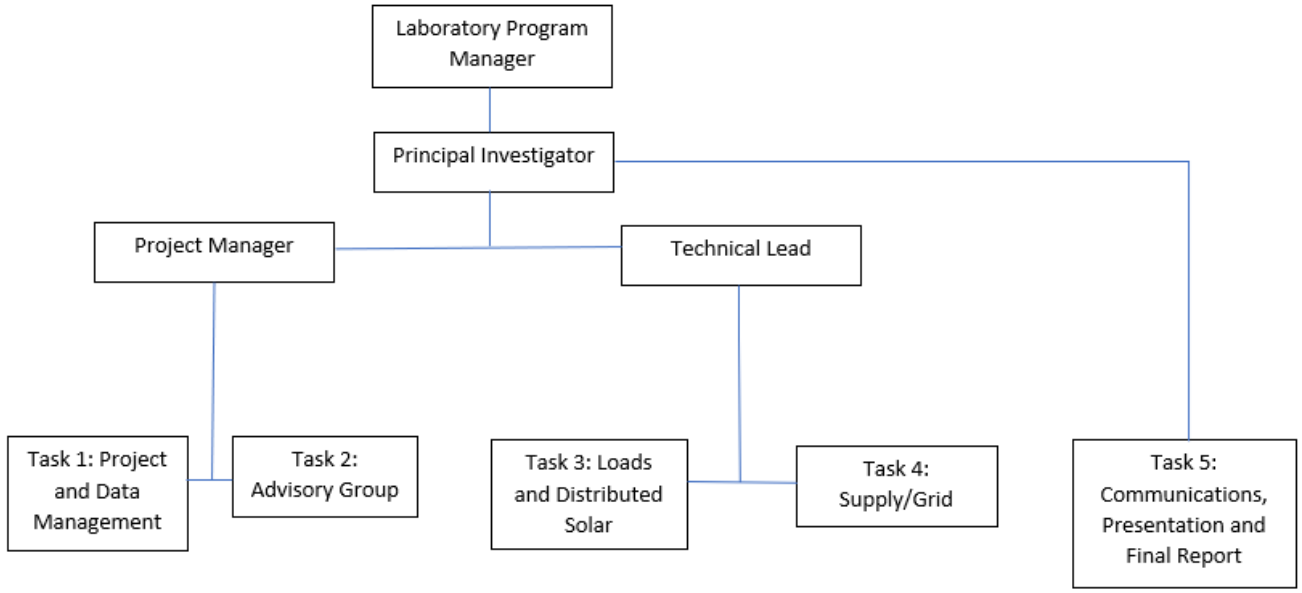


Figure 1: Study Team Structure

## Subcontracts

NREL may subcontract with partners to complete the scope of work. Partners and the subcontract scope of work will be determined by NREL. NREL will use funding from this agreement to fund subcontractors when subcontracts will be used.

# Project Communication and Document Management

## Project Communication

NREL will communicate via virtual meetings, phone and email as needed.

A travel budget and travel structure has been outlined in the Project Management task. NREL has proposed travel for select meetings.

Bi-weekly project team meetings and subject matter expert meetings will be conducted virtually through Microsoft Teams.

### Document Management

All deliverables and project documents will be shared through a Microsoft Teams collaboration site, accessible by NREL and RPU designated staff throughout the period of performance. Microsoft Teams is also linked to SharePoint and documents can be accessed, uploaded, and edited through either platform.

#### *Naming Conventions and Version Control*

Project documents shared through the collaboration site will follow a specific name convention structure provided at the time of the site creation. All project documents will remain on the collaboration site throughout the life of the project, to ensure all versions and edits are retained for future reference. Project documents should not be shared via email.

## Proposed Task Scopes

### Task 1: Project and Data Management

#### Task 1.1 Project Management

The NREL project management team will consist of the PI, Technical Lead, Data Manager, and Project Manager. The team will work together to guide the study, provide clear communication with RPU, lead the task leads, achieve the project's desired outcomes, and remain on schedule and budget.

The NREL project management team will be responsible for task delegation, reviewing deliverables for accuracy and completion, managing the project schedule in conjunction with RPU, preparing and reviewing any scope changes or contract amendments, shared document management, attending meetings outlined above, managing project risk, managing project budget and expenses, and ensuring completion of the project.

#### *Deliverables*

- Detailed project schedule, with input from RPU
- Kick-off event presentation and facilitation
- Quarterly progress report containing high level status on deliverables, funding, scope and overall project completion. Template to be created by NREL.

#### Meetings

##### *Kick-off Event*

NREL and RPU, together, will host a kick-off event for the NREL and RPU project teams, advisory group, RPU executives, and other identified individuals within two months after a contract is signed and initial funding is received and allocated to this Agreement. NREL will travel to Riverside to host in person, subject to NREL and DOE travel restrictions and policies. Riverside will be responsible for securing a location. NREL will create content and an agenda for the kick-off meeting, to be shared with RPU for input. NREL attendees will also meet with RPU SMEs to share data and models and discuss technical task specifics.

### *Bi-weekly Project Team Meetings with RPU*

NREL will participate in bi-weekly project team meetings with RPU to provide project updates, review project progress, prepare for public and AG meetings, review preliminary results, provide updates on anticipated activities, and to address information requests. Meetings will be held virtually for 1 hour on an agreed-upon day and time, every two weeks. NREL attendees will include the PI, Technical Lead, Data Manager, and Project Manager.

### *Quarterly RPU Executive Meetings with NREL*

NREL will provide written updates on project progress for each quarterly RPU Executive Meeting. NREL will attend the RPU executive meetings twice a year, in person subject to NREL and DOE travel restrictions and policies. To minimize costs, it would be ideal if these quarterly meetings coincide with the quarterly advisory group meetings. Meetings that are not attended in-person will be attended virtually. NREL attendees will include the PI or Technical Lead.

### *Quarterly RPU Board and City Council Member Meetings*

NREL will participate in presentations and updates to the RPU board **when needed**. NREL will discuss technical progress, study results, and address technical questions brought up in these meetings. NREL will attend the RPU board and city council member meetings twice a year, one occurrence in person and one occurrence virtually, subject to NREL and DOE travel restrictions and policies. To minimize costs, it would be ideal if in-person meetings coincide with the quarterly advisory group meetings or the quarterly RPU executive meetings. Meetings that are not attended in-person will be attended virtually. NREL attendees will include the PI or Technical Lead.

### *Subject Matter Expert Meetings*

NREL task leads will participate in subject matter expert meetings with RPU staff to move project progress forward. Meetings may be held virtually and scheduled with advanced notice, if possible.

### *Meetings Schedule*

IP: Planned In-person V: Planned Virtual

| Year 1 | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 | M9 | M10 | M11 | M12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Kick-off Event** | | IP | | | | | | | | | | |
| **Advisory Group Prep Meetings** | V | V | | V | V | | V | V | | V | V | |
| **Quarterly Advisory Group Meetings** | | | IP | | | IP | | | IP | | | IP |
| **RPU Executive Meetings** | | | IP | | | V | | | IP | | | V |
| **RPU Board and City Council Meetings** | | | IP | | | | | | V | | | |

| Year 2 | M13 | M14 | M15 | M16 | M17 | M18 | M19 | M20 | M21 | M22 | M23 | M24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Kick-off Event** | | | | | | | | | | | | |
| **Advisory Group Prep Meetings** | V | V | | V | V | | V | V | | V | V | |
| **Quarterly Advisory Group Meetings** | | | IP | | | IP | | | IP | | | IP |
| **RPU Executive Meetings** | | | V | | | IP | | | V | | | IP |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **RPU Board and City Council Meetings** | | | V | | | | | | IP | | | |

Table 1: Proposed meeting schedule for Years 1 and 2

### Travel

NREL will travel to attend specific meetings in person, subject to NREL and DOE travel restrictions and policies. Attendees will be determined prior to each meeting. Efforts to minimize costs will be taken by selecting specific attendees based on meeting content, minimizing the length of each trip, and attending select meetings pertinent to project success.

| Meeting Title | Number of NREL Attendees | Number of Planned Travel Days | Total Meetings over POP |
|---|---|---|---|
| **Kick-off Event** | 6 attendees | 2-3 days (1-2 nights) | 1 meeting |
| **Advisory Group Meetings** | 2-3 attendees | 2 days (1 night) | 8 meetings (quarterly) |
| **RPU Executive Meetings** | 1-2 attendees | 2 days (1 night) | 4 meetings (bi-annual) |
| **RPU Board and City Council Meetings** | 1-2 attendees | 2 days (1 night) | 2 meetings (annually) |

Table 2: Travel structure by meeting

### Task 1.2: Data Management

Data management is a critical aspect of large, integrated modeling projects. To answer questions about how to reliably meet 100% renewable energy in the future, we will leverage many traditionally independent NREL models in innovative and holistic ways. This process will require that these independent models work together. The data management task will take the following forms:

*General data management:* The general data management subtask involves managing project-wide data sets, databases, and servers and providing access for these resources for the project modeling teams. It might also involve finding project-wide solutions for the handoff of data that meet both the needs of the project and external collaborators. Additionally, this subtask includes curating a list of data sources and working with RPU on specific data requests.

*Data set generation:* The data set generation subtask involves generating new data sets using either the analysis of existing data sets (e.g., geographic information system (GIS) siting analysis) or state-of-the-art machine learning methodologies to generate synthetic data sets to fill in existing data gaps, on an as-needed basis.

*Integrated modeling data coordination:* The integrated modeling data coordination subtask involves coordination management across model teams. This includes ensuring that project-wide data sets and assumptions are being applied and translated appropriately across models, managing the integrated modeling handoff data flow and timeline, working with teams to adopt handoff data standards (e.g., version control, comprehensive metadata, universal formats, controlled transformations), and ensuring that time-series data follow specific project-wide protocols.

*Model test development:* Building on the integrated modeling data coordination subtask, the model test development subtask will involve building out model-specific data checks at each end of a model simulation. This will require that a specific set of tests be performed on model input and output data, and without these tests passing, a model simulation will fail. Requiring checks as part of the model simulation, as opposed to an optional add-on manual step, will force models to ensure that data processes are not introducing errors along the model pipeline. These tests will check for common errors caused by data

transformations, look for common time-series data problems, and look for expected results (e.g., substation counts, total amount of energy, total peak demand, total amount of adopted distributed photovoltaic (DPV) to ensure that models are consistent (where appropriate).

## Task 2: Advisory Group

RPU will coordinate the selection process of the Advisory Group, with input from NREL. The AG will provide comments and recommendations, but final scenarios will be selected by RPU and NREL. The AG meetings will be comprised of designated stakeholders to ensure continuity throughout the project. All meeting presentations and materials/notes will be made available for public review and comments after each meeting. Materials provided will be in English and Spanish by either NREL communications or a subcontractor.

### Subcontractor

NREL may subcontract the facilitation of AG meetings and other work, as needed, to third party subcontractors. Potential subcontractors include, but are not limited to, Kearns & West and University of California, Riverside. The subcontractor for facilitation of AG meetings will be responsible for meeting moderation, use of technology for combined in-person and virtual meetings (hybrid meetings), meeting notes and documenting meeting outcomes for the project and direction.

### Quarterly Advisory Group Meetings

Meetings will be held quarterly, combined in-person and virtual, on site at an RPU/City location. RPU will be responsible for securing a meeting location. NREL will travel to Riverside for quarterly meetings subject to NREL and DOE travel restrictions and policies. If restrictions are in place, NREL will attend quarterly meetings virtually. Travel participants include the PI, Technical Lead and one Task Lead per meeting, as necessary. NREL will create the AG meeting slide deck and agenda with input from RPU. Monthly prep meetings will be held to ensure agreement on meeting content is achieved and coordinate meeting efforts between RPU, NREL and the subcontractor.

### Deliverables

- Quarterly Advisory Group Presentation
- Quarterly Advisory Group Meeting Notes and Outcomes

## Task 3: Loads and Distributed Solar

### 3.1 Residential, Commercial (Building Stock Growth, Energy Efficiency, Electrification)

Residential and commercial buildings are responsible for the majority of RPU's load today. For most utilities, load has increased over time due to new construction, but the general load shape has remained relatively consistent, allowing for long-term projections based on economic and population growth projections.

To meet ambitious carbon neutrality goals, it is likely that existing buildings in Riverside will need to be retrofitted to increase energy efficiency, electrify existing natural gas loads, or some combination thereof. As shown in the LA100 study, changes to the building stock at this scale can have a significant impact on both future load shape and peak demand. These changes impact the entire utility, from distribution feeders up through transmission and generation planning.

To better understand these impacts, the NREL team will model the existing Riverside building stock today and will project the building load into the future under four scenarios:

1. **Reference**: Business as usual, which includes some equipment turnover within the building stock based on existing federal and California appliance efficiency standards, but no significant electrification or energy efficiency adoption.
2. **Moderate**: Includes some level of electrification and energy efficiency beyond minimum efficiency standards.
3. **High**: Includes high levels of both electrification and energy efficiency.
4. **Stress**: Includes high levels of electrification with reference (minimal) new energy efficiency adoption. This scenario represents a worst-case for capacity and infrastructure planning purposes and may justify investments into energy efficiency to reduce infrastructure and generation costs.

To the extent possible, NREL will reuse scenario assumptions and future projections developed for the LA100 study, as the building stock in Riverside is similar in many ways to the building stock in LA. These will be modified as appropriate to match Riverside, potentially including factors such as different weather conditions and different building sizes, types, and vintages of construction.

Area-wide new construction and demolition will be included in the scenarios, and NREL will work with Riverside city staff to understand where within the city this growth and demolition is expected to occur.

This task will leverage NREL's ResStock and ComStock models, which are bottom-up, physics-based models that represent the distribution of characteristics found in the existing Riverside building stock today. Each model creates a one-year timeseries profile of building loads for all fuels on a 15-minute timescale. The load profiles from these models will serve as the foundational loads used in the customer solar and storage, distribution, demand response, and bulk power system modeling. Direct greenhouse gas emissions from onsite combustion of fossil fuels in buildings will be reported for all scenarios.

#### *Deliverables*

- Final presentation (minimum 20 slides) of the data and methods for creating baseline and future building loads
- Dataset of building load profiles to be used as an input to the other modeling studies
- Final report (or chapter in loads report, minimum 40 pages) describing data, methods, and scenario assumptions for creating baseline and future building loads

### 3.2 Transportation (Personal, Commercial, Busses, Public Charging Stations)

While today's electric vehicles (EVs) make up less than 1% of total vehicles on the road, one out of eight new vehicles sold in California in 2021 was electric. Technology progress, infrastructure investments, and policies to reduce GHG and pollutants emissions are enabling rapid growth in EV adoption for personal vehicles (*i.e.,* cars, SUVs, passenger vans, and pick-up trucks), fleets (taxis, ride-hailing), as well as commercial medium and heavy-duty trucks and buses.

EVs represent an enormous load growth opportunity, with some projections showing them representing over a quarter of total electricity demand in 2050. At the same time, EV loads are highly flexible (with the average passenger car parked for 96% of the time and many heavy vehicles also regularly parked for 10 or more hours per day) and managed charging could be exploited to support power system planning and operations to reduce costs, maximize efficiency, and increase system reliability while offering electricity cost savings for EV drivers. Therefore, it is critical to understand how EVs will impact the RPU resource portfolio and its planning, and to develop effective and reliable managed charging programs. This task will develop scenarios of EV adoption over time to estimate the required charging infrastructure and hourly electricity loads associated with EV charging, possibly also including managed (or smart) charging solutions.

This task will leverage NREL's Transportation Energy & Mobility Pathway Options™ (TEMPO) model to develop adoption scenarios for personal, fleet, and commercial vehicles in the RPU territory. TEMPO is a transportation demand model that covers the entire U.S. transportation sector with an implicit spatial resolution and an hourly temporal resolution. Key features of the TEMPO model include the ability to generate long-term pathways to achieve system-level goals and explore the impacts of technological breakthroughs and behavioral changes. TEMPO employs an innovative representation of passenger mobility demand stemming from household-level decisions that determine vehicle adoption/ownership and use based on sociodemographic characteristics (e.g., income, household composition), technology attributes (e.g., cost, travel time, comfort, safety, preference), geography (e.g., urban, secondary cities, rural), and household-type specific weekly mobility and travel requirements. The team will also leverage NREL's Electric Vehicle Infrastructure Projection Tool (EVI-Pro) model to estimate the charging infrastructure requirements for each adoption scenario. Developed in collaboration with the California Energy Commission, EVI-Pro draws on detailed data regarding personal vehicle travel patterns, EV attributes, and charging station characteristics to estimate how much EV charging infrastructure is needed in a designated area to meet a given demand.

The combination of the two tools will allow estimating the number of EVs on the road by vehicle class and consumer type, their usage, charging infrastructure requirements to support them, and corresponding annual hourly charging load profiles (8760 hours per year) at various private (e.g., home, truck depots) and public locations. In addition to baseline charging loads, the NREL modeling pipeline allows for estimation of charging flexibility for use in electricity supply models to simulate alternatively managed charging solutions.

The overall EV charging loads modeling pipeline includes:

1. Estimating aggregate **vehicle adoption scenarios** for personal vehicles (cars, SUVs, passenger vans, and pick-up trucks), fleets (taxis, ride-hailing), and commercial medium and heavy-duty vehicles in the RPU's territory. The team will leverage a combination of RPU provided data, NREL internal data, and publicly available data to develop informative scenarios varying key uncertain parameters.
2. **Temporal resolution**: Estimate hourly energy use needs accounting for vehicle characteristics and temperature variations that heavily impact EV fuel economy.
3. Estimating private and public **charging infrastructure requirements** (number, type, and location of charging stations) and public station use, including hourly load profiles
4. **Spatial disaggregation:** In coordination with other tasks, especially the distribution team, disaggregate annual hourly load profiles to desired spatial resolution to consistently match buildings (*e.g.,* for home charging) or distribution system needs.
5. **Managed charging** (static based on heuristics): Explore different charging behaviors, including simple coordination with the grid to provide demand response and scheduled/managed charging. This task will create (possibly multiple) alternative hourly load profiles that are expected to reduce grid impacts based on simple heuristics (*e.g.,* exogenous time-of use rates).
6. Support use, interpretation, and **integration of EV loads** with demand response and bulk power system modeling and work related to distribution system and hosting capacity analysis.
7. Report the direct GHG emissions (i.e., tailpipe emissions) from the various transportation adoption scenarios.

### *Deliverables*

- Final presentation (minimum 20 slides) content of the modeling pipeline, key assumptions, and adoption scenarios for various EVs in the RPU's territory
- Dataset of estimates for public charging station requirements

- Dataset of baseline and managed (based on simple heuristics) charging load profiles (8760 data points per year in each year through 2040)
- Final report (or chapter in loads report, minimum 40 pages) with complete documentation of methods, assumptions, and results.

## 3.3 Customer and Community Solar and Energy Storage

### *Customer Solar and Energy Storage*

Distributed energy resources such as behind-the-meter (BTM) rooftop solar (DPV) and customer sited battery storage are a growing source of generation and understanding their long-term impact on the RPU resource portfolio is critical. This task will assess projections of DER adoption in the RPU territory using NREL's dGen™ tool, a geospatially rich, bottom-up market penetration model that simulates the potential adoption of DERs for residential, commercial, and industrial entities. dGen is unique because of two key innovations –first, the use of multiple spatially-resolved data to define the technical, economic, and market factors affecting technology adoption; second, formulation as an agent-based model (ABM), which permits a detailed representation of how consumers make decisions individually and in aggregate.

The NREL modeling team has earlier worked with the Los Angeles Department of Water and Power as part of the LA100 study and Orlando Utility Commission (OUC) in developing distribution feeder/circuit level DER adoption forecasts. Chapter 4 (Customer-Adopted Rooftop Solar and Storage) and Chapter 7 (Distribution System Analysis) of the FINAL REPORT: LA100—The Los Angeles 100% Renewable Energy Study analysis used strikingly granular data sets (individual household/customer level) provided by the utility partners.

The following summarizes the overall DER adoption modeling approach:

1. Developing feeder/circuit level "agents" (potential DER consumer adopters) and assigning them attributes based on individual sector-specific customer types (residential, non-residential etc.). The agents will be developed based on customer characteristics such as customer class type, building types (owner/renter, single family/multi-family), retail tariff, etc. The team will leverage a combination of RPU provided data, NREL internal data, and publicly available data.
2. A key determinant of DPV market potential is the amount of technically viable rooftop space. This sub-task will use a combination of previously collected data and statistical methods to assess DPV technical potential for RPU. Specifically, we will leverage existing NREL data or data from other sources and analyses assessing rooftop solar technical potential using LiDAR remote sensing.
3. Integrate and assign the disaggregated loads to agents. The disaggregated loads would include sector-specific hourly 8760 load shapes.
4. Model and generate spatially-disaggregated DER adoption forecasts for distributed PV and storage. This will also include evaluating the impacts of RPU incentive programs to incentivize the adoption of DPV and customer sited battery storage. The adoption model will be trained using historic data on DER adoption and evaluated by comparing its performance to out-of-sample data (i.e., data the model didn't use during training). The improved projection will allow RPU to assess the portions of its territory that are more likely to experience DER growth and adjust resource and distribution infrastructure planning accordingly.
5. Support customer-adopted-DER work related to distribution system and hosting capacity analysis.

### *Community Solar and Energy Storage*

This task will conduct a GIS-based techno-economic analysis to screen and rank potential sites for local solar and storage (i.e. ground-mount community solar and/or solar deployed through the feed-in tariff), including specific sites such as Pellisier Ranch as well as solar installations on several agricultural areas in

the city looking to install solar in combination with agricultural uses, including greenhouses. It will employ consideration of land use, value of leased land, and other detailed siting exclusions to identify specific sites suitable for local solar and storage. The spatial granularity of this analysis will help to refine the outcomes of the bulk system planning task and add site-specific utility-scale solar to the distributed solar analysis.

#### *Deliverables*

- Final presentation (minimum 20 slides) content of the methods and algorithms used for customer solar and customer energy storage
- Final presentation (minimum 20 slides) content of methods for community solar analysis
- Dataset of potential sites for local solar and storage
- Final report (or chapter in loads report, minimum 30 pages) containing both the finalized set of DER adoption scenarios and community solar scenarios.

### 3.4 Load Allocation, Projection, Gaps

This task is responsible for two key outcomes – 1) annual hourly load profiles for multiple load projections in every model year (with the final year being 2040) for bulk system analysis (Task 4.1) and 2) customer-level loads for detailed distribution network modeling (Task 4.2). The first outcome will be achieved by combining modeled loads and distributed resources with information from RPU on other loads (e.g., large customers not modeled as commercial buildings, water utility energy use, agricultural pumping, street lighting, etc.) as well as system level information on distribution losses, annual energy use, peak loads and RPU current assumptions about energy efficiency and electrification. These data will be combined to create up to four load projections: Reference, Moderate, High, and Stress. The first projection would represent our best understanding of business as usual. The latter three mimic the load projections in the LA100 study, adjusted to reflect current State and local regulations. This task utilizes relevant RPU data to inform the projections. An additional challenge is that load projections will need to use weather patterns synchronized with the modeled wind and solar resource data. Thus, calibrating the baseline load data against RPU data from other weather years may require additional analysis and input from RPU engineering teams.

The distribution task (Task 4.2) requires load to be allocated to specific locations within feeders. The building and transportation modeling employed by NREL captures load heterogeneity by constructing and simulating representative sample buildings and vehicles that each represent up to hundreds of similar vehicles and buildings. This style of modeling produces accurate aggregate load profiles but might not fully capture existing and future customer-level loads that fall within the tails of energy-use distributions. Thus, a specific task is required to realistically assign these aggregate, sampled loads first to feeders and then to customer nodes within the distribution system. Generally, this process will result in customer-level loads that do not represent the full range of variability observed when examining individual customer loads, but this task will aim to capture the general trends of load changes and the majority of feeder-level variability that is to be expected and could adjust some customer-level representations to better reflect observed, e.g., customer billing data.

This task combines simulation data from ResStock, ComStock, and TEMPO with customer billing data, customer- and parcel-level meta data, distribution system, and other data to create realistic aggregate and customer-level profiles.

Subtasks:

1. Utilize RPU existing loads data to construct baseline profiles for non-modeled loads
2. Integrate RPUs projections for energy and peak demand into projection workflow as comparisons for modeled and non-modeled loads

3. Create a baseline year assignment of aggregate, sampled loads to the customer level for use in distribution system modeling
4. Calibrate baseline year loads and evaluate against feeder-level supervisory control and data acquisition (SCADA). This will require ensuring that total energy matches the total energy in the aggregate load projection (i.e., in total sample to agent scaling factors must result in no net change in energy use), and that differences in weather year (i.e., between modeled data, billing data, and SCADA) are handled in a satisfactory manner.
5. Allocate loads to future years using existing loads and projections for future loads
6. Compile data into bulk load projections

#### *Deliverables*

- Final presentation (minimum 20 slides) content of the data and methods for creating load projections for bulk power system analysis
- Final presentation (minimum 20 slides) content of the data and methods for creating customer-level load data for distribution system analysis
- Final report (or chapter in loads report, minimum 40 pages) describing the load projections at both the bulk system and distribution system levels
- Dataset of aggregate and disaggregated loads

### 3.5 Demand Response

Demand response (DR) and other forms of demand-side participation can reduce system costs by offsetting new capacity builds, shifting consumption from high- to low-cost times, and providing other grid services. In this project, we plan (1) to consult with RPU concerning what types of DR programs or time-varying tariffs they might be interested in implementing; (2) to estimate the potential size of the demand response resource based on the detailed load projections developed in Task 3.4, literature review, and other data sources; (3) to estimate participation rates or elasticities that could be induced by different levels of DR incentive and/or amount of difference between lowest and highest priced tariff blocks; and (4) to pass this information along to the power system modeling teams for further analysis.

#### *Deliverables*

- Final presentation (minimum 20 slides) content of the data and methods for creating DR and time-varying tariff assumptions for each load projection
- Final report (or chapter in loads report, minimum 30 pages) describing the potential for DR to impact system planning and operations

#### *Compiled Deliverables for Task 3*

- All Task 3 subtasks will have various presentations for subject matter expert meetings and AG meetings to update on progress when relevant
- Final report(s) and presentation(s) for Task 3 could take various formats based on interest from RPU and the AG, and NRELs decision based on the results that should be highlighted. Potential report/presentation formats are, 1) a single Task 3 report/presentation with chapters for subtasks, or 2) individual reports/presentations for some or all subtasks, subject to availability of funding.

## Task 4: Supply/Grid

### 4.1 Bulk Power

Bulk power evolution will provide an understanding of the evolution of grid needs – including potential increased interconnection – and operational challenges for Riverside as it moves towards clean energy targets and existing gas plants reach their end of life. This task will evaluate the pathways for growth on

the bulk power network for Riverside and will investigate future changes to bulk-side operations and dispatch needs, integrated with load growth and distributed-side resources as described in previous tasks.

This task will generate a set of portfolios for up to 4 scenarios based on RPU input. The portfolios will start with existing and planned projects derived from the RPU IRP process, and then add capacity over time to meet the 2040 target. Additional generation capacity will utilize input from the customer solar, storage, and community solar task (Task 3.3), and use estimates of the least cost-combination of resources needed to achieve the target while maintaining resource adequacy. Simulations will consider cases both with and without the new Riverside Transmission Reliability Project (RTRP). Other variations across the scenarios will be driven by assumptions and restrictions to be determined, and could include allowance of natural gas use offset by renewable energy credits, and load growth.

These generation scenarios will then be evaluated in detail using the production cost modeling tool PLEXOS® or similar tool. The model simulates the unit commitment and economic dispatch of RPU resources including energy storage. It also evaluates transmission adequacy using simplified DC optimal power flow. Simulations will be performed at hourly resolution to ensure the proposed scenarios can achieve the desired levels of resource adequacy. Simulations will include a set of outage cases to ensure the portfolios are robust to outages of RPU's transmission interconnections (either the existing interconnection or the RTRP) The analysis will not include a detailed representation of the California Independent System Operator (CAISO) market. However, it will evaluate the possibility of exchanges between RPU and CAISO for some fraction of RPU's energy and capacity requirements, as well as limited sales to CAISO of surplus renewable generation, using estimates of forward prices for clean energy resources. Provision of operating reserves (regulating, flexibility and spinning contingency) can be considered by either self-provision, or the assumption that reserves are provided by the CAISO with a set of pre-determined market prices.

The annualized and cumulative costs of the resulting portfolios will also be reported, based on projected costs of the various generation, storage, and transmission assets developed, and financing factors such as RPUs projected cost of capital. We will provide analysis of changes to operations of existing assets, how new assets are used to replace existing resources, any impacts to interactions with CAISO, and the direct emissions from the various scenarios. The cumulative direct GHG emissions that comprise the load and bulk system portfolio scenarios will also be reported in this task final report.

*Deliverables*

- Dataset of project capacity, costs, and location by year.
- Hourly and annual simulation results demonstrating contribution by resource during normal cases and cases of extended transmission outages.
- Final report (minimum 30 pages) with complete documentation of methods, assumptions, and results.

### 4.2 Distribution

The distribution task will rely on and be closely coordinated with Task 3.

*4.2.1: Develop distribution system models for DISCO:* This subtask will develop distribution system models for RPU's service territory (all or part depending on the research questions) for use in NREL's Distribution grid Integration Solution Cost (DISCO) model for upgrade analysis. The assumptions of the modeling work include:

- RPU's models: RPU has their primary network modeled in Synergi and captured in ArcFM, an extension of Esri ArcGIS. Customer information system and/or distributed energy resource (DER)

databases have information on customer DER and larger commercial DER can be utilized. There is some mapping of the distribution secondaries in GIS. NREL will use the data from these resources that has been geographically mapped for the primary network and the distribution secondaries for modeling. Out of scope will be to model the details of unmapped (i.e., RPU does not have GIS data) distribution secondaries. Where these are not present NREL will model secondaries as a lumped load connected to the primary.

- RPU's distribution system: Modeling may use both the exiting distribution system and the 2026 RPU distribution system that might create a split system, where the city load is split between two 230/69 kV substations. RPU's engineering team already have both current and the split system design in its models that can be provided to NREL. In scope is to model RPU's 12.47 kV, 4 kV primary network and substations and RPU's secondaries for which there are existing models in ESRI/ArcFM. RPU's distribution is entirely radial with no meshed secondary network or closed loop systems.
- RPU's voltage asset controls: RPU will work with NREL to capture their current approach to controlling primary voltage control assets (e.g., load-tap changer transformers, voltage regulators and any capacitor banks currently in use). The approach will be to capture the control philosophy for the entire service territory and not match every individual control asset.
- NREL DISCO Modeling: NREL will model RPU's service territory in OpenDSS for scenario and upgrade analysis in DISCO creating a three-phase unbalanced power-flow model of the primary and secondary network as available.

*4.2.2: Evaluate network models:* This subtask will evaluate, through comparison, the network models NREL builds in OpenDSS and those that RPU has existing in Synergi to ensure the model build and conversion was successful. Comparisons can be made, where available, to AMI meter voltage data and SCADA, this can inform if there are any major errors in the distribution system models. Comparisons of the OpenDSS and Synergi models are expected to be within +/- 2% and between the OpenDSS models and SCADA and AMI measurements to be within +/- 5%. This subtask will run snap-shot power-flows as it will occur before time-series net load profiles are available from Task 3.

*4.2.3: Receive load data evaluated against SCADA:* This subtask will receive net load data, i.e. native load consumption plus disaggregated DER (e.g. PV, EV) time-series power profiles, from the Load Allocation, Projection, Gaps task. The data will have been evaluated against RPU SCADA and AMI and agreed to be ready for use in the power-flow models before use in the distribution task. The data will have several load scenarios related to electrification and efficiency adoption and forecasts up to 2040. This subtask will take this data and integrate into the distribution system power-flow models for DISCO.

*4.2.4: Run base-case time-series power-flow:* This subtask will run a base-case (i.e. current year) time-series power-flow to examine the current health of RPU's distribution system, examining system losses, voltage drop and performance with respect to ANSI C84.1 voltage bounds/RPU's character of service and asset thermal loading.

*4.2.5: Run-upgrade scenarios for high DER adoption (without NWA):* This subtask will run NREL's DISCO to perform analysis on RPU high DER adoption scenarios and examining potential RPU upgrades required for load growth and to overcome network constraints introduced by DER (e.g. thermal load, over-voltages). The following assumptions are made for this subtask:

- DISCO system upgrades and costs**:** Reconductoring, transformer upsizing, voltage regulators, capacitor banks.
- Network constraints: Upgrades will be made to overcome the following network constraints; thermal overloading, voltage violations of character of service, voltage unbalance.

- Non-wire alternatives (NWA): For this subtask network upgrades will be performed without considering non-wire alternatives which will be examined in the subsequent subtask.

*4.2.6: Establish NWA scenarios:* Non-wire alternatives (NWA) are alternatives to alleviate and delay the need for network upgrades. These include advanced control, use of distributed energy resources and programs such as demand response. This subtask will create 5-10 specific non-wire alternative scenarios such that RPU can quantify the value of such programs as a means to alleviate the need for upgrades in high DER adoption scenarios. The NWA for potential consideration are the following:

- Smart inverter (SI) voltage control: DER smart inverters have the ability to operate volt-VAR and volt-Watt control. RPU is not mandated to use these functions as it does not fall under the California Public Utility Commission (CPUC) Rule 21 order. These SI advanced voltage control algorithms could provide benefits to RPU as a NWA.
- Behind-the-meter/co-sited solar+storage for solar self-consumption/export limit: Solar+storage installations are becoming increasingly prevalent due to declining prices of Lithium-ion energy storage and utility rate structures limiting solar export and motivating the self-consumption of customer DER generation. Solar self-consumption (i.e. charging from excess net solar and stored to cover later native load consumption) is a means to prevent excess solar being exported to the grid and can help alleviate network constraints. Export limiting using storage can achieve the same outcome; both self-consumption and export limiting are potential NWA for RPU.
- Flexible interconnection with DER curtailment: Flexible interconnection allows and can incorporate the curtailment of DER generation as a condition for interconnection. DER curtailment can be based on local network constraints and is a future NWA for consideration by RPU.
- Smart electric vehicle charging: Electric vehicles are expected to place major burdens on utility asset due to the huge relative increase in load consumption they are expected to bring. Smart charging (e.g. charging during off-peak hours) could significantly reduce the need for network upgrades and is seen as a major potential NWA for utilities.

*4.2.7: Run upgrade scenarios with NWA:* This subtask will run NREL's DISCO to perform analysis on RPU high DER adoption scenarios and examining potential RPU upgrades using the NWA scenarios. This will allow RPU to quantify the benefits of NWA in terms of avoided and deferred network upgrades.

*Deliverables*

- Interim presentations on power flow results, validation, network upgrade analysis, and NWA scenarios
- Dataset of models and modeling results
- Final presentation (minimum 30 slides on distribution task) in coordination with bulk system task
- Final report (minimum 60 pages) with complete documentation of methods, assumptions, and results.

## Task 5 Communications, Presentations, and Final Report

### 5.1 Communications

In partnership with the RPU Communications team, the NREL Communications team will develop and execute a comprehensive communications plan for the study that includes:

- Communications strategy and project management
- Target audience analysis and message development
- Editorial review and formatting support for ~20 key deliverables (not including final presentations and final report, which are detailed separately below)
- Content review, formatting, and publishing support for ~15 presentations:

    - Kick-off meeting
    - Quarterly Advisory Group meetings
    - Final presentations
- Graphic design to support 10-15 visuals for key deliverables and presentations
- Final report production:
    - Formatting, design, editing of full-length report and shorter Executive Summary
    - Release to NREL's Publications Database

### 5.2 Final Presentations

NREL will prepare and publish final presentations to summarize study findings. This will include an overview presentation with a high-level summary and two technical task presentations (Tasks 3 and 4). Presentations will be part of the final AG meeting.

### 5.3 Final Report

NREL will prepare and publish a detailed final report consisting of the final reports from each task that explains the methodology and study findings. The detailed report will be accompanied by a shorter Executive Summary that distills the key findings into a digestible format for broad audiences. These materials will be published to NREL's Publications Database on NREL.gov. The final report will not be printed or physically distributed by NREL.

## Schedule

The schedule of 24 months has the potential to include several deliverables that could be completed before the end of the period of performance, however the integrated nature of modeling and data linkages is likely to require all final presentations and reports be delivered near the end of the 24-month period to ensure consistency. Interim results and ongoing discussions on study assumptions and methodologies will be a key part of the quarterly AG and more frequent subject matter expert meetings.

## Deliverables

### Deliverable Category Definitions

**Project Status:** Deliverables of this category will be used to communicate project status and progress.
**Presentation:** Deliverables in this category may present technical information on data, modeling results, and white papers.
**Dataset:** Deliverables of this category represents delivery of data to RPU that was created as part of the study. This could also be made publicly available if approved and preferred by RPU.
**Final Presentation:** May present technical or high-level information on methodology, data, modeling results, and white papers. Will be vetted through a review process prior to presentation and may be released publicly with agreement from both the RPU and NREL project leads.
**Final Report:** Final content completed and approved. RPU and the AG will have opportunities to make written comments, with the period of comment not to exceed two weeks. Other stakeholders may have the opportunity to comment at the discretion of the NREL study team and RPU, and subject to availability of funding. The final report will be vetted through a review process prior to completion and may be published.
**Final Deliverable:** Final content completed and approved

### Deliverables Schedule

| Task/Subtask | Deliverable Category | Deliverable Name | Due Date |
|---|---|---|---|
| **Task 1: Project and Data Management** | | | |

| | | | |
|---|---|---|---|
| 1.0 | Project Status | Detailed project schedule | Month 1 |
| 1.0 | Final Deliverable | Kick off meeting presentation and facilitation | Month 2 |
| 1.0 | Project Status | Quarterly progress report | Quarterly |
| **Task 2: Advisory Group** | | | |
| 2.0 | Final Deliverable | Quarterly AG meeting presentation | Quarterly |
| 2.0 | Final Deliverable | Quarterly AG meeting notes and outcomes | Quarterly |
| **Task 3: Loads** | | | |
| 3.0 | Final Deliverable | Final report describing data, methods, and scenario assumptions | Month 24 |
| 3.1 | Dataset | Dataset of building load profiles to be used as an input to the other modeling studies | Month 24 |
| 3.1 | Final Presentation | Final presentation of the data and methods for creating baseline and future building loads | Presented at appropriate AG meeting |
| 3.2 | Dataset | Dataset of estimates for public charging station requirements<br>Dataset of baseline and managed (based on simple heuristics) charging load profiles (8760 data points per year in each year through 2040) | Month 24 |
| 3.2 | Dataset | Dataset of baseline and managed (based on simple heuristics) charging load profiles (8760 data points per year in each year through 2040) | Month 24 |
| 3.2 | Final Presentation | Final presentation content of the modeling pipeline, key assumptions, and adoption scenarios for various EVs in the RPU's territory | Presented at appropriate AG meeting |
| 3.3 | Dataset | Dataset of potential sites for local solar and storage | Month 24 |
| 3.3 | Final Presentation | Final presentation content of the methods and algorithms used for customer solar and customer energy storage | Presented at appropriate AG meeting |
| 3.3 | Final Presentation | Final presentation content of methods for community solar analysis | Presented at appropriate AG meeting |
| 3.4 | Dataset | Dataset of aggregate and disaggregated loads | Month 24 |
| 3.4 | Final Presentation | Final presentation content of the data and methods for creating load projections for bulk power system analysis | Presented at appropriate AG meeting |
| 3.4 | Final Presentation | Final presentation content of the data and methods for creating customer- | Presented at appropriate AG meeting |

| | | | |
|---|---|---|---|
| | | level load data for distribution system analysis | |
| 3.5 | Final Presentation | Final presentation content of the data and methods for creating DR and time-varying tariff assumptions for each load projections | Presented at appropriate AG meeting |
| **Task 4: Supply/Grid** | | | |
| 4.0 | Final Deliverable | Final report describing data, methods, and scenario assumptions | Month 24 |
| 4.1 | Dataset | Dataset of project capacity, costs, and location by year | Month 24 |
| 4.1 | Dataset | Hourly and annual simulation results demonstrating contribution by resource during normal cases and cases of extended transmission outages. | Month 24 |
| 4.2 | Dataset | Dataset of models and modeling results | Month 24 |
| 4.2 | Presentation | Interim presentations on power flow results, validation, network upgrade analysis, and NWA scenarios | Presented at appropriate AG meeting |
| 4.2 | Final Presentation | Final presentation in coordination with bulk system task | Presented at appropriate AG meeting |
| **Task 5: Communications, Presentations, and Final Report** | | | |
| 5.2 | Final Presentation | Final presentation on Task 3 results | Month 24 |
| 5.2 | Final Presentation | Final presentation on Task 4 results | Month 24 |
| 5.2 | Final Presentation | High-level study presentation | Month 24 |
| 5.3 | Final Report | Cumulative Final Report* | Month 24 |

*The cumulative final report will be presented as a set of chapters from the technical tasks. These chapters will be produced to also serve as standalone reports.

## Budget

| Task/Subtask | Year 1 Budget | Year 2 Budget | Total Budget |
|---|---|---|---|
| **Task 1: Project and Data Management** | | | |
| **1.1 Project Management** | $443,613.71 | $438,258.86 | $881,872.57 |
| **1.2 Data Management** | $206,682.71 | $197,958.86 | $404,641.57 |
| **Task 2: Advisory Group** | | | |
| **2.0 Advisory Group** | $373,502.71 | $455,935.86 | $829,438.57 |
| **Task 3: Loads and Distributed Solar** | | | |
| **3.1 Residential and Commercial** | $417,205.71 | $425,444.86 | $842,650.57 |
| **3.2 Transportation** | $346,969.71 | $370,686.86 | $717,656.57 |
| **3.3 Customer Solar and Energy Storage, Community Solar** | $523,009.43 | $276,191.71 | $799,201.14 |
| **3.4 Load Allocation, Projection, Gaps** | $297,107.71 | $252,451.86 | $549,559.57 |
| **3.5 Demand Response** | $164,855.71 | $174,884.86 | $339,740.57 |
| **Task 4: Supply/Grid** | | | |
| **4.1 Bulk Power** | $324,369.71 | $512,914.86 | $837,284.57 |
| **4.2 Distribution** | $663,990.71 | $572,912.86 | $1,236,903.57 |
| **Task 5: Communication, Presentations, and Final Report** | | | |
| **5.1 Communications** | $166,055.71 | $170,844.86 | $336,900.57 |
| **5.2 Final Presentations** | $48,755.71 | $148,166.86 | $196,922.57 |
| **5.3 Final Report** | $44,909.71 | $165,107.86 | $210,017.57 |
| **Total** | **$4,021,029** | **$4,161,761** | **$8,182,790** |

# Exhibit A – Potential Additional Tasks

*Note: The costs for tasks in this Exhibit A are estimates, are not included in the budget or timeline at time of execution and may change based on the timing or circumstances of a request. To exercise tasks in this Exhibit A, the agreement will be modified in accordance with Article XXI. "Entire Agreement and Modifications" to add such tasks to the Statement of Work and add necessary funding to the agreement.*

## Task 6: Communications, Presentations, and Final Report

### Task 6.1 Communications - $176,400

- **Branding ($32,400):** Develop unique brand for the study with input and direction from RPU; create PPT and Word templates for deliverables, presentations, etc.
- **Spanish Translation ($24,000):** Procure text translation and develop Spanish version of the kickoff meeting, Advisory Group, and public outreach presentation slides (Note: Only the deliverables listed here will be translated, and this does not include live interpretation)
- **Video Production ($90,000):** Create series of 5 short videos to communicate about the project and its results: 1 introductory video, 1 overall results video, 3 on results from each technical area (Note: No Spanish translation will be provided)
- **Digital Outreach ($30,000):** Prepare and publish content for press releases/news stories and social media promotion of the study on NREL channels (primarily around project commencement and final study release)

## Task 7: Community

### 7.1 GHG Emissions associated with the Riverside 100 scenarios - $383,500

NREL will provide a suite of analyses to characterize benefits of the Riverside study in terms of changes to GHG emissions, air quality and air quality-related public health effects. GHG emissions will be estimated for the power sector for all scenarios, years, and power generation technologies. The emission estimates will be on a direct combustion and full life cycle basis. Life cycle assessments capture all emissions attributable to a MWh of generation, including fuel sources and their supply chains, commissioning and decommissioning of the power plants and operations and maintenance. This analysis will be based on NREL's groundbreaking LCA Harmonization Project (https://www.nrel.gov/analysis/life-cycle-assessment.html) which has synthesized the results of over 3,000 published LCAs of power generation technologies, and was recently expanded to include storage technologies, like lithium-ion batteries and hydrogen fuel cells. The results of the GHG analysis will be disaggregated by fuel type, by technology and by life cycle phase.

In addition, NREL will quantify the GHG emissions associated with fuels demanded by the load sectors evaluated in this study – buildings and transportation. Where a particular fuel use is de minimus, we will not evaluate it, focusing on those that have significant usage. Based on results from LA100, we can evaluate natural gas used in buildings (both commercial and residential) for space and water heating and cooking, and gasoline and diesel used in light-duty vehicles as well as diesel, natural gas, and propane used in urban transit and school buses. If any of these fuels are used in other sectors in Riverside in more than a de minimus extent, we can also evaluate GHG emissions associated with them. If any other fuels not listed above are important in Riverside, scope will need to be added to evaluate their GHG emissions using methods commensurate with how we have evaluated the other fuels. GHG emissions associated with both combustion and upstream emissions from acquisition, processing, transport, storage and delivery of the fuels (what is known as the "fuel cycle") will be quantified.

### 7.2 Air Quality and Public Health

If of interest for phase 2, scope of work can be developed.

### 7.3 Energy Justice/Equity
If of interest for phase 2, scope of work can be developed.

### 7.4 Economics and Jobs
If of interest for phase 2, scope of work can be developed.

### 7.5 Green Waste and Food Waste
If of interest for phase 2, scope of work can be developed.

## Task 8: Visualizations

### 8.1 Data Viewer & Application Programming Interface (API) – $331,500
The Data Viewer will comprise a custom web-based application, providing users an accessible and performant platform to view, compare, analyze, and download data. The Data Viewer will be designed specifically around the unique characteristics and results of the Riverside 100 Study, allowing on-the-fly assessments of the study scenarios, model outputs, and associated datasets. Additionally, the design and development of the Data Viewer will be conducted in parallel with the Riverside 100 Study website (outlined in Task 8.2) to ensure a consistent user experience across the web-based products.

NREL's Geospatial Data Science (GDS) software development team oversees a portfolio consisting of several dozen web-based data visualization applications, including the Los Angeles 100% Renewable Energy website (https://maps.nrel.gov/la100) and LA100 data viewer (https://maps.nrel.gov/la100/data-viewer). The Data Viewer will be able to leverage the existing GDS software platform, infrastructure, components, and best practices of the entire portfolio while being designed and developed specifically for the unique requirements and characteristics of the Riverside 100 Study.

The Data Viewer development effort will include creation of a custom API allowing user selected parameters to be accessed from the database and displayed as a corresponding map, chart, or other data viz output in the Data Viewer user interface (UI). Utilizing highly robust and scalable Amazon Web Services (AWS), the API will use a combination of EC2 (Elastic Compute) and S3 (Scalable Storage Service) to keep the Data Viewer lightweight and responsive, resulting in an optimized user experience for accessing and viewing complex datasets.

### 8.2 Riverside Accelerating Clean Energy Study Website - $390,000
A Riverside Accelerating Clean Energy Study website on NREL.gov will be designed and developed based on a user-focused approach. This will produce an organized information architecture allowing novice to technical users the ability to gain meaningful information on the study and understand primary considerations with achieving 100% renewable goals, as well as access technical resources, detailed study results, and relevant datasets. The website will be designed and developed in parallel with the Data Viewer (described in Task 8.1) to create a seamless user experience.

### 8.3 Task and Data Visualizations - $327,600
Visualizations will be integrated into the modeling pipeline, tightly coupling the modeling simulations with data visualization, both before and after a simulation run. More specifically, this effort will develop a suite of visual analytics to be used by technical staff to verify and evaluate the models and analyze the reliability and economic efficiency of the RPU system. This work will result in an improved ability to perform quality control on the data and modeling assumptions early on. It will help prevent a cascading effect of data errors throughout the data pipeline, ultimately saving the project time and money while ensuring the credibility of the study. The visualization work will be primarily focused on:

- Building & EV loads
- Distributed generation
- Bulk power (PLEXOS, etc.)
- Distribution

Leveraging the visualizations developed for the analysts, we will create visualizations in the form of illustrations and narrated animations to support collaboration and communication between NREL and RPU stakeholders. These will include draft and final narratives, illustrations, and animations highlighting key aspects of scenarios and modeling results.

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# Appendix B-5 – Patent Rights

(Alternative III - no R&D performed)

[RESERVED] – No research, development, or demonstration is to be conducted in the performance of the Statement of Work.

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## Appendix C-3– Rights in Technical Data

(Alternative IV - facility services agreement or federal funds/nonproprietary)

**1.** The following definitions shall be used:

A. "Generated Information" means information produced in the performance of this Agreement or any facility subcontract under this Agreement.

B. "Proprietary Information" means information which is developed at private expense, is marked as Proprietary Information, and embodies (1) trade secrets or (2) commercial or financial information which is privileged or confidential under the Freedom of Information Act (5 U.S.C. 552 (b)(4)). For clarity, Proprietary Information includes engineering, vulnerability, or detailed design information about proposed or existing infrastructure, as well as utility customer information which is scrubbed of personally identifiable information including account numbers, utility usage information, and service locations.

C. "Unlimited Rights" means the right to use, disclose, reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, in any manner and for any purpose, and to have or permit others to do so.

**2.** Generated Information shall not be marked as Proprietary Information. If the Sponsor provides Proprietary Information to the Contractor to perform the work, such Proprietary Information will be destroyed or returned to the Sponsor as directed by the Sponsor in writing. Except as specified in this clause, the Government and the Contractor agree not to disclose properly marked Proprietary Information to anyone other than the Sponsor without written approval of the Sponsor, except to Government employees who are subject to the statutory provisions against disclosure of confidential information set forth in the Trade Secrets Act (18 USC 1905). Sponsor shall have Unlimited Rights in all Generated Information. Subject to the provisions of this clause, the DOE and the Contractor shall have Unlimited Rights in all Generated Information and in any data provided by the Sponsor (unless such provided data is marked as Proprietary Information). In addition, the Government and Contractor shall have Unlimited Rights in all information (including Proprietary Information provided by Sponsor) to the extent such information is not removed from the Contractor’s facility before termination of this Agreement. The Sponsor agrees that the Contractor may provide to the DOE, a non-proprietary description of the work to be performed under this Agreement.

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# Appendix D – Background Intellectual Property

Patents, Patent Applications, and Record of Inventions

**Project Title**: Riverside 100 Study

The Contractor and the Sponsor have identified and agreed that the following Background Intellectual Property may be used in the performance of work under this Agreement and may be needed to practice the results of this Agreement.

**Contractor:**
SWR-20-47, titled "TEMPO™ (Transportation Energy & Mobility Pathway Options)"
SWR-18-10, titled "EVI-Pro (Electric Vehicle Infrastructure Projection Tool)"
SWR-17-09, titled "dGen™ (Distributed Generation Market Demand Model)"
SWR-20-02, titled "DISCO (Distribution Integration Solution Cost Options)"
SWR-19-15, titled "ResStock™"
SWR-19-33, titled "ComStock™"

**Sponsor:**
None Expected

"Intellectual Property" means patents, trademarks, copyrights, mask works, and other forms of comparable property rights protected by Federal Law and foreign counterparts, except trade secrets.

"Background Intellectual Property" means the Intellectual Property identified by the Parties that was in existence prior to or is first produced outside of this Agreement, except that in the case of inventions in those identified items, the inventions must have been conceived outside of this Agreement and not first actually reduced to practice under this Agreement to qualify as Background Intellectual Property.

Each Party may use the other Party's identified Background Intellectual Property solely in performance of research under the Statement of Work detailed in Appendix A of this Agreement. This Agreement does not grant to either Party any option, grant, or license to commercialize, or otherwise use the other Party's Background Intellectual Property outside of this Agreement. Licensing of Background Intellectual Property, if agreed to by the Parties, shall be the subject of separate licensing agreements between the Parties.

The Parties understand that Background Intellectual Property may control or dominate a Subject Invention generated under this Agreement. For any such Subject Invention controlled by Contractor Background Intellectual Property, Contractor agrees to negotiate in good faith with the Sponsor to establish terms of the nonexclusive, commercial license. It is understood by the Sponsor that the Contractor shall have no obligation to grant such a license to the Sponsor and may grant exclusive or nonexclusive commercial licenses to others or sell or assign all or part of the rights in the Background Intellectual Property to any third party(ies), subject to any pre-existing rights held by the Government and obligations to others.

The Parties agree to maintain all unpublished Background Intellectual Property as confidential. Upon termination of this Agreement, each Party agrees to promptly discontinue its use of the other Party's Background Intellectual Property and will, at the other Party's request, return or destroy all remaining Background Intellectual Property. In the event the Contractor terminates this Agreement (1) for breach with respect to any material provision thereof; or (2) pursuant to the Termination Article of this Agreement, the Sponsor's rights to all NREL Background Intellectual Property will automatically terminate.

Each Party has used reasonable efforts to list all relevant Background Intellectual Property, but Intellectual Property may exist that is not identified. Neither Party shall be liable to the other Party because of failure to list Background Intellectual Property.