Example Project Submission

Prepare your answers in advance, then fill out the form online at **calnext.com/how-to-participate/#project**

Please note, all fields are required.

PROJECT TEAM INFORMATION

1. Submission Date

4/26/2024

2. Project Name

Multifamily Domestic Hot Water Recirculation Survey

Titles should be concise, between 5-6 words

3. Company or Organization Name

Phoenix Electric, LLC

4. Submitter Name

Edith Clarke

5. Title

Owner

6. Phone Number

555-555-5555

7. Email Address

eclarke@phoenixelectric.org

8. Is this the first time you have submitted this project or idea?

No

9. Project Submitter Type

Entrepreneur

9a. If Other selected, please describe.

n/a

10. Have you or your team reviewed available websites and resources to ensure the proposed project research is not duplicative?

Yes

10a. If available, please provide names and links of recently completed studies related to this project.

Studies should be completed in the last three years or be the most recently completed work.

There are several related studies and efforts to the proposed scope of work:

Mehdi Zeyghami of PG&E recently presented results from laboratory testing of manual and automatic balancing methods for high-rise hot water distributions systems at the 2024 Hot Water Forum ("How to Enhance Comfort and Efficiency by Effective Balancing of Hot Water Distribution Systems in a Multifamily Building: Lab Evaluation of Different Balancing Methods").

A 2011 PIER study gathered data from gas domestic hot water recirculation systems at a variety of multifamily buildings (Multifamily Central Domestic Hot Water Distribution Systems). This led to Title 24, Part 6 measures covering the insulation, control, and design of multifamily distribution piping most recently updated over the previous two code cycles: Multifamily Domestic Hot Water Distribution, 2022-MF-DHW-F and Multifamily Domestic Hot Water led by AESC.

Since the proposed study will, in part, affect central heat pump water heater retrofits, recent and ongoing CalNEXT studies are relevant: Commercial and Multifamily CO2-Based Heat Pump Water Heater Market Study and Field Demonstration (ET22SWE0017), Master Mixing Valve Field Study (ET22SWE0047), Characterization of Central Heat Pump Water Heating in the Multifamily Market (ET24SWE0027), and Multifamily Central Heat Pump Water Heater Field Study (ET24SWE0029).

Finally, two recently projects submitted to CalNEXT called "Market Study of Recirculation Pumps for Commercial Domestic Hot Water Systems" and "Field Study of Advanced Recirculation Pumps for Commercial DHW Systems" have some similarities but are distinct courses of research. While those studies are focused on pumping controls in low-rise commercial buildings, this study is focused on recirculation loads and losses in high-rise multifamily buildings. The design, measures, technologies, and conditions in existing buildings are distinctly different.

Includes a thorough list of completed and ongoing studies. If available, past emerging tech studies are valuable. Links are beneficial compared to generally referencing studies by name.

PROJECT SUMMARY

11. Please provide a brief description of the proposed project that will serve as the public description of the project.

Make sure to describe the technology or technology deployment method being researched including what it does and why it is unique. This is a good place to include the research question/hypothesis. Your description must be 500 words or less and will be publicly displayed on the CalNEXT website if your Project Plan is approved.

Temperature maintenance losses often account for around 30% of total thermal loads in centralized domestic hot water systems in multifamily buildings (but can be as high as 60%). Correction of these omnipresent recirculation inefficiencies in high-rise multifamily buildings has direct implications on heat pump hot water system design, energy usage, and sizing. A full understanding of the recirculation loads, their driving factors, corrective actions, and their relationship to building characteristics would benefit central heat pump water heating market transformation. Currently, central heat pump water heater design and sizing take a conservative approach in the absence of better information. Often they are generously oversized to ensure that both hot water demand and recirculation losses can be met. A full understanding of temperature maintenance losses would enable improvements to existing design tools, reduce oversizing,energy consumption, associated installation costs, and potentially expand market offerings from systems relying on electric resistance swing tanks.

Additionally, there may be an opportunity for updating or creating new efficiency portfolio measures for existing multifamily buildings. These can be standalone measures for existing buildings or provide added value to central heat pump water heater retrofits. Existing measures covering pumping controls and insulation could be updated, market potential can be quantified justifying tailored marketing efforts for existing programs, and new measures could be possible for interventions such as rebalancing or crossover remediation. A field survey of recirculation systems in existing high-rise buildings will inform recommendations towards each of these ends.

This study will gather field data from 20 multifamily buildings to quantify recirculation loads and their driving factors. Recirculation loads will be measured and correlated to as-built conditions such as pipe sizing, layout, balancing, insulation, and thermally isolating pipe supports. The impacts of each factor will be quantified so that existing design tools can be adapted to accurately account for recirculation losses based on a simple set of building condition inputs. This data will also be paramount to the expansion of design tools and sizing methodology for systems without swing tanks such as return-to-primary and multipass temperature maintenance configurations. These configurations are being tested in PG&E lab tests and could reduce installation costs, footprint, and energy consumption while expanding commercially available products. All of this would increase market transformation towards central heat pump water heater systems and this field study would be a key step in that direction. In addition to central heat pump water heater goals, the bases for existing measures in eTRM will be reviewed in case the survey data yields an opportunity for updates. Furthermore, the opportunities for balancing and crossover correction will be explored, with possible recommendations for new measure development.

Responses should not include confidential or customer information.

12. Is the solution/technology available in the market today?
Which best describes the current state of the solution? Check all that apply.

- [x] It is commercially available
- [ ] It has finished conducting field demonstration(s)
- [ ] It has finished conducting lab demonstration(s)
- [ ] It has completed prototype development
- [ ] Not sure

The CalNEXT program is intended to fund research projects on technologies that are commercially available today or can be within the next few years.

13. Please describe the target market sector applicable to this technology.

For example, Residential, Multifamily, Commercial, Hard to Reach (HTR) customers, Disadvantaged Communities (DAC), Commercial, Industrial, Agricultural, Other

Multifamily, Hard-to-Reach, Disadvantaged Communities

14. Which type of research most closely aligns with this proposed project?

Market Characterization ⌄

14a. How might your project support energy efficiency programs?

Support new/updated workpaper development ⌄

TPM / PORTFOLIO PRIORITY

15. Which technology area does this proposed project most closely align?

Whole Buildings ⌄

16. How does the proposed project align with the Technology Priority Maps? If it does not align, please explain why this project should be a priority.

Please call out the Technology Research Area listed in the TPM and specifically describe which opportunities, barriers, and Research Initiatives stated in the TPMs your project is looking to address. For more information and to review the TPMs, please visit: **https://calnext.com/resources/#tpm**

The proposed project aligns with the Commercial-Duty Water Heater technology family under the Water Heating TPM. In particular, the project will support the adoption of central heat pump water heater systems for multi-family buildings, specifically called out as an example technology. Opportunities called out in the TPM that match this project include "system configuration options,… temperature maintenance systems,… draw patterns,… reducing the complexity of all-electric centralized HPWHs,… [and] installed cost and space requirements compressor of HPs and storage tanks." Data collection, understanding of temperature maintenance loads, and design considerations based on those data can help with all those TPM opportunities. A specific barrier called out in the TPM that aligns with this project is the"minimal documentation and empirically determined hot water load profiles for various non-resbuilding types, important for developing sizing tools, design guidance, and regulatory updates."The study also aligns with the Alternative Design Strategies family in the Water Heating TPM which is concerned with the aspects of hot water systems outside of the water heater, itself.

Here the submitter clearly explains why the degree to which the project aligns with the TPMs and the specific barriers the project seeks to address within the Technology Research Area

PROJECT VALUE AND IMPACT

17. How does the project benefit utility programs with electrification, load flexibility, new measures, and savings for utility programs?

Discuss benefits to efficiency portfolios, load flexibility, grid decarbonization, expected kWh/kW savings, Total Resource Cost (TRC), and Total System Benefits (TSB) as appropriate.

Central heat pump water heaters are poised for adoption across a broad swath of the multifamily building sector. There is potential for 1.7 million tons of avoided greenhouse gas emissions and$350 million of total system benefits per year in the existing California multifamily sector. The proposed course of study will fill in a key information gap in the implementation of central heat pump water heaters. The recirculation load data and proposed course of action for design tool updates will help avoid oversizing of temperature maintenance systems, reduce costs, reduce footprint, and help remove a lingering design barrier. Furthermore, recirculation losses data and reliable prediction are important for the design and adoption of alternative designs such as multipass or return-to-primary temperature maintenance designs. These alternate configurations will expand product availability, feasibility, low-GWP heat pump options, and may even improve efficiency in some situations. All this will be in aid of utility electrification, load flexibility, and energy savings programs.

Beyond the direct benefits of central heat pump water heater installations, remediation of inefficiencies in the distribution systems of existing multifamily buildings is also a widespread opportunity. There are several existing measures for recirculation pump control and pipe insulation and recent Title 24 efforts have highlighted the importance of optimizing distribution systems. This study will also explore the opportunity for updates to existing measures and possible new measures for additional corrective measures for existing buildings (e.g. rebalancing and crossover correction).

CalNEXT projects have the intended goal of supporting utility programs. If there are specific utility programs your project might support, please include the names of the programs and explain if the benefit is direct or indirect and why. Please include the metrics mentioned in the question as relevant.

18. How does the project benefit Hard-to-Reach (HTR) utility customers and Disadvantaged Communities (DAC)?

State if your project is located in a Disadvantaged or Hard-to-Reach community. Describe how and explain what percent of the project funding will be spent in these communities. Describe project outcomes that will directly benefit DAC/HTR communities, including expected reduction in customer energy burden. How will the project seek input/engagement from these communities? How will the outcomes of this work uniquely benefit HTR/DAC communities?

Multifamily buildings inherently are disproportionately represented by low-income and DAC customers in California. Around 90% of the units in multifamily buildings in California are occupied by renters. The sites selected for measurement in the study will similarly be disproportionately occupied by low-income and DAC residents. The measurements will help inform future hot water retrofits that the building owners choose to explore and, in general, will help improve design tools for this building sector. Ultimately, it is expected that the data,measures, and design tool updates will reduce costs, improve feasibility, and improve efficiency for the multifamily building sector. The team will prioritize DAC residences and commit to surveying at least 50% of the buildings in DAC zip codes. The team will attempt to quantify any observable differences in distribution systems between DAC and non-DAC buildings and refer to any important findings regarding recirculating domestic hot water found in the completed Low-Income Multifamily Housing Characteristics Study (ETSWE220033).

This field should mention how the implementation of the project will directly benefit the HTR/DAC communities (ex. Demonstration site is in a CalEnviroScreen designated Area, the project employs members of a DAC), how the project plans to engage these communities, AND how the results of the project may UNIQUELY benefit HTR/DAC communities after the project is over.

19. Briefly summarize the current market landscape for the subject technology (manufacturers, distributors, retailers, installers/contractors/technicians, customers, existing programs & incentives, etc.). Include known barriers that would prevent these market actors from adopting the technology and who should be engaged to overcome the known barriers. If the project includes research to address these items, explain.

Please reference sources of market scan or research and share methodology of these assumptions. Consider who this technology is for, how you know it is wanted/needed, and how it might be adopted by this market. Identify any existing programs that can support scaling this technology.

The current market landscape for central heat pump water heater systems comprises manufacturers, designers, consultants, and a customer base. There are approximately 1.9 million multifamily residences served by central water heating systems in California, many of which could be candidates for heat pump water heater system retrofits. These retrofits can be facilitated by designers and engineering firms with knowledge of heat pump and plumbing systems. These design firms rely on guidance and tools available from subject matter experts, such as the Ecosizer tool. The Ecosizer tool is a freely available design tool that can prescribe system sizing specifications given building inputs and heat pump water heater configurations. However, this pre-eminent design tool requires updates.

The Ecosizer and any other design tool should account for recirculation, temperature maintenance loads in its methods. These loads inform the sizing of the electric resistance swing tank or heat pump supplying temperature maintenance. However, these methods are currently conservative due to a lack of empirical data and prediction capabilities of recirculation loads. Manufacturers such as Mitsubishi and Small Planet Supply are similarly constrained by a lack of recirculation load data. They, too, rely on conservative sizing approaches. Rectifying this information gap will have many benefits across the central heat pump water heater industry and market actors. This important data is highly unlikely to be gathered and analyzed by any effort outside of an emerging technologies program.

Regardless of heat pump water heater usage, there are existing measures available for multifamily distribution systems through various programs. These include the Multifamily Energy Efficiency Program, Energy Savings Assistance, TECH, and Low-Income Weatherization Program. The proposed study may be able to update existing measures, provide additional information and market potential to justify program updates, and possibly facilitate the development of new measures targeting unaddressed distribution system inefficiencies. For instance, the field survey can complement the laboratory work conducted by PG&E towards new balancing measures. Balancing procedures are widely poorly implemented or have degraded over time in existing buildings. Crossover is a persistent, unaddressed issue in many multifamily buildings. The magnitude of the opportunity is unknown, but anecdotal evidence suggests that these issues are ripe for program support and savings potential.

This is where you can tell us what you know about the potential demand for the project technology, what the barriers are for meeting or expanding that demand, and how your project can address some of those barriers.

20. Please explain the business case and justification for the project. If the project will include measure / savings research and/or testing, please explain how.

Include why this is different from incumbent technology or completed research, what benefits there will be to customers, and any energy, carbon or demand reduction estimates. Specify the targeted Research Initiative topic, which must be listed as "Immediate Need" in the relevant TPM. CalNEXT will consider innovative technology and/or innovative research; explain your justification for both. Please include calculation/justification for estimates. If there is a sense of urgency (i.e. a program need) in achieving the outcomes associated with this project please explain.

The proposed course of study will be complementary to several ongoing projects. A number of field studies of central heat pump water heater systems are underway across California under the CalNEXT and EPIC programs. These field demos will go a long way to lend confidence to the market. Additionally, a PG&E lab study is testing some alternative configurations (multipass temperature maintenance and return-to-primary designs) and recirculation balancing methods(manual, automatic flow, and thermostatic balancing valves). Incorporating accurate temperature maintenance loads into design tools will be necessary to encourage adoption and proper design of those alternate configurations.

Empirical recirculation load data and distribution system conditions will enable lower-cost, smaller-footprint, higher-confidence implementation of central heat pump water heaters. The gathered data and regression analyses to factors such as piping dimensions, balancing, and insulation will enable improvement of design tools that can predict recirculation loads based on simple building parameter inputs. Thus, the business case, cost-effectiveness, and confidence in reliability at any given site will be enhanced. This will similarly improve the cost-effectiveness and feasibility of central heat pump water heaters across utility programs for both new construction and existing buildings.

Empirical temperature maintenance load data and prediction is also important for ongoing and future code compliance software development incorporating central heat pump water heaters. Hot water code compliance software needs to be updated with appropriate temperature maintenance loads, similar to design and sizing tools.

Additionally, remediation of distribution inefficiencies prior to central heat pump water heater design is crucial. Similar to the idea that efficiency upgrades to a single family home should be done before sizing solar panels, reducing building hot water loads can improve the cost-effectiveness and justification of heat pump water heater installations.

This is a great place to discuss what sets your research, product, or deployment method apart from what has already been done. Consider specifying what energy programs or codes & standards you would like the results of your project to inform.

PROJECT DETAILS

21. What is the scope for the project?

As appropriate, describe what work you will do as part of this project, including number of sites, the type of data being collected, how work will be done and to what level of detail, etc.

The scope of the project will include a field survey of California multifamily buildings with central hot water, analysis of collected data, discussion of implications on central heat pump water heater design, recommendations for sizing tool development, and recommendations for possible eTRM measure updates or development. These data, tasks, and results will be captured in reporting deliverables that chart an explicit path towards design guidance, sizing tool expansion, and measure development. The enhanced design tools will facilitate more cost-effective market adoption of central heat pump water heaters, including heretofore uncommon but advantageous design options.

To achieve these goals, the project team will:

1. Measurement Plan (2 month): Develop a measurement plan that can capture recirculation,temperature maintenance loads and all driving factors. For instance, the measurement plan will specify the length of monitoring period per site (e.g. two weeks), measurement instrumentation(e.g. flow meter, temperature meters), and building conditions to be documented. Building conditions to be documented will include items such as number of residences, occupants, hot water end-uses, plumbing distribution, piping insulation, hot water flow balancing, and thermal isolation (e.g. pipe hangers).

2. Site Recruitment (4 months): Recruitment of 20 multifamily sites with central hot water,leveraging the team's network of hot water designers, installers, and consultants. Sites will ideally be identified across the state and with varying building size, but it is not expected that temperature maintenance loads will be particularly dependent on climate zone – especially in comparison to other driving factors.

3. Data Collection (8 months): Data collection and measurement at each site. The data collection will comprise (1) monitoring of recirculation loads for a short time (e.g. two weeks),(2)as-built plumbing plans, and (3) a site walk through assessment. The team will also interview multifamily building owners, hot water system designers, and plumbers to gather information on distribution system maintenance practices (especially regarding pumping, balancing, and crossover).

4. Analysis (3 months): Analysis of the recirculation loads in relation to hypothesized driving factors. Regression analysis techniques will be used to assess the influence of individual factors on temperature maintenance loads. These loads will be quantified on a per-unit basis (e.g. Btu/hr per residence) as a function of influential factors (e.g. insulation level).

A strong scope of work will include a succinct overview of the proposed project, including which market(s) will be focused on. The scope will include major tasks/milestones along with deliverables which will incorporate short term outcomes (what is expected immediately after the project is complete) and long term outcomes (how the work translates to energy efficiency programs, codes & standards, market transformation programs, and stakeholder benefit).

Answer continued on next page ↓

Answer continued from previous page

5. Impacts and Recommendations (1 months): The analysis and findings will provide a basis for recommendations on design guidance and sizing tools. The team will evaluate the results to recommend how existing sizing tools (e.g. Ecosizer) can incorporate a simple set of inputs to account for temperature maintenance loads in their sizing calculations. Additionally, the temperature maintenance loads will also be discussed in relation to different central heat pump water heater design configurations. In other words, the team will discuss how temperature maintenance loads under different conditions may or may not enable alternative system design(return-to-primary and multipass, for example). Recommendations for how the findings can be incorporated into sizing tools will separately consider three temperature maintenance design approaches (electric resistance swing tank, multipass temperature maintenance tank, and return-to-primary). The team will provide recommendations for possible updates to existing distribution and recirculation eTRM measures and the outline for possible new measures, if identified as feasible and promising (e.g. crossover correction and rebalancing).

6. The scope will also include CalNEXT reporting deliverables (preliminary, draft, and final reports). The team will also likely share the findings to industry stakeholders in the form of conference proceedings or working group presentations (such as to the Advanced Water Heating Initiative).

22. What are the expected outcomes of the project?

Be explicit: include long term and short term outcomes, describe how the research project may lead to increased adoption of the subject technology. Activities may include but are not limited to supplying data for a new measure package, incorporating recommendations into a new or existing EE program. Provide a clear description for how to ensure these outcomes can be achieved.

The final deliverable will be a report that includes individual and aggregate data from the surveyed sites and their recirculation loads. The report will present how temperature maintenance loads can be predicted for any given site based on building characteristics. This is crucial for the advancement and development of appropriately sized central heat pump water heaters in various configurations at minimal cost, size, and grid impact. The study will produce recommendations for how to adapt sizing tools and design guidelines to incorporate this new understanding borne from this dataset. Ultimately, the study will result in improved sizing tools,guidance for central heat pump design under various configurations, and more efficient, lower-cost market transformation of the multifamily water heating sector. This outcome will improve throughput, rate of adoption, and claimable savings by impacted utility programs as well as compliance software for future building code updates. The reporting will also include findings on remediation potential in existing building distribution systems and recommendations for the existing measure portfolio.

Outcomes should describe the direct expected outcomes of the project in the short and longer term. The expected outcome should tie into the what was described in the scope.

23. How will this project engage with relevant stakeholders during the project?

List identified stakeholders and proposed engagement, or how stakeholders will be identified and engaged throughout the project.

The project team will engage with a variety of stakeholders during this study. The project team has extensive history and experience in the water heating sector including with central heat pump systems in multifamily buildings. The team has connections to manufacturers, consultants, program administrators, and building owners, all of which could be leveraged for input and host site recruitment. These parties include Mitsubishi, Rheem, Lochinvar, Small Planet Supply, Phoenix Electric LLC, New Buildings Institute, DOE National Laboratories, CLEAResult, Ecotope, Bonneville Power Administration, Association for Energy Affordability, water heating experts at California IOUs, and others.

As a portal to the entire range of water heating subject matter experts and stakeholders, relationships with the Advanced Water Heating Initiative leadership and working groups will be leveraged for outreach and engagement. The team will conduct outreach to these parties to garner feedback during project planning and in the development of conclusions. The team will present the findings and recommendations at the end of the study to these stakeholders in order to encourage optimal of the findings in ongoing efforts across the water heating industry.

IOU staff and program administrators will also be engaged regarding study goals and data collection. It will be important to consult these parties during project planning to ensure that any opportunity to fill in information gaps is not missed. For instance, the staff conducting distribution system testing at PG&E will be consulted on field data collection methods, critical factors defining recirculation inefficiencies, and possible paths towards updated and new eTRM measures.

Describe the projects stakeholder engagement strategy including who will be engaged and how they will benefit the project

24. Once a Project Plan is approved, roughly how long will it take to complete the project and all the required project deliverables?

18 months ⌄

Select the option that is closest to the expected time frame

25. Explain how you will successfully deliver the project. Who are the critical project partners that you will be including to support you with the work?

State what organization will lead the project, and identify team members such as the manufacturer, another consulting firm, lab, or local California-based customer(s) you might use for a demonstration or deployment project, etc. What capabilities does your organization already have, and what do they need to build or find in others. How will you address critical dependencies? Share as much as you can to help us understand how you will deliver this project cost effectively and within the timeframe.

Phoenix Electric will lead the management and execution of the study in all aspects with contributions from two project partners. The combined team has the expertise and network to effectively execute the scope, without any skill gaps:

- *Phoenix Electric will contribute to the measurement plan development, host site recruitment, field surveying, data analysis, and report writing.*
- *Ecotope will contribute to the measurement plan development, host site recruitment, data analysis, and recommendations for design tool development.*

Highlight partnerships and explain how the project would benefit as a result.

Bullet points are suitable with monthly timelines.

26. What San Diego Gas & Electric, Southern California Edison, or Pacific Gas & Electric company energy efficiency or decarbonization programs do you expect to be impacted from this research?

All current and future programs that are engaged with multifamily central heat pump water heating would benefit from the outcomes of this research. These include, but are not limited to the TECH program, MF custom programs, Multifamily Energy Efficiency Program, Energy Savings Assistance, Energy Smart Homes, CHPWH workforce training and education seminar programs, and the IOU Codes and Standards Enhancement program.

List the utility programs that could benefit from this research and explain how the research will impact them.

COST

27. Please indicate the approximate funding needed from the program, including required report writing, incentives for customer participation and field installations.

Up to $200,000

27a. Please provide a rough breakdown of cost items. ← **New Field**

28. Is there any co-funding that will contribute to funding this proposed project?

No

28a. If Yes to the above question, will it be from any of the following sources: CEC, EPIC, DOE, GET or DRET?

Y/N

29. Please upload additional documentation with more project details that would help the team better understand your project and its benefit to the energy efficiency programs.

Upload files

SUBMIT

30. What questions or concerns do you have about completing a CalNEXT project?

None

31. Who referred you to submit this proposal (Name and Organization)?

Please read the CalNEXT Terms of Use and accept them below to complete your submission.

☑ I accept the CalNEXT **Terms of Use**