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Docket Number:	17-EPIC-01
Project Title:	Development of the California Energy Commission Electric Program Investment Charge 2018 â€“ 2020 Triennial Investment Plan
TN #:	215929
Document Title:	Richard Brown Comments: Dynamic Management of Variable-Speed HVAC Systems for Load and Energy Reduction
Description:	N/A
Filer:	System
Organization:	Richard Brown
Submitter Role:	Public
Submission Date:	2/10/2017 6:06:41 PM
Docketed Date:	2/10/2017

Comment Received From: Richard Brown
Submitted On: 2/10/2017
Docket Number: 17-EPIC-01

Dynamic Management of Variable-Speed HVAC Systems for Load and Energy Reduction

Additional submitted attachment is included below.

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The Energy Commission is currently soliciting ideas and stakeholder input for the 2018 – 2020 EPIC Triennial Investment Plan. For those that would like to submit an idea for consideration in the 2018-2020 EPIC Triennial Plan, we ask that you complete the form below. Submittals are due by **5:00 p.m. on February 10, 2017.**

Part 1. Initiative Description and Purpose:

1. Please provide a brief description of the proposed initiative:

Initiative: Dynamic Management of Variable-Speed HVAC Systems for Load and Energy Reduction
Energy efficient and zero-net energy (ZNE) buildings are increasingly using variable speed HVAC systems, such as mini-split and variable refrigerant flow (VRF) systems, to save heating and cooling energy. These units tend to be controlled individually, which does not allow whole-building coordination and grid-response. This initiative would develop software and hardware solutions to enable coordinated and grid-responsive control of variable-speed HVAC systems. These solutions will allow air conditioning (and heating) demand to be managed and temporarily shed when required for grid and building services, and save energy by taking better advantage of the variable-speed capability of modern mini-split systems. The initiative involves several elements: 1) developing architectures for data communication and control that enable interoperability and aggregated control of multiple HVAC units, 2) integration of variable-speed products with

2. What technical and/or market barriers would the proposed initiative help overcome? For scientific analysis and tools, what knowledge gaps would the proposed initiative help fill?

There are several technological barriers that need to be overcome: 1) in buildings served by multiple mini-split or VRF systems for each tenant, there is no central Building Automation System (BAS) to command these distributed AC loads, 2) different ACs have different IR codes, thus requiring a method for interoperable control, 3) some ACs have a toggle for On/Off operation so it can be confusing to know what is the current status of AC, 4) users might operate ACs directly so the controller will not know the current status, and 5) ACs behave differently after power is resumed after a blackout.
To address these challenges, this initiative will develop solutions to enable coordinated control of mini-split and VRF systems, as well as control systems that communicate with the grid to control multiple systems to provide services to the grid. The solutions should make use of communication standards such as OpenADR for grid signals.

Part 2. Benefits and Impacts

3. If this initiative is successful, either fully or partially, what would be the expected impact? Who are the primary users and/or beneficiaries?

The major outcome and benefit from this initiative is expected to be a low-cost, easily-deployable method for enabling load management in mini-split and VRF HVAC units. In California, this will be particularly beneficial in ZNE buildings, which are increasingly using these variable-speed systems to improve energy efficiency through zoning and variable operation. Adding grid responsiveness to these systems will allow ZNE buildings to have tailored load shapes to reduce the load variability of rooftop solar systems, provide grid services, and reduce utility bills.

4. Describe what quantitative or qualitative metrics or indicators would be used to evaluate the impacts of the proposed initiative:

The goal of this initiative is to demonstrate prototype systems that can reduce the coincident peak load of a single mini-split or VRF unit by at least 15%, and the combined load of multiple units by at least 50%. The ultimate goal is to enable collective control of multiple units to produce fine-grained load shapes that can provide grid services and offset the impact on the grid of variable renewable generation. Through better use of variable-speed operation, the target is a 10% reduction in estimated annual energy use. These levels have been achieved for unitary rooftop units in commercial buildings, so should be achievable in mini-split systems as well.

5. Please provide a list of peer-reviewed references that support the responses for questions 3 and 4. Proposed initiatives that include peer-reviewed references will be given stronger consideration.

6. (For technologies only) What competitive advantages does the proposed technology solution have over current benchmark technologies? If the technology is beyond the prototype stage, what strategies do you suggest to bring to scale?

The proposed solution has improved interoperability compared to current technologies, which should lead to lower capital costs and improved flexibility and extensibility over time. The system also allows whole-building control of HVAC units for energy and load management. To take these solutions to scale, it will be important to involve manufacturers of mini-split and VRF units in the research.

Part 3. Connection to Energy Commission's EPIC Framework
Energy Commission staff have developed a draft strategic framework to guide the CEC's planning and implementation of EPIC across triennial investment cycles. One of the objectives of the draft strategic framework is to communicate a consistent set of priorities for organizing current and future EPIC investments.

7. Please indicate which of the following strategic framework themes you feel the proposed initiative best fits within:
    - Advance Technology Solutions for Deep Energy Savings in Building and Facilities
    - Accelerate Widespread Customer Adoption of Distributed Energy Resources
    - Increase System Flexibility from Low-Carbon Resources
    - Increase the Cost-Competiveness of Renewable Generation
    - Create a Statewide Ecosystem for Incubating New Energy Innovations
    - Maximize Synergies in the Water-Energy-Food Nexus
    - Develop Tools and Analysis to Inform Energy Policy and Planning Decisions
    - Catalyze Clean Energy Investments in California's Underrepresented and Disadvantaged Communities

If Other, Please Specify

Advance Technology Solutions for Deep Energy Savings in Buildings and Facilities