

DOCKETED

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HVAC

See attached document.

Additional submitted attachment is included below.

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Please accept the following comments related to the HVAC Workshop held on 12/21/2017:

Davis Energy Group (currently Frontier Energy) has completed research projects under the Energy Commission's Energy Technology Advancement Program (ETAP), Public Interest Energy Research (PIER), and Electric Program Investment Charge (EPIC) programs, and federal programs over the past two decades that respond to current needs for HVAC solutions that reduce GHG emissions and provide demand flexibility. Key takeaways from this research are:

- Much CEC research that has been completed has not been applied; more funding is needed to support commercialization of emerging technologies
- Programmatic EPIC GFO's make it difficult for developers to advance the state of individual technologies
- By applying "building as a system" concepts, opportunities for developing low carbon, low GWP, and peak load avoidance solutions can be found
- Heat pumps offer opportunities that gas heating does not, and air-to-water and water-to-water systems increase design flexibility and offer several advantages

Examples of this research include:

1. "NightSky" Cooling: Using water sprayed on a roof surface at night to obtain cooling by night sky radiation and evaporative cooling. Has been demonstrated to meet 100% of summer comfort needs in both commercial and residential applications. Demonstrations include the Office of State Printing (Sacramento), Verifone office building (Auburn), Employment Development Department building (Los Angeles), and All-Weather Windows plant (Vacaville). Since energy use to operate spray pumps occurs only at night, there is no on-peak energy use except for distribution. For supplemental cooling, chillers can be used for off-peak cooling of stored water.
2. "NightBreeze" ventilation cooling and air conditioner pre-cooling: The Energy Commission supported several grant cycles to develop this technology, which was commercialized between 2004 and 2007. Changes in the way furnace manufacturers control fan motors made integration with furnaces very challenging, but it can be used with hydronic air handlers. PG&E supported a field study that showed energy and demand savings, and it is now recognized by the residential compliance model (CBECC).
3. Radiant floor cooling: A PIER program led by Architectural Energy Corporation and managed by Oak Ridge National Laboratory studied the successful use of radiant cooling to offset peak load in a Winters, CA residence. Following up on this, DEG managed a Building America funded project in Tucson that demonstrated that a home could be radiantly cooled entirely off peak while improving system

performance by operating the air-to-water heat pump at night when outdoor temperatures were lower. The same heat pump provided efficient winter heating.

4. Frontier Energy is currently conducting research using one of PG&E's Central Valley Research Homes (CVRH) to investigate radiant heating and cooling using ceiling panels and an air-to-water heat pump. An ETCC report will be released in January.
5. Frontier Energy is currently working with UC Davis (WCEC) on an EPIC-funded project to develop low-cost ground heat exchangers for water-to-water heat pumps.

Conclusions from this work are as follows:

1. For larger new commercial buildings or major renovations, roof spray cooling offers a very viable alternative to compressor-based cooling. Radiant distribution (slab or ceiling) can use more mild temperature water than is needed for fan coil systems. Heat pumps can be used for supplemental nighttime cooling and to produce warm water for heating. Hydronic distribution facilitates zoning, and ventilation can be provided by DOA systems with outside air tempered by water coils.
2. For small commercial and residential buildings, radiant heating and cooling using packaged air-to-water or water-to-water heat pumps provides the following advantages:
 - a. Water instead of refrigerant is used as the distribution medium, which facilitates efficient zoning.
 - b. Central water-water or air-water heat pumps are factory charged, eliminating the potential for refrigerant release during installation.
 - c. Radiant heating and cooling of slab foundations can be done very economically (there is only the cost of the tubing), and slabs provide free energy storage.
 - d. Radiant ceiling panels provide some thermal storage and can be retrofitted.
 - e. Both radiant floor and ceiling systems eliminate attic ducts and duct heat losses/gains, and bypass the need for the costly placement of ducts within conditioned space.
 - f. Hydronic systems allow the potential for adding storage to provide demand flexibility or complete off-peak cooling .

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