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Errata for the Staff Final Electric Program Investment Charge: Proposed 2018 – 2020 Triennial Investment Plan

p. 19. Table 1, which shows the Energy Commission's proposed EPIC funding by program area, is updated to reflect California Department of Finance projections for inflation between 2018 – 2020 which provide a California specific consumer price index adjustment.

p. 27, 28. Initiative 1.1.3 \$1 LED A-19 Lamp Prize removed.

p.35. Initiative 1.2.3 revised to remove mention of the Manufactured Housing Construction Safety Standards

p. 40, 42 – 43. Initiative 1.3.1 expanded in scope to include advanced low-energy HVAC technologies.

p. 148. Removed language on researching environmental impacts of offshore wind, which is covered in Theme 7.

p. 270. Updated to include Appendix D.

Appendices Cover Page. Updated to include Appendix D.

Appendices Table of Contents. Updated to include Appendix D.

Appendix B.

p. B-8 – B-10. Updated with additional comment summaries and staff responses

p. B-24. Updated with additional comment summary and staff response

Appendix D.

Added to include summary and staff responses to written comments received on the Staff Final *Electric Program Charge: Proposed 2018 – 2020 Triennial Investment Plan*

investors, raised concerns over intellectual property language that potentially grants IOU's or other load-serving entities a royalty-free license to IP developed with EPIC funds. Private sector companies interpreted the language to mean that IOU's or other load serving entities could take their intellectual property if private sector companies enter into an EPIC award agreement.

The Energy Commission seeks to clarify this term as applicable to all investment plans to what it believes is the intent to grant load-serving entities (LSE) with a free license to use analytical tools and models developed with EPIC funds, such as the recently developed StorageVET™, that can be used for distribution planning and

decision-making purposes that benefit electric ratepayers. No licenses are to be granted for any other type of technology developed. For example, if an EPIC recipient developed a new type of solar PV technology, no license will be granted to an LSE since they would not be manufacturing developed EPIC technologies.

The Energy Commission and the CPUC would still retain march-in rights to obtain unused intellectual property if it is in the best interest of the electric ratepayers. Royalty provisions would also be retained. See the section *Intellectual Property* starting on page 265 for more detail.

EPIC Investment Areas and Funding

As mentioned earlier, the *EPIC 2018 - 2020 Investment Plan* is organized by eight strategic objective themes each with multiple sub-themes and funding initiatives. The strategic themes cut across all three

program areas. Table 1 below shows the proposed budget allocation divided by program area, as well as proposed administrative costs.

Table 1: California Energy Commission EPIC Funding by Program Area 2018 – 2020 (millions \$)¹³

Program Area	Amount
Applied Research and Development	\$140 159.8
Technology Deployment and Demonstration	\$151.7 173.2
Market Facilitation	\$58.3 66.6
Program Funding Total	\$350399.6
Administration	\$38.8 44.4
Total EPIC 2018-2020 Funding	\$388.8444.0

Source: California Energy Commission

¹³ Any additional funds that may be allocated to the Energy Commission as a result of any CPI adjustment will be used to increase the budget proportionally across all areas. This budget utilizes the California Department of Finance projections for inflation for the 2018 - 2020 period.

designs for outdoor lighting could redefine form factors for pole and street lighting into entirely new concepts. In California, non-LED streetlights represent about 70 percent of all fixtures and represent a large potential for untapped savings.

Primary Users and Beneficiaries	Commercial, institutional and industrial facilities could use and benefit from the initiative.
Metrics and Performance Indicators	Increased adoption of SSL lighting; reduced operation and maintenance costs; reduced energy use for lighting.
Topic(s) addressed	Novel LED Applications
Value Chain	Demand-side Management
Program Area(s)	Applied Research and Development

~~Initiative 1.1.3 \$1 LED A-19 Lamp Prize~~

Description	<p>Despite the wide range of added value presented by SSL technology, the higher initial cost of LEDs when compared to traditional lighting technology remains a barrier. The added features of LEDs such as spectrum controllability and internet connectivity also add to the cost. Further research is needed to continue to drive SSL cost down while maintaining product quality and feature richness. This initiative would provide a cash prize to manufacturers of LED A19 lamps that do all of the following:</p> <ul style="list-style-type: none"> • Meet or exceed the light output of a 100 watt incandescent light bulb measured in lumens per watt • Meet or exceed the Energy Commission's specifications for color rendering, durability and performance • Demonstrate and install the lamp in buildings in disadvantaged communities, including residential, multifamily, small commercial and industrial buildings • Market the lamp at a cost of \$1 (or no more than twice the cost of competing incandescent bulbs)
Impact if Successful	A low-cost high-quality 100-watt-equivalent A-19 LED lamp could produce substantial energy savings by replacing use of incandescent and CFL lamps in homes and businesses in California.
Primary Users and/or Beneficiaries	This initiative would be beneficial to renters, including low-income residents as well as the small commercial sector and industrial sector.

Metrics and Performance Indicators Topic(s) addressed

Price and sales of 100-watt LED, incandescent, and CFL bulbs.

Value Chain

Technical and Cost Advancements

Demand-side Management

Program Area(s)

Applied Research and Development

Table 3 Ratepayer Benefits Summary For Sub-Theme 1.1

Initiative	Promote Greater Reliability	Lower Cost	Increased Safety	Societal Benefits	GHG Emissions Mitigation and Adaptation	Lower Emission Vehicles/Transportation	Economic Development	Public Utilities Code 740.1	Public Utilities Code 8360
Initiative 1.1.1 Pilot and Test New Solid-State Lighting Features and Applications with Energy Savings and Added Functionality	X	X		X	X		X	X	
Initiative 1.1.2 Test Novel Luminaire Systems Architecture and Form Factors That Leverage the Unique Properties of LEDS	X	X	X	X	X		X	X	
Initiative 1.1.3 \$1 LED A-19 Lamp Prize	X	X		X	X		X	X	

Source: California Energy Commission

Primary Users and/or Beneficiaries	Ratepayers, building owners, building occupants, regulatory agencies, construction industry, architects and engineers, manufacturers, innovators/entrepreneurs, research community, and technology investors
Metrics and/or Performance Indicators	Metrics of success will include: 1) lower heating, cooling, and lighting energy demand in buildings using advanced window and building envelope systems; 2) successful development of a practical test method for residential and multifamily envelope efficiency; 3) the participation of many production homebuilders, and 4) the successful production and sustainability of many highly efficient single and multifamily buildings after the project has completed.
Topic(s) addressed	Advanced Window and Building Envelope Systems
Value Chain	Demand-side Management
Program Area(s)	Technology Demonstration and Deployment

Initiative 1.2.3 Multifamily Factory Built Homes Competition for Highly Efficient Building Envelopes

Description	<p>With increasing housing prices, modular construction including mobile homes can offer housing that is cheaper and faster to build. Modular construction homes are assembled in a factory. However, all manufactured homes produced in the nation conform to one set of preemptive standards, the Manufactured Housing Construction Safety Standards, enforced and maintained by the U.S. Department of Housing and Urban Development. The standards contain thermal requirements that were last updated in 1994, and the requirements are far less stringent than California's Title 24. As past research focused on single family factory-built homes, this initiative will focus on multifamily units that could be installed in disadvantaged communities and will be coordinated with Theme 8. Similar to Initiative 1.2.2, this initiative will conduct a contest for the most efficient building envelope for multifamily factory-built homes. A limited number of manufactured home builders will be selected to compete for the design and construction of the most efficient envelopes.</p> <p>A third-party firm will be selected to test a random selection of factory-built homes entered in the contest. The third party will develop a metric and test method for a quick assessment of the factory built multifamily buildings. This test will include such metrics as air leakage, conduction losses, solar heat gain, daylighting efficacy, and may also include comfort and other</p>
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Table 6: Previous and Planned EPIC Investments on HVAC

Topics	2012-14 Investment Plan	2015-17 Investment Plan
Mechanical HVAC Systems	Climate Appropriate HVAC Systems for Commercial buildings (EPC-15-004)	Energy Efficiency HVAC Packages for Existing Residential Buildings (EPC-16-005)
	Next Generation Residential Space Conditioning System (EPC-14-021)	Benefits and Challenges in Deployment of Low GWP A3 Refrigerants in Residential and Commercial Cooling Equipment (EPC-16-041) Pending
Solid State Heating and Cooling	Radiant Systems for Energy Efficiency and Comfort (EPC-14-009)	No current or planned investments
Heat Pumps	Low Cost, Large Diameter, Shallow Ground Loops for Ground-Coupled Heat Pumps (EPC-15-019)	No current or planned investments

Source: California Energy Commission

2018-2020 FUNDING INITIATIVES

The proposed initiatives will develop and test advanced and climate appropriate HVAC technologies and controls to improve performance and cost-effectiveness, and move them closer to deployment and commercialization. In addition, this ~~The~~ initiatives also focuses on testing and demonstrating advanced high-efficiency electric HVAC and refrigeration systems that provide the same or better performance and operational cost as natural gas fired systems and on advanced low-energy HVAC system solutions. The demonstrations should look at a mix of building types – single family residential, multifamily, small commercial, and large commercial – across various climate zone and IOU service areas.

Develop and test emerging HVAC and refrigeration systems and controls

Emerging HVAC systems, such as direct current compressors, cold climate heat pumps, and electrochemical compressors are needed because of the potential performance/energy savings over conventional equipment and environmental issues with current refrigerants. There is also a need to move toward low- or zero GWP and ozone depletion potential (ODP) refrigerants and to focus on HVAC systems that are suitable for all climate zones while keeping high efficiency.

In addition, several advanced low-energy HVAC systems have shown promise, for example mixed mode radiant cooling heating, personal comfort systems, systems that do not require the vapor compression cycle, and systems that use natural ventilation. Though the building industry is interested in these technologies, research results, measurements of energy, comfort and cost performance are needed to inform building designers.

Initiative 1.3.1 Develop and Test California Climate Appropriate Advanced HVAC Systems and Electric Heat Pump Space and Water Heaters

Description

This initiative focuses on promoting advanced and innovative HVAC technology solutions and includes low-energy HVAC systems, and advanced electric heat pump space and water heaters.

Low-Energy HVAC Systems

There are several advanced low-energy HVAC systems that are candidates for additional focused research. Examples include: personal comfort systems, natural ventilation and mixed mode, radiant cooling and heating, chilled beams, underfloor air distribution, displacement ventilation, systems and non-vapor compression systems. Research is needed to expand the use of these technologies while also improving fundamental understanding, and then using this knowledge to develop new and practical solutions, including equipment design tools, guidance for efficient operation and control that maintains a high indoor environmental quality and occupant comfort, and updating of relevant standards and codes.

Electric Heat Pumps

In recent years, manufacturers have designed electrically-driven heat pumps for cold-climate operation through the use of multi-stage, variable-speed, or booster compressors, advanced refrigerant management, improved defrost control, alternative refrigerants, and other features.

This heat pump portion of the initiative will develop and test advanced electric California climate appropriate heat pumps for space and/or water heating that can perform at low-ambient temperatures without affecting performance, energy efficiency or operating costs. Potential areas of consideration include elimination of defrost (or frost buildup) and backup heat sources to improve the performance and energy efficiency of cold climate heat pumps. The prototype heat pump to be developed for space conditioning must have an HSPF $\geq 12/\geq 27.5$ SEER (including fan energy). Coefficient of Performance (COP) ≥ 3.2 (at 5 degrees F and maximum capacity) and for water heating the average COP ≥ 4 as measured in the laboratory and in actual installations. The prototype would be tested in a mix of

building types, such as single-family, multifamily, and small commercial buildings across various California climate zones (hot and cold climates) and IOU service areas.

Impact if Successful

Increase familiarity of these advanced and innovative low-energy HVAC technology solutions by the building and design community by addressing gaps in knowledge and performance. This would support the wider application of these low-energy HVAC technologies to help achieve aggressive energy reduction.

Incorporating advanced compressor designs, defrost techniques, and other features improves the performance of cold climate heat pumps beyond previous products. This improvement could result in reducing operating costs and increase consumer interest in purchasing and using electric heat pumps for space and water heating.

Primary Users and/or Beneficiaries

Residential and commercial building owners, equipment manufacturers, HVAC contractors

Metrics and Performance Indicators

Efficiency of HVAC (energy savings compared to current state-of-the-art HVAC or standard heat pumps), satisfactory performance based on occupant surveys.

Topic(s) addressed

Technical and Cost Advancements

Value Chain

Demand-side Management

Program Area(s)

Applied Research and Development

Initiative 1.3.2 Develop and Test Electrochemical Compression Systems

Description

Mechanical compressors in cooling equipment are very energy-intensive and have an efficiency around 65 percent. In place of a noisy motor-driven compressor, electrochemical compressors can improve the efficiency by about 30 percent. Hydrogen gas combines with water, ammonia, or another refrigerant and drives the combined working fluid through a standard vapor-compression cycle.

The research would develop and test a working prototype in a California light commercial building and document the energy savings over a year of monitoring. Data will be collected on performance, savings, and operations over various load conditions.

2018-2020 FUNDING INITIATIVES

The Energy Commission's initiatives will focus on areas not included in previous investments to help achieve California's energy and GHG reduction goals. There are two research areas on this topic: 1) develop an advanced manufacturing and installation approach for utility-scaled land-based wind components; and 2) develop a real-time remote monitoring and control system for offshore and land-based wind technologies. ~~The initiatives may solicit proposals for applied research to investigate emerging issues and advance understanding of environmental impacts of offshore wind.~~ The initiatives may also solicit proposals for technology development and demonstration to advance the manufacturing and installation process of land-based wind technology and advance performance of proactive condition monitoring technologies for both onshore and offshore wind energy facilities.

Initiative 4.2.1 Advanced Manufacturing and Installation Approach for Utility-Scale Land-Based Wind Turbine Components

Description

This initiative will fund projects to support advanced manufacturing techniques of wind turbines components and introduce new composite material for wind towers and blades. Taller tower and larger turbine blades present new challenges to the wind industry because larger turbine blades, capable of harnessing more wind energy, increase rotor costs and structural loads on the nacelle, rotor, and tower. Also, the drivetrains must be able to endure greater loads. This initiative could lead to new manufacturing processes for blade shells and wind towers, new design and test innovative drivetrain concepts for more reliable components, and stronger materials for turbine blades and towers. The projects are aimed at improving the performance of wind technology for high and low speed wind sites, while lowering the LCOE of wind energy in California. The DOE Wind Program is concentrating efforts on improved performance, lower costs, and reduced market barriers of wind power. This initiative will leverage DOE's efforts applied to advanced manufacturing techniques to wind turbine components.

Impact if Successful

This initiative could help California achieve its energy and GHG reduction goals by improving the performance of wind technology and exploring untapped areas with lower wind speeds. Advancing manufacturing techniques for larger wind technologies, create opportunities for further LCOE reductions and increase the share of wind energy in the electricity mix.

Primary Users and/or Beneficiaries

The primary direct beneficiaries of the research findings would be land-based wind technology developers and operators. The advanced manufacturing techniques in wind turbine

APPENDICES

APPENDIX A: Summary of Stakeholder Comments and Energy Commission Staff Responses on the February 3, 2017, Scoping Webinar

APPENDIX B: Summary of Stakeholder Comments and Energy Commission Staff Responses on the March and April 2017 Scoping Workshops

APPENDIX C: Summary of Verbal Stakeholder Comments and Energy Commission Staff Responses on the Electric Program Investment Charge Proposed 2018 - 2020 Triennial Investment Plan

[APPENDIX D: Summary of Stakeholder Comments and Energy Commission Staff Responses on the Electric Program Investment Charge Proposed 2018 - 2020 Triennial Investment Plan](#)

These Appendices are available as a separate volume, publication number:

CEC-500-2017-023-APA-C

California Energy Commission
STAFF REPORT

THE ELECTRIC PROGRAM INVESTMENT CHARGE: PROPOSED 2018 – 2020 TRIENNIAL INVESTMENT PLAN

Appendices A-~~DE~~: Stakeholder Comments and Energy
Commission Staff Responses

California Energy Commission
Edmund G. Brown Jr., Governor



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This research can include tool development, system specifications and performance metrics, assessment methodologies to determine energy savings potentials, market alliances and M&V methods.

Discussion and Staff Response to TN216627

Staff agrees that there is a need for developing packages of technologies for retrofit solutions. The best way to develop practical packages is for research-oriented groups to work together with commercial builders and renovation contractors to balance energy development with practical issues of cost, permitting, finance, and construction. Staff expects that these areas would be within the scope of Subtheme 2.4. More experimental, early-stage approaches, including synergies from combinations of technologies, could be developed under initiatives in Theme 1.

Low Global Warming Potential Refrigerants

TN216819 Tom Hutchinson:¹²³

Tom Hutchinson commented support for transitioning to low-GWP refrigeration technologies

TN216820 Kevin Davis:¹²⁴

Kevin Davis commented support for transitioning to low-GWP refrigeration technologies

TN216826 Tristam Coffin:¹²⁵

Tristam Coffin urged the Energy Commission to prioritize funding for low-GWP refrigeration technology

TN216832 Keilly Witman:¹²⁶

Keilly Witman commented support for the transition from high GWP refrigerants to natural refrigerants.

TN216838 Joe Kokinda:¹²⁷

Joe Kokinda commented support for transitioning to low-GWP refrigeration technologies

¹²³ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216819_20170406T083227_Tom_Hutchison_Comments_Support_funding_for_transition_to_lowGWP.pdf

¹²⁴ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216820_20170406T084627_Kevin_Davis_Comments_Support_funding_for_transition_to_lowGWP_t.pdf

¹²⁵ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216826_20170406T093334_Tristam_Coffin_Comments_Support_funding_for_transition_to_lowGW.pdf

¹²⁶ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216832_20170406T110418_Keilly_Witman_Comments_funding_for_research_on_natural_refrigerant_use_in_supe_rmarkets.pdf

¹²⁷ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216838_20170406T122509_Joe_Kokinda_Comments_Support_Low_GWP_Refrigerants_Action.pdf

TN216865 Howell Feig:¹²⁸

Howell Feig urged the Energy Commission to prioritize funding for low-GWP refrigeration technology

TN216875 North American Sustainable Refrigeration Council:¹²⁹

The North American Sustainable Refrigeration Council (NASRC) encouraged the Energy Commission to support the adoption of low-GWP refrigeration technologies. The NASRC comments that adoption of low-GWP technologies has substantial long-term effects on avoided emissions and will help California meet its greenhouse gas reductions goals.

TN216876 Shira Norman:¹³⁰

Shira Norman urged the Energy Commission to prioritize funding for low-GWP refrigeration technology

TN216877 Ky Gruenfeldt-Roy:¹³¹

Ky Gruenfeldt-Roy commented support for funding the transition to low-GWP refrigeration technologies.

TN216878 Andrew Chandler:¹³²

Andrew Chandler commented support for funding low-GWP refrigeration technologies for grocery store industry.

TN216890 Geoff Amos:¹³³

Geoff Amos commented support for funding low-GWP refrigerant solutions for grocery stores.

TN216895 Scott Mitchell:¹³⁴

Scott Mitchell commented support for transitioning to low-GWP refrigeration technologies.

128 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216865_20170407T063202_Howell_Feig_Comments_Support_funding_for_transition_to_low-GWP_technologies.pdf

129 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216875_20170407T115200_NASRC_Comments_Support_funding_for_transition_to_low-GWP_technologies.pdf

130 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216876_20170407T120220_Shira_Norman_Comments_Prioritize_Funding_for_LowGWP_Refrigerati.pdf

131 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216877_20170407T115909_Ky_GruenfeldtRoy_Comments_Support_funding_for_transition_to_low.pdf

132 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216878_20170407T131341_Andrew_Chandler_Comments_Support_funding_for_transition_to_lowG.pdf

133 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216890_20170407T144225_Geoff_Amos_Comments_Funding_for_low_GWP_Refrigerant_solutions_for_Grocery_Stores.pdf

134 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216895_20170407T152741_Scott_Mitchell_Comments_Support_funding_for_transition_to_low-GWP_technologies.pdf

TN216903 Sumner Tison:¹³⁵

Sumner Tison commented support for transitioning to low-GWP refrigeration technologies.

TN216915 Joseph Semiklose:¹³⁶

Jose Semiklose commented support for transitioning to low-GWP refrigeration technologies.

TN216926 Clay Rohrer:¹³⁷

Clay Rohrer urged the Energy Commission to prioritize funding for low-GWP refrigeration technology

T216972 Jim Geers:¹³⁸

Jim Geers commented support for transitioning to low-GWP refrigeration technologies

T216976 Liz Whiteley:¹³⁹

Liz Whiteley urged the Energy Commission to prioritize funding for low-GWP refrigeration technology

Discussion and Staff Response to TN216819, TN216820, TN216826, TN216832, TN216838, TN216865, TN216875, TN216876, TN216877, TN216878, TN216890, TN216895, TN216903, TN216915, TN216926, T216972, and T216976

Research on alternative refrigerants and low global warming potential refrigeration technology is considered under Initiative 1.7.1.

135 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216903_20170407T155004_Sumner_Tison_Comments_Support_funding_for_transition_to_lowGWP.pdf

136 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216915_20170410T101411_Joseph_Semiklose_Comments_Low_GWP_refrigerants.pdf

137 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216926_20170410T151902_Clay_Rohrer_Comments_Low_GWP_Technology.pdf

138 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216972_20170411T202329_Jim_Geers_Comments_Support_funding_for_transition_to_low-GWP_technologies.pdf

139 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216976_20170412T093142_Liz_Whiteley_Comments_Support_for_natural_refrigerants.pdf

Entrepreneurial Support

TN216770 Los Angeles Cleantech Incubator:¹⁶⁹

The Los Angeles Cleantech Incubator (LACI) encourages the Energy Commission to continue support for local stakeholder networks and engagement opportunities which can be leveraged to quickly transform an initial modest investment by the Energy Commission into multi-stakeholder, long-term environmental, economic and social impacts. LACI also recommends that the Energy Commission should take a holistic approach to energy stakeholder engagement that includes engaging and supporting market adoption among key clean energy customer segments.

LACI recommends the Energy Commission continue regularly convening stakeholders, raising awareness of the clean energy sector, hosting workshops to educate interested investors about clean energy, and publishing case studies and technical “roadmap” reports that inform investors about the state and future of the clean energy sector in California.

LACI recommends the Energy Commission explore supporting organizations or partnerships that have a specific focus on and method of funneling clean energy innovation into DACs. As well as build infrastructure and a mechanism for follow-on scaling and replication support after a successful DAC pilot.

Discussion and Staff Response to TN216770

The recommendations provided by LACI fall under the scope of initiatives under theme 5 and theme 8. Theme 5 seeks to expand the energy innovation ecosystem to reach a broader network of stakeholders and support greater clean energy entrepreneurship. Theme 8 seeks to expand clean energy investments in California’s disadvantaged communities.

¹⁶⁹ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN216770_20170330T164922_LACI_Comments_2018-2020_Triennial_Investment_Plan.pdf

APPENDIX D: Summary of Stakeholder Comments and Energy Commission Staff Responses on the *Electric Program Investment Charge Proposed 2018 - 2020 Triennial Investment Plan*

HVAC

TN217243 Paul Raftery:¹⁸⁸

Paul Raftery comments that the supported HVAC technologies identified in Initiatives 1.2.2 and 1.2.3 are often only technologically and economically feasible to deploy in new construction. The median building in the US is about four decades old, and thus these improvements will not have a large impact on building energy consumption until far into the future, even if those technologies gain a large market share immediately. The only initiative that focuses on existing buildings (Initiative 1.2.1) artificially constrains applicants to one particular type of solution; that of improving the building envelope. However, there are other approaches that may yield comparable or larger reductions in HVAC energy use at lower cost. For example, expanded indoor temperature ranges enabled by personal comfort systems and air movement, fault detection and diagnosis and improved control sequences for HVAC systems, even gamification of energy consumption for building operators.

Mr. Raftery proposes that the Energy Commission support solutions that explicitly focus on reducing HVAC energy use in the existing building stock through another subtheme under Theme 1. Given the challenge of finding economically and technically feasible ways to improve the efficiency of the existing building stock, the solicitations should not be constrained to any one particular technology. It may be most effective to have an open call for solutions to this problem. This way, potential applicants will not be deterred from submitting an application, or constrained in how they approach the problem, and the Energy Commission can assess each proposal on its merit - based on its impact, practicality, and economic feasibility. For example, a subtopic such as: Develop Tools and Technologies to Improve Energy Efficiency in Existing Buildings.

Discussion and Staff Response to TN217243

The Energy Commission has expanded Initiative 1.3.1 to include other types of HVAC systems that are appropriate for California climates.

¹⁸⁸ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN217243_20170421T134705_Paul_Raftery_Comments_More_focus_on_technically_and_economicall.pdf

TN217247 Carlos Duarte:¹⁸⁹

Carlos Duarte comments that the energy consumption for cooling has steadily increased over the years due to more buildings becoming internally load driven and hence the need for Subtheme 1.3 (HVAC systems). However, this section focuses only on improving the efficiency of the vapor-compression cycle. The vapor compression cycle is not only energy intensive but also requires a high capital investment to install the needed HVAC components. Mr. Duarte suggests the Energy Commission also focus on addressing mechanical plant and overall building designs that will not require the vapor-compression cycle.

The adiabatic cooling process, as seen in cooling towers, is one potential replacement for the vapor-compression cycle but is highly dependent on weather conditions and the requirements of the distribution system that it serves. Therefore, it can be coupled with the advantages of radiant systems that include: 1) larger heat transfer areas that directly cool occupants through radiation; 2) higher thermal energy transport efficiency and; 3) the ability to effectively engage the building's thermal mass to store and move cooling loads to more favorable weather conditions. Precedent has already been set with the David Brower Center building located in Berkeley, CA, which is a medium-sized commercial office building that does not require a compression cycle for cooling. Instead, it relies on a cooling tower and radiant system approach to provide a comfortable environment to the occupants. However, this is one case, and additional research is needed in the building design and radiant system controls to export this concept to other climates and applications in California. Eliminating the vapor-compression cycle from HVAC systems will reduce energy and water consumption far more significantly than technologies that incrementally improve the efficiency of those existing systems.

Discussion and Staff Response to TN217247

The Energy Commission has expanded Initiative 1.3.1 to include other types of HVAC systems that are appropriate for California climates.

TN217248 Fred Bauman:¹⁹⁰

Fred Bauman suggests the Energy Commission focus on development of advanced low energy, innovative HVAC system solutions and a broader system based approach than the three areas listed in Subtheme 1.3. Mr. Bauman proposes that Energy Commission include another initiative under Subtheme 1.3 (or create a separate Subtheme), with a suggested title of "Development of Advanced Low-Energy, Innovative HVAC System Solutions for Comfortable and Healthy Buildings." There are several advanced low-energy HVAC systems that could be candidates for additional focused research. These include: personal comfort systems, natural ventilation and mixed mode, radiant cooling and heating, chilled beams, underfloor air distribution, and displacement ventilation, systems. Proposals would be aimed at improving fundamental understanding of the technology and using this knowledge to develop new and practical design tools, provide guidance for efficient operation and control that maintains a high indoor environmental quality, and updating of relevant standards and codes.

189 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN217247_20170421T141920_Carlos_Duarte_Comments_More_focus_on_mechanical_plant_designs_w.pdf

190 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN217248_20170421T141110_Fred_Bauman_Comments_Development_of_Advanced_LowEnergy_Innovati.pdf

Discussion and Staff Response to TN217248

The Energy Commission has expanded Initiative 1.3.1 to include other types of HVAC systems that are appropriate for California climates.

Also Initiative 7.3.2 identifies potential research in the public health research roadmap to include energy performance and indoor air quality of passive versus active ZNE building designs.

In addition, the comment proposed several initiatives including a few ventilation solutions including natural ventilation and displacement ventilation. The Energy Commission recognizes the importance of ventilation to indoor air quality and the overall energy efficiency of the building. The Energy Commission has funded many ventilation research projects to improve indoor air quality through both its EPIC and Natural Gas Research Programs. For example, EPC-15-033, Ventilation Solutions for Energy Efficient California Schools: Improving Indoor Air Quality through Advanced, High Performance HVAC. This project will develop and demonstrate approaches to improving ventilation and indoor environmental quality in California Schools. Displacement ventilation is one of the approaches under study in this project. Another project funded under the Natural Gas research program, PIR-14-003, is studying the control of minimum outdoor air ventilation rates in existing and new commercial buildings in California. The Energy Commission also funded a project with UC San Diego (500-10-025, Natural Ventilation for Energy Savings in California Commercial Buildings) that concluded that retrofitting natural or mixed-mode ventilation into California buildings provides both significant energy savings and improved occupant satisfaction with the indoor environment. However, they also found that caution is needed where exposure to excessive particulate matter or ozone may increase the risk of long term health problems.

TN217257 Shichao Liu:¹⁹¹

Shichao Liu comments that developing innovative HVAC solutions for the sleep environment is crucial for both energy reduction and occupant health outcomes. However, the proposed HVAC initiatives focus little on sleep environment. Shichao Liu proposes that the Energy Commission support innovations focusing on HVAC solutions for the sleep environment to reduce energy consumption in residential buildings. Contact base heating (electric blankets) can be an order of magnitude more efficient than air heating. The Energy Commission should also encourage initiatives under Theme 1 to enhance occupants' thermal comfort and sleep quality. Shichao Liu suggests that solicitations encourage smart HVAC solutions (for example, incorporating occupants' feedback in the loop using IoT) to control the micro-environment of a sleeping occupant rather than to heat/cool the entire space.

Discussion and Staff Response

The National Sleep Foundation recommends that room temperatures be set between 60° and 67° F for optimal sleep. Lower temperatures promote deep continuous sleep. The Energy Commission suggests this is a better fit in a consumer education program.

¹⁹¹ http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN217257_20170421T164023_Shichao_Liu_Comments_Smart_energyefficient_HVAC_solutions_for_c.pdf

Healthy Buildings

TN217249 Stefano Schiavon:¹⁹²

Stefano Schiavon comments that the proposed draft subthemes under Theme 1 recognize that California needs healthy and comfortable buildings. However, there are three major limitations:

(a) The goals of healthy and comfortable buildings should be applied to all the solutions that may have an influence on people. For example, Subthemes 1.3 (HVAC systems), 1.4 (control and automation), 2.1 (efficient communities), 3.1 (demand response), 8.1 and 8.2 (disadvantaged communities) do not take into explicit account the building occupants and how they may respond to the proposed solution. Mr. Schiavon suggests having health and comfort in the titles of the sections above, in particular for Subtheme 1.3 and 1.4.

(b) In commercial buildings, the cost of employees is roughly two orders of magnitude higher than the cost of energy, and building management knows this. When applied to commercial buildings, the Energy Commission should assess the impact of energy efficient technologies on worker productivity. This is a key parameter that the private sector would like to know because an energy efficient solution that may have a real (or perceived) negative impact on people will not be implemented. Conversely, if any of a number of types of productivity gain can be documented, a technology will gain an irresistible market driver assuring widespread implementation. Mr. Schiavon suggests adding productivity as a metric and/or performance indicator in all the solutions that could be applied to commercial buildings and that may have an influence on people.

(c) Only occupant satisfaction is present as a "Metrics and/or Performance indicators" in Subtheme 1.2. People well-being, comfort and productivity metrics should be present in all the sections mentioned above.

Discussion and Staff Response to TN217249

For item (a), the Energy Commission can include the goals of healthy and comfortable buildings to Subthemes 1.2, 1.3 and 1.4. Subtheme 1.4.2 addresses the human aspect of design thinking including strategies such as human-in-the-loop controls. Although not explicitly stated, health and comfort are considered part of the human paradigm.

For items (b and c), the Energy Commission can consider including these goals in solicitations that address occupant comfort.

In addition, the Energy Commission has previously funded projects focused on healthy indoor environment. For example, through the Natural Gas Research Program, PIR-14-007, a project titled Health and Efficient New Gas Homes. This project included field study and analysis activity to investigate the changes in indoor air quality associated with further air-tightening. The Energy Commission recognizes the importance on healthy buildings and the need to directly estimate the health effect at various ventilation levels. This topic has just been identified as a future research topic in the February 2017 special issue of Indoor and Built

¹⁹² http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN217249_20170421T135918_Stefano_Schiavon_Comments_More_focus_on_health_wellbeing_and_pr.pdf

Environment editorial on ventilation. Additionally, this area could be considered in Initiative 7.3.2 for the public health research roadmap.

Natural Ventilation

TN217250 Jovan Pantelic:¹⁹³

Jovan Pantelic proposes that the Energy Commission support the use of natural ventilation, through the development of strategies, sensing technologies, and tools that can provide key information in the decision-making process affecting new construction and retrofit in the residential and commercial sector. Jovan Pantelic also proposes that the evaluation matrix takes into account energy, air quality, and thermal comfort.

Discussion and Staff Response to TN217250

The Energy Commission has previously funded a project on natural ventilation (500-10-025, Natural Ventilation for Energy Savings in California Commercial Buildings) for energy saving in commercial buildings. As indicated in response to TN217248, this study concluded that retrofitting natural or mixed-mode ventilation into California buildings would provide both significant energy savings and improved occupant satisfaction with the indoor environment. However, caution is needed where exposure to excessive particulate matter or ozone may increase the risk of long term health problems. As the comment correctly pointed out and the report findings indicate, outdoor pollution levels have a significant impact on use of natural ventilation and that strategies that restrict window use on high-pollution days could reduce negative health impacts and associated costs from exposure to outdoor air ozone and particulates. The Energy Commission has funded a project on smart ventilation (EPC-15-037). This project will include a study on smart control of ventilation based on indoor and outdoor conditions, including pollution levels.

Electric Vehicles

TN217264 CALSTART:¹⁹⁴

CALSTART suggests analysis to establish a viable business case, mitigate high peak charging loads, and recommend adding enough intelligently planned charging infrastructures for medium- and heavy-duty electric and plug-in hybrid electric vehicles (MHDEVs). Given the recent advancements in technology, along with proposed investor-owned utility combined investments totaling \$1 billion in transportation electrification, most of it concentrated on MHDEVs, the timing of such an assessment is critically important to the success of wide spread transportation electrification.

193 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN217250_20170421T142741_Jovan_Pantelic_Comments_Use_of_natural_ventilation_considering.pdf

194 http://docketpublic.energy.ca.gov/PublicDocuments/17-EPIC-01/TN217264_20170421T170313_William_Van_Amburg_Comments_CALSTART_Supplemental_Comments_to_D.pdf

Discussion and Staff Response to TN217264

The California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program is tasked with determining the statewide charging station deployment strategy and is performing modeling and analysis that considers where the vehicles are being deployment and vehicle travel patterns. This analysis will inform charging station deployment plans.

In this EPIC investment plan, the Energy Commission will continue to develop and demonstrate advanced communication controls for PEVs and grid infrastructure, which could facilitate greater charging station rollout and develop a VGI-enabled business case for greater market adoption. There is coordination across these groups.

Proposed awards under the *EPIC 2015 - 2017 Investment Plan* include energy management demonstrations for electric bus transit fleets. Continuing focus on fleet energy management demonstration projects, including for transit and commercial fleets, is envisioned under Initiative 3.2.1. Activities in the proposed *EPIC 2018 - 2020 Investment Plan* under Subtheme 3.2 are envisioned to significantly advance progress toward long-term solutions in the medium- and heavy-duty PEV segment including suites of control technologies, sustainable programs, and combinations of distributed generation and on-site energy storage.