

**DOCKETED**

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# Enabling Building Decarbonization with R&D



Laurie ten Hope  
June 14, 2018  
California Energy Commission  
Energy Research & Development Division



# Getting to 2030 Goals

To summarize the E3 study, California needs:

- Advances in energy efficiency to reduce consumption
- Electrification of energy services in buildings
- More R&D needed for hard to electrify end uses
- Increased renewable power generation to about 70%
- Diversity in renewable energy systems and integrated solutions
- More electric vehicles

The study also finds:

- Consumer behavior is key to realizing decarbonization goals.



# Energy Commission RD&D Programs

Reducing energy use across sectors and prioritizing technologies to optimize low carbon generation

## **Electric Program Investment Charge - \$125M/yr**

- ▶ **Energy Efficiency & Demand Response**
- ▶ **Renewable Energy & Adv. Gen.**
  - ▶ **Smart Communities**
- ▶ **Smart Grid, Storage, DER**
- ▶ **Environmental**
  - ▶ **Climate Adaptation and Infrastructure Risk Reduction**
- ▶ **Electric Vehicle Grid Integration**
- ▶ **Market Facilitation**

## **Natural Gas R&D- \$24M/yr**

- ▶ **Energy Efficiency**
- ▶ **Renewable Energy & Adv. Gen.**
- ▶ **Pipeline Safety**
- ▶ **Environmental**
  - ▶ **Methane Leakage**
  - ▶ **Climate Adaptation and Infrastructure Risk Reduction**
- ▶ **NG Transportation**



# Promoting Low or No-Carbon Alternatives for Energy End Uses



a. High efficiency heat pumps in multifamily retrofits



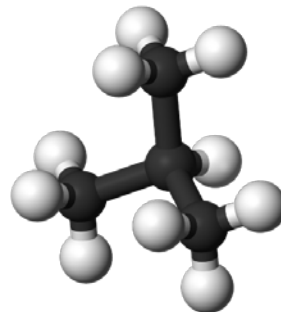
b. Electric heat pumps for space conditioning



c. Central heat pumps in new multifamily buildings



d. Electric hot water heat pumps for new homes



e. Low global warming refrigerants



f. Gas-fired heat pumps for water and air conditioning in restaurants



# Promoting Low or No-Carbon Alternatives for Energy End Uses



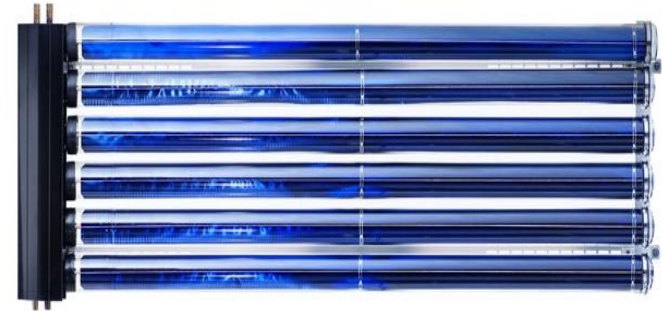
a. Solar thermal and absorption chiller to provide hot water and cooling at a hotel



c. Induction cooking for food service



d. Residential heat pump dryer



b. Evacuated tube solar thermal system at a pharmaceutical plant



e. Ground-coupled heat pumps with helical coil heat exchangers



# Promoting Low or No-Carbon Alternatives for Energy End Uses

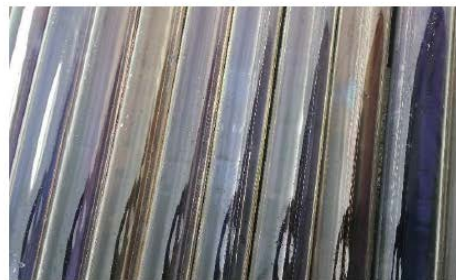
## A Novel Low-Cost, High-Efficiency Solar Powered Micro-CHP System



PV panels  
15%-20%  
Electric Efficiency  
~\$100/m<sup>2</sup>



Solar thermal collectors  
50%-60% Thermal  
Efficiency  
~\$100/m<sup>2</sup>



Solar CHP collector  
15%-20% Electric Efficiency  
50%-60% Thermal Efficiency  
Total cost: ~\$100/m<sup>2</sup>





# Promoting Low or No-Carbon Alternatives for Energy End Uses

## On-Site Electricity Generation from Food Waste



Containerized digester *Flexibuster* at the Navy Base Ventura County

## Innovative, Community-Scale, Organic Waste-to-Energy Facility



HZIU Kompogas high-solids anaerobic digestion system designed to meet SLO County organics diversion goals

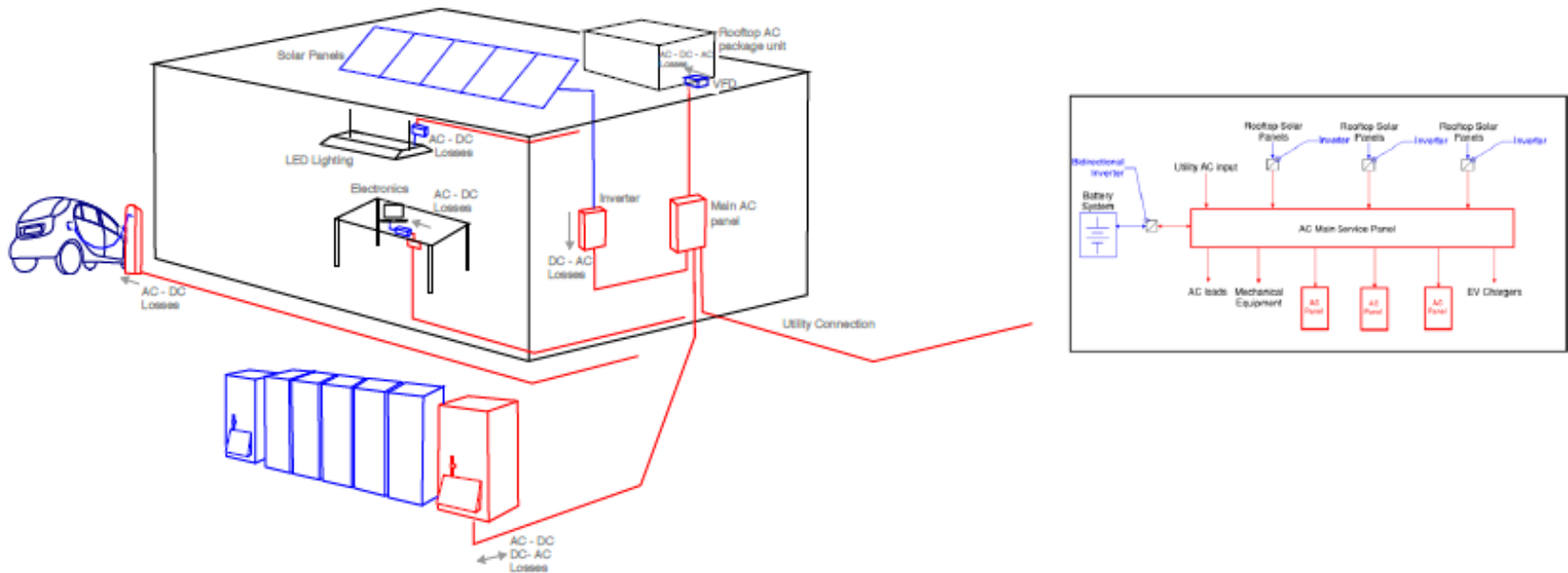




# Direct Current Buildings and Facilities

Much of today's equipment uses direct current (DC). But electricity is delivered using alternating current (AC). Integrating renewable energy production, such as PVs, could enable direct DC use and increase the efficient use of site-generated electricity.

Commercial: AC with PV + EV + BS





# Potential Future Research Areas

- EPIC Investment Plan:
  - HVAC and Water Heating
    - Develop and Test California Climate Appropriate Advanced HVAC Systems, Water Heaters
    - Electrochemical Compression Systems
    - Designing and Manufacturing Improved Heat Exchangers
  - DC Buildings
    - DC Building Distribution Systems to Enable New ZNE Commercial Buildings
    - Development of Cost Competitive, Efficient Hybrid AC/DC Appliances
- Natural gas research – budget plan
  - Increase efficiency from natural gas using facilities
  - Improve building envelopes in existing buildings



# Balancing Building Energy Demand and Grid Needs with DERs



Smart Inverter

Vehicle Grid Integration





# Balancing Building Energy Demand and Grid Needs with DERs

Building-scale

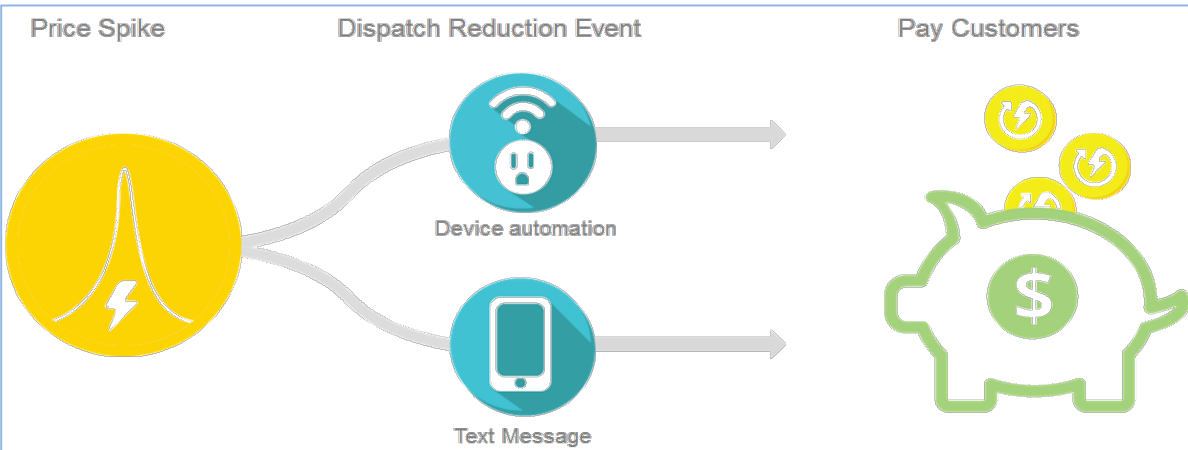


Community-scale



# Increasing Customer Connectivity and Empowerment

*Alternative Energy Systems is automating price-based device management*



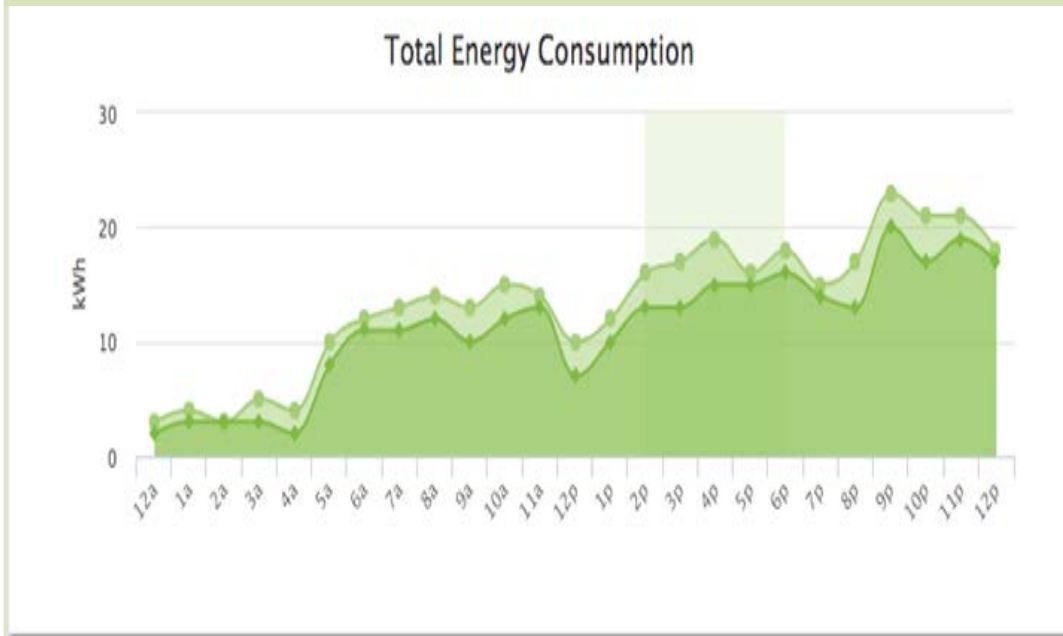
*OhmConnect engages customers using social media and pays them to provide DR with revenue earned by selling their aggregated load reductions into wholesale energy markets*





# Increasing Customer Connectivity and Empowerment

*CIEE is expanding the ability of EMS to control of devices from multiple vendors*



*ZNE Alliance is demonstrating a continuously optimizing EMS at Pomona College*



# Research on Fugitive Methane Emissions in Buildings



**Residential:** Emissions equivalent to ~0.5% of the total sector natural gas consumption





# For More Information on R&D Projects

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CA.GOV CALIFORNIA ENERGY COMMISSION ENERGY INNOVATION SHOWCASE

HOME SEARCH

SEARCH projects

HIGHLIGHTING ENERGY INNOVATION  
**BY THE NUMBERS**

DOLLARS AWARDED  
**\$470 MILLION**

PROJECTS AWARDED  
**279**

MATCH FUNDING  
**\$223 MILLION**

**FEATURED PROJECTS**

**High-Fidelity Solar Power Forecasting Systems for Solar Plants**  
This project will focus on the development and validation of tools capable of monitoring ...  
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**Demonstrating Energy Efficient Drying for Walnuts**  
This project will demonstrate a novel infrared technology for walnut drying at pilot and ...  
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**Advance Wastewater Treatment Using Forward Osmosis**  
This project will demonstrate an advanced water treatment technology that uses ...  
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**Bringing A New Generation of LED Lighting Solutions to Market**  
The purpose of this agreement is to design and develop innovative light-emitting diode ...  
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**City of Fremont Fire Stations Microgrid Demonstration**  
The project will design and build low carbon-based microgrids at three fire stations ...  
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This project will develop low-cost, lowpower, accurate, calibration-free, and compact ...  
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**DISADVANTAGED COMMUNITIES**

**MICROGRIDS**

**WASTEWATER TREATMENT**

**RENEWABLES FORECASTING**

## EPIC Innovation Showcase

► <http://innovation.energy.ca.gov>