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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

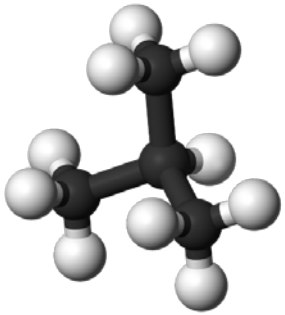
# Promoting Low or No-Carbon Alternatives for Energy End Uses


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

b. Evacuated tube solar thermal system at a pharmaceutical plant

c. Induction cooking for food service

d. Residential heat pump dryer

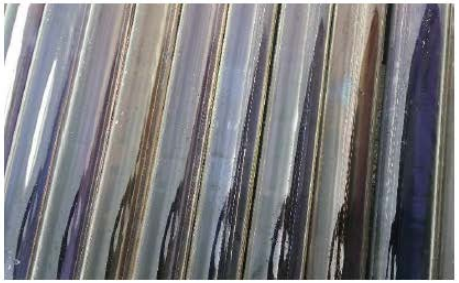
e. Ground-coupled heat pumps with helical coil heat exchangers

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

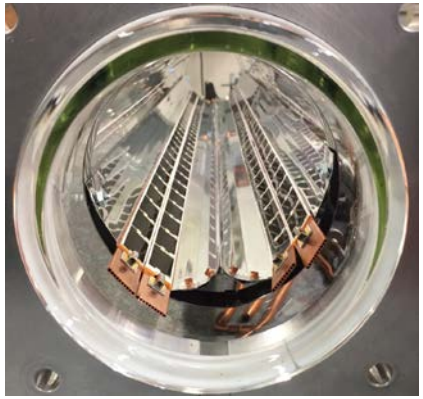
## A Novel Low-Cost, High-Efficiency Solar Powered Micro-CHP System

PV panels
15%-20%
Electric Efficiency
~$100/m$^2$

Solar thermal collectors
50%-60% Thermal
Efficiency
~$100/m$^2$



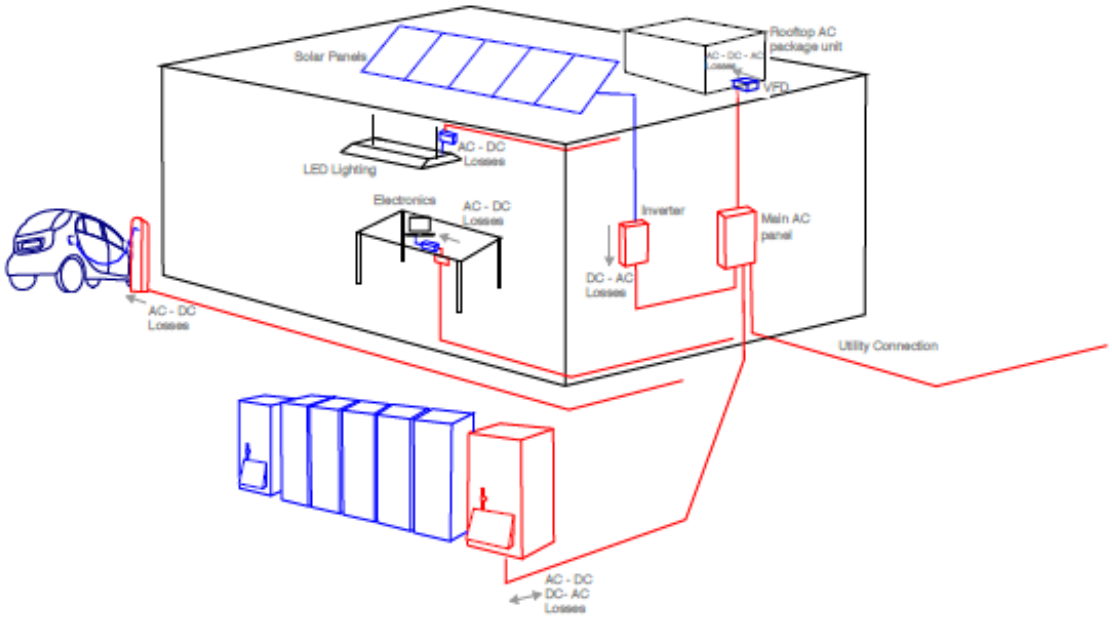
Solar CHP collector
15%-20% Electric Efficiency
50%-60% Thermal Efficiency
Total cost: ~$100/m$^2$

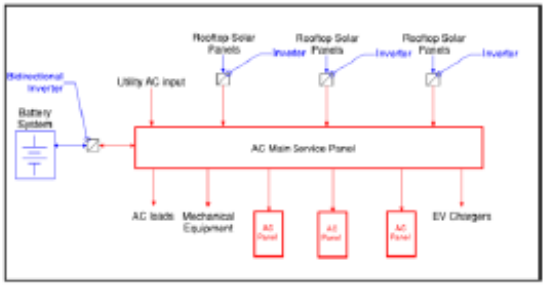


# Direct Current Buildings and Facilities

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


Vehicle Grid Integration

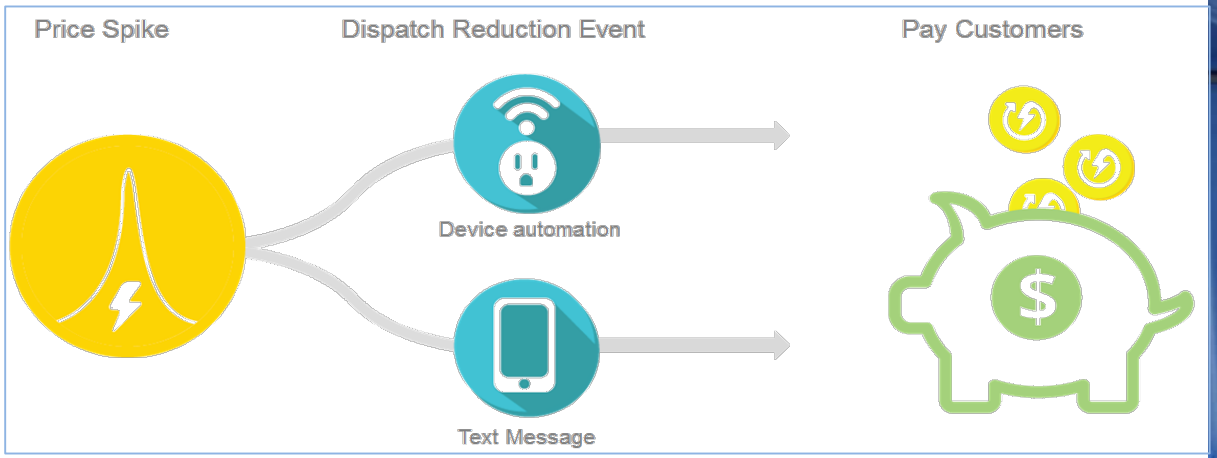

Smart Inverter

# Balancing Building Energy Demand and Grid Needs with DERs

Building-scale


Community-scale

# Increasing Customer Connectivity and Empowerment

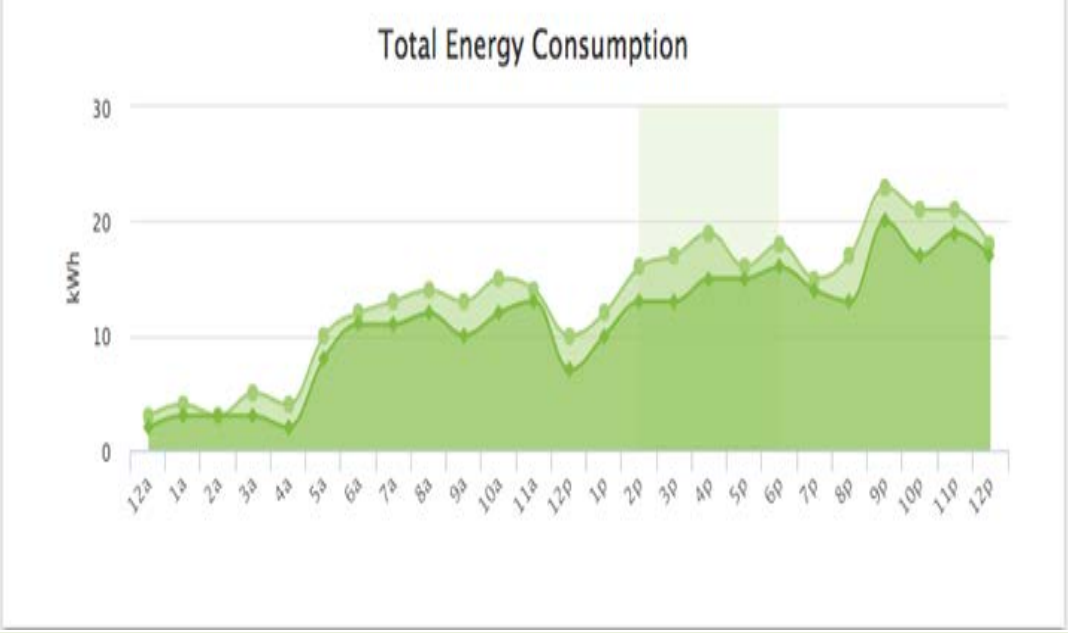



***OhmConnect*** *engages customers using social media and pays them to provide DR with revenue earned by selling their aggregated load reductions into wholesale energy markets*

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

# Increasing Customer Connectivity and Empowerment

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

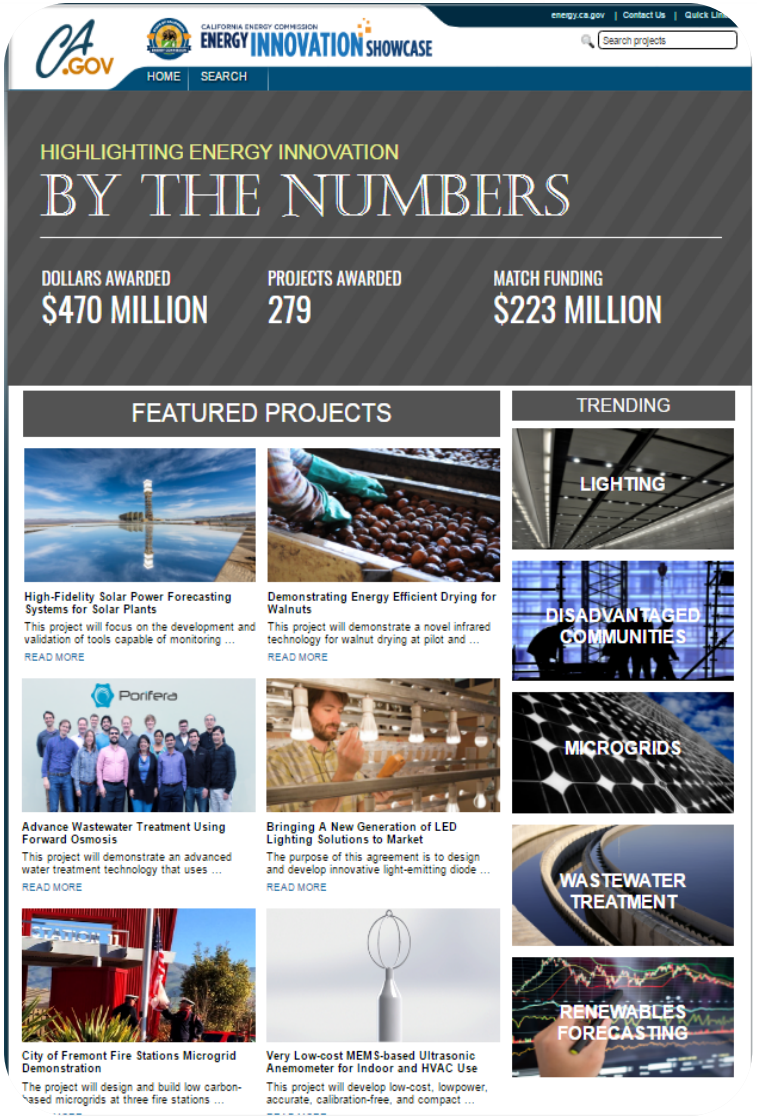



***ZNE Alliance** is demonstrating a continuously optimizing EMS at Pomona College*

# 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




## EPIC Innovation Showcase

- http://innovation.energy.ca.gov