IEc

California Energy Commission EPIC Benefits: Building Energy Efficiency

Presented by: Angela Vitulli
Industrial Economics

Nov. 19, 2020

Presentation Overview

1. Identify key potential benefits associated with EPIC's support of advancing building energy efficiency technologies and construction practices

2. Present IEc's approach to developing a forecast of load reduction and fuel shifting from market adoption

3. Present resulting benefits forecasts

Building EE Grants and Benefit Categories

$169 million, 78 grants:

- Building Envelope
- Lighting
- HVAC
- Fenestration
- Integrated construction
- Integrated controls

Energy Savings (Electricity and Gas) lead to:

On-bill Savings for ratepayers

Savings to Utilities: avoided procurement, avoided peak load and new generation capacity, avoided T&D losses

Social Welfare Benefits:

- Avoided health impacts
- Avoided social cost of carbon

Approach

1. Select technologies from grants 2014-2019
    - **19** grants that received **$41 million**
2. Conduct Delphi panel to predict market adoption of 19 technologies
3. Use model to translate market adoption into energy savings
4. Use energy savings forecast as inputs into benefits tools

Technologies in Delphi Panel- HVAC

HVAC

- Ground source heat pump (helical coil)
- Window mounted heat pump (Treau)
- Hydronic radiant heating/cooling
- Next generation HVAC (variable speed compressor/fan, DR ready, dual fuel, low GWP refrigerant)

HVAC Controls

- Smart ventilation controls
- Integrated thermostat and ceiling fan system

HVAC Related

- Skycool panels
- Magnacaloric refrigerant
- Low cost MEMS-based anemometer

Technologies in Delphi Panel- Non HVAC

- Lighting
  - Ultra Thin Flexible LED panels
  - Flexible, networked lighting controls
- Plug loads
  - Efficient designs for TVs, computers, game consoles
  - Zero net- DC power from PV for hardwired end uses
- Windows
  - Triple paned with low-conductance aluminum frames
  - Energy generating windows (Clear View)
- Cool walls (solar reflective paint mix-in)
- Integrated daylighting/shading system
- Low cost insulated roof deck assemblies for attics (fiberglass or cellulose)
- Commercial foodservice appliance design (induction)

Approach – Overview of Delphi Panel Method

- Delphi Panel is a type of expert elicitation
  - Individual interviews with experts
  - Confidential process
  - Anonymized responses presented to experts in comparative format
  - Follow-up interviews used to move towards convergence
- Emerged in 1950s from decision theory
- Used by many agencies
  - USEPA – regulatory analyses
  - Nuclear Regulator Commission – safety and policy
  - CPUC + NYSERDA – building energy code compliance assessment

Approach – Delphi Panel for this Project

Selected 12 Panelists meeting specified criteria

Panelists reviewed information packet on grants

- Technology description, technical potential, stage of development, target market, cost data, links to EPIC or DOE reports

Phase 1 interviews provided initial market share predictions

Phase 1 report IEc shared anonymized predictions

Delphi Panel –Round 1 Presentation to Experts

Example of **Phase 1 Report**: Cool Walls

Commercial - Existing

Expert	2025	2030	2035	2040	2045	Trend	Rationale
Average	**5%**	**8%**	**12%**	**16%**	**21%**		
Expert A (You)	10%	20%	30%	40%	50%		· Aesthetics are likely to affect market uptake, multi-family and commercial buildings will likely have less resistance to implementing energy efficiency measures that affect exterior building aesthetics.
Expert B	4%	6%	7%	9%	10%		· Commercial buildings are less aesthetically oriented.
Expert C	1%	2%	5%	10%	20%		· Estimates assume this is applicable only to the solar reflective coatings; corrugated aluminum siding proposal is absolute non-starter. · Market uptake will only occur if this is a very cheap option. · This is most beneficial to buildings that are daytime occupied.
Expert D	1%	2%	3%	4%	5%		· Commercial building owners least likely to adopt this technology because they do not pay for cooling costs. · Only beneficial in warmer climate zones.
Expert E	1%	1%	1%	2%	3%		· First cost and lack of color options are both issues. For large buildings, may increase temperatures of surrounding surfaces (parking lots) and cars. Split incentive: less benefit compared to added cost compared to residential market. · Retroreflector described as most promising, but aesthetics and redirected light issues were not addressed; this option not likely to be taken up by market.

Approach – Energy Saving Model

Phase 2 interviews: finalize market share predictions

Final predictions incorporated into the model to estimate energy savings

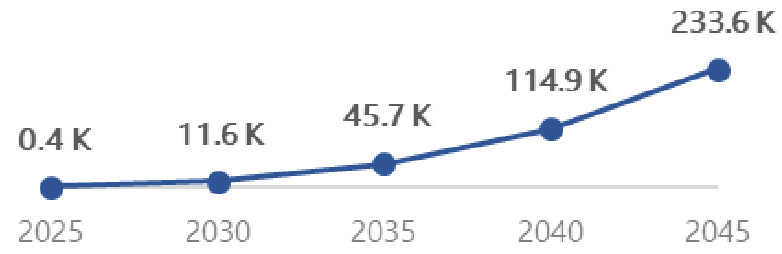
Model Inputs

- Customer end-use sector
- Start year for savings
- Technical potential
- Construction forecasts
- Fuel and electricity prices
- Fuel type
- Electricity rate type
- EUL
- Renovation assumptions (existing buildings)

Results – Gross Energy Savings

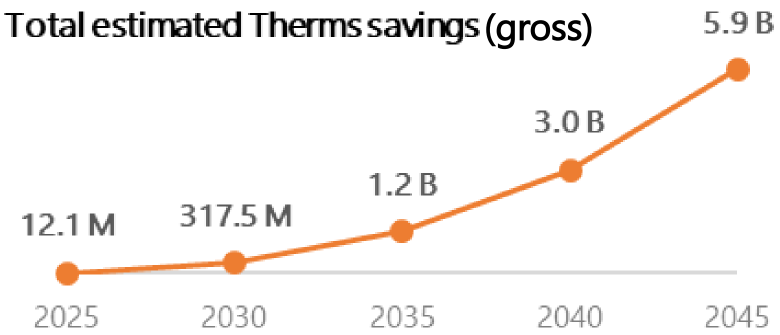
By 2045, cumulative **233,600 GWh reduced electrical load** and **5.9 Billion therms of natural gas** avoided across 19 technologies

Total estimated GWh savings (gross)



GWh	2025	2030	2035	2040	2045
Total	**0.4 K**	**11.6 K**	**45.7 K**	**114.9 K**	**233.6 K**
Residential	0.2 K	4.7 K	17.6 K	42.8 K	83.8 K
Commercial	0.2 K	7.0 K	28.1 K	72.2 K	149.8 K

Total estimated Therms savings (gross)



Therm	2025	2030	2035	2040	2045
Total	**12.1 M**	**317.5 M**	**1.2 B**	**3.0 B**	**5.9 B**
Residential	8.4 M	212.9 M	793.0 M	1.9 B	3.7 B
Commercial	3.7 M	104.5 M	416.9 M	1.1 B	2.2 B

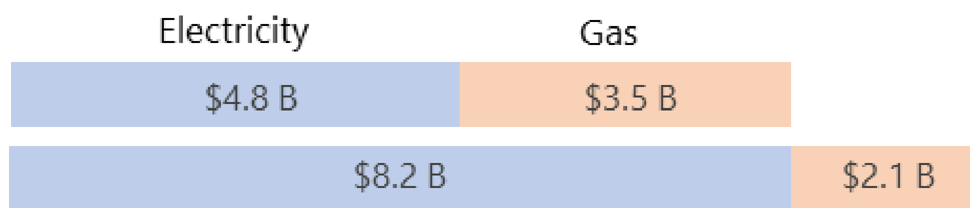
Results – On-bill Savings

$

Total estimate for all markets and energy sources at 7% discount rate:

$18.6 Billion

On-bill Savings	Electricity	Gas
Total	**$13.0 B**	**$5.6 B**
Residential	$4.8 B	$3.5 B
Commercial	$8.2 B	$2.1 B



Results - System-Level Avoided Costs

Total estimate for all markets with 7% discount rate:

$7.8 Billion

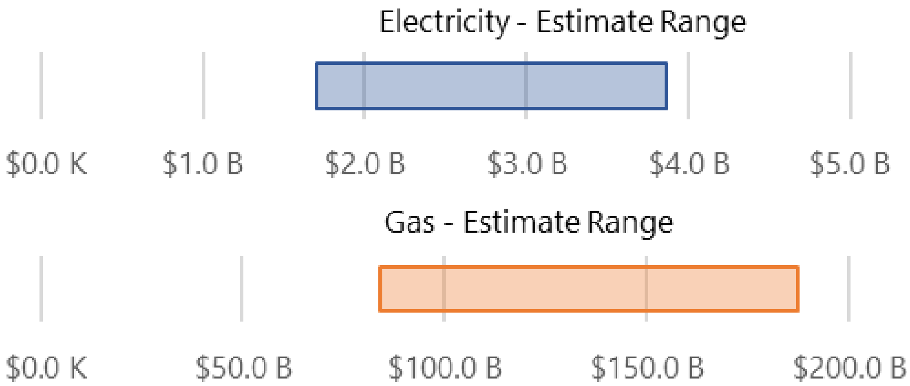
System Level Avoided Costs	
Total	**$7.8 B**
Residential	$2.9 B
Commercial	$4.9 B

Results – Health Effects

Total estimate for all markets and energy sources at 3% discount rate:

$85.9 -191.0 Billion

Health Effects - All Pollutants and Sectors	Low	High
Total	**$85.9 B**	**$191.0 B**
Electricity	$1.7 B	$3.9 B
Gas	$84.2 B	$187.2 B

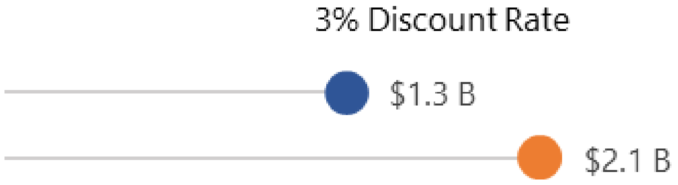


Results – Social Cost of Carbon

Total estimate for all markets and energy sources at 3% discount rate:

$3.4 Billion

Social Cost of Carbon				
	2.5%	3%	5%	95th Per.
Total	**$2.2 B**	**$3.4 B**	**$527.6 M**	**$6.7 B**
Electricity	$857.2 M	$1.3 B	$206.7 M	$2.6 B
Gas	$1.3 B	$2.1 B	$320.9 M	$4.1 B



Results - First Cost Scenario Analysis

First costs scenarios with 7% discount rate:

$4.4 -8.9 Billion

Benefits to Rate Payers and Utilities: **$26.4 Billion**

Social Welfare Benefits: **$89.3 – 194.4 Billion**

Compare to CEC Investment: **$41 Million** for 19 Technologies, **$169 Million** for all Building EE Investments

IEc

Questions?

Angela Vitulli
AVitulli@indecon.com
617-354-0074

Building EE Grants Included in Analysis

Number	Title
EPC-14-012	Comparing Attic Approaches for Zero Net Energy Homes
EPC-15-019	Low cost helical coil Ground Heat Exchanger
EPC-15-024	Zero Net Energy Plug Loads
EPC-14-009	Optimizing Radiant Systems for Energy Efficiency and Comfort
EPC-16-013	Integrating Smart Ceiling Fans and Communicating Thermostats to Provide Energy-Efficient Comfort
EPC-15-027	Electric Plug Load Savings Potential of Commercial Foodservice Equipment
EPC-14-010	Solar-Reflective "Cool" Walls: Benefits, Technologies, and Implementation
EPC-14-013	Very Low-cost MEMS-based Ultrasonic Anemometer for Use Indoors and in HVAC Ducts
EPC-18-003	Ultra-thin Flexible LED Lighting Panels
EPC-16-032	Leading in Los Angeles: Demonstrating Scalable Emerging Energy Efficient Technologies for Integrated Façade, Lighting and Plug Loads
EPC-14-021	Development and Testing of the Next Generation Residential Space Conditioning System for California
EPC-18-025	Scale-up of magnetocaloric Materials for High Efficiency Magnetic Refrigeration
EPC-14-066	High-Performance Integrated Window and Facade Solutions for California Buildings
EPC-14-017	Developing Flexible, Networked Lighting Control Systems That Reliably Save Energy
EPC-15-037	Smart Ventilation for Advanced California Homes
EPC-15-021	Mobile Efficiency for Plug Load Devices
EPC-18-019	Low-GWP, high-efficiency heat pump and air conditioner
EPC-18-006	Radiative Sky Cooling-Enabled Efficiency Improvements on Commercial Cooling Systems
EPC-18-004	Accelerating Commercialization of Advanced Energy Efficient Windows