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# Greenhouse Gas Abatement with Distributed Generation in California's Commercial Buildings

**Chris Marnay, Michael Stadler, Tim Lipman, Judy Lai, Gonçalo Cardoso, and Olivier Mégel**

**Environmental Energy Technologies Division**

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***http://eetd.lbl.gov/EA/EMP/emp-pubs.html***

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# Greenhouse Gas Abatement with Distributed Generation in California's Commercial Buildings

**Keywords:** carbon emissions, climate change, combined heat and power, commercial buildings, distributed generation, microgrids

**Project started:** January 2009
**Team:** Chris Marnay, Michael Stadler, Tim Lipman, Judy Lai, Gonçalo Ferreira Cardoso, Olivier Mégel
**Project partner:** University of California, Berkeley

## *Motivation & Objective for this Research*

**to determine the role of distributed generation (DG) in greenhouse gas reductions by**

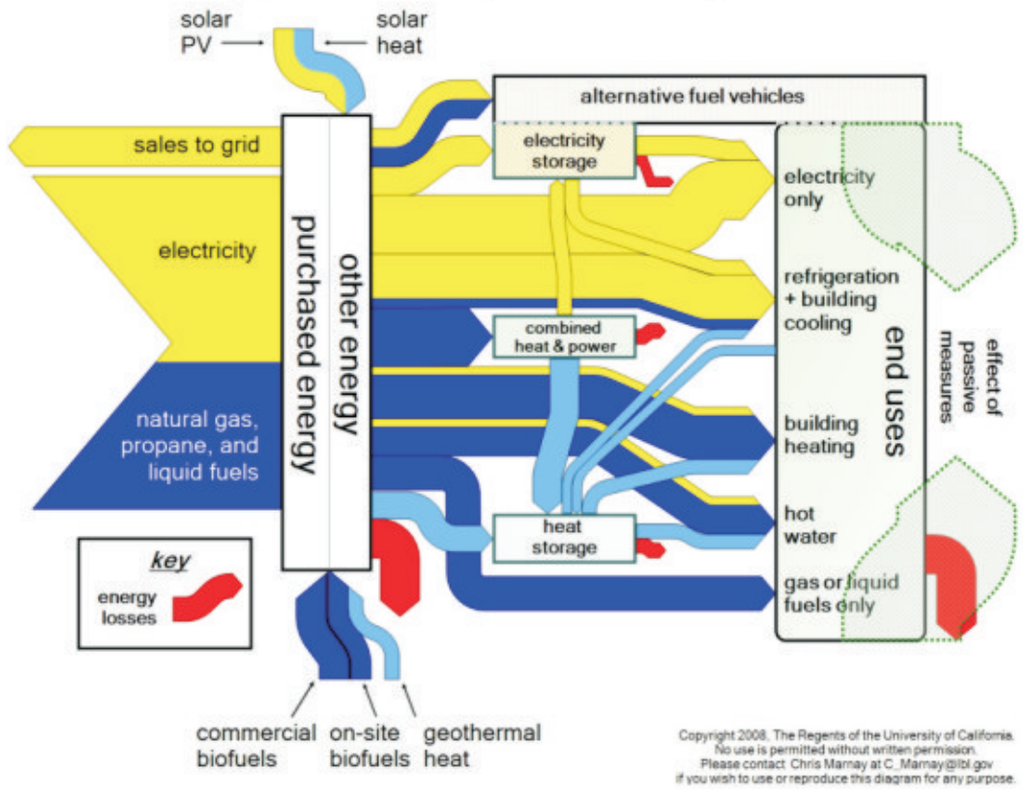
- **applying the Distributed Energy Resources Customer Adoption Model (DER-CAM)**
- **using the California Commercial End-Use Survey (CEUS) database for commercial buildings**
- **selecting buildings with electric peak loads between 100 kW and 5 MW**
- **considering fuel cells, micro-turbines, internal combustion engines, gas turbines with waste heat utilization, solar thermal, and PV**
- **testing of different policy instruments, e.g. feed-in tariff or investment subsidies**

## *Distributed Energy Resources Customer Adoption Model (DER-CAM)*

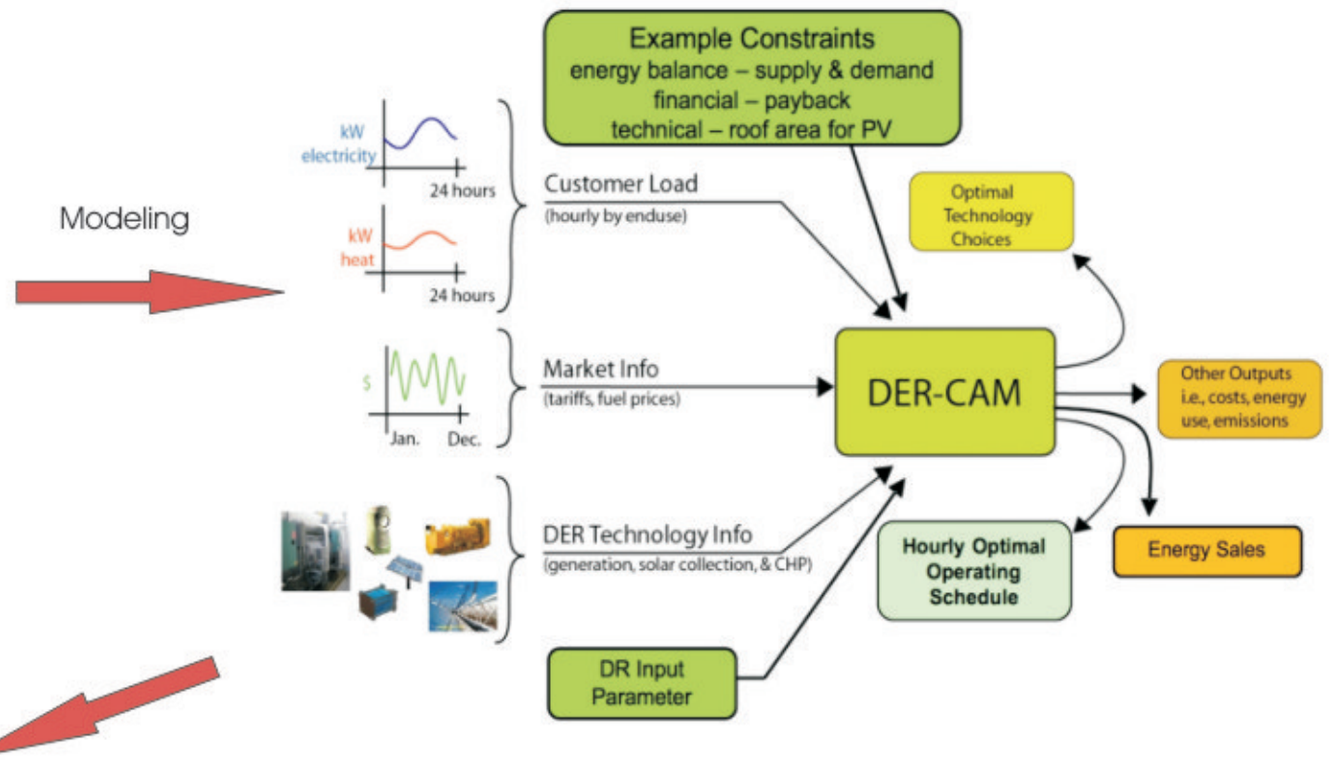
DER-CAM optimization techniques find both the combination of equipment and its operation over a typical year that minimizes the site's total energy bill, including amortized capital costs, or $CO_2$ emissions by considering

- hourly load profiles for electric, heating, cooling, and natural gas loads
- any onsite technology that can be described by capital costs, O&M costs, efficiency, etc.
- building / microgrid energy balance
- operating constraints, e.g. solar radiation
- regulatory constraints, e.g. $CO_2$ prices / taxes or zero-net energy buildings

Schematic of the Energy Flow in a Building - Global Concept




High Level Schematic of DER-CAM



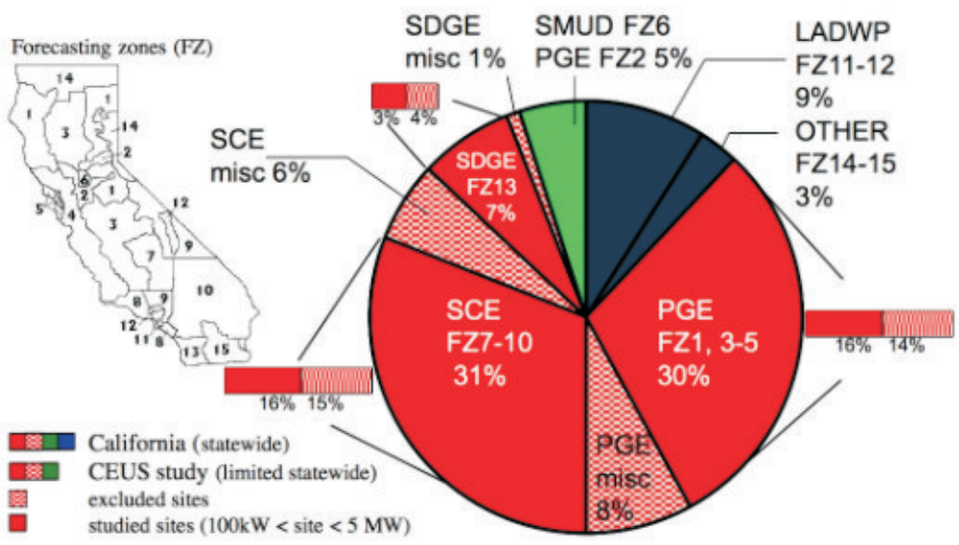

## *California Commercial End-Use Survey (CEUS) database*

CEUS database contains 2790 premises from PG&E, SMUD, SCE, and SDG&E service territories:

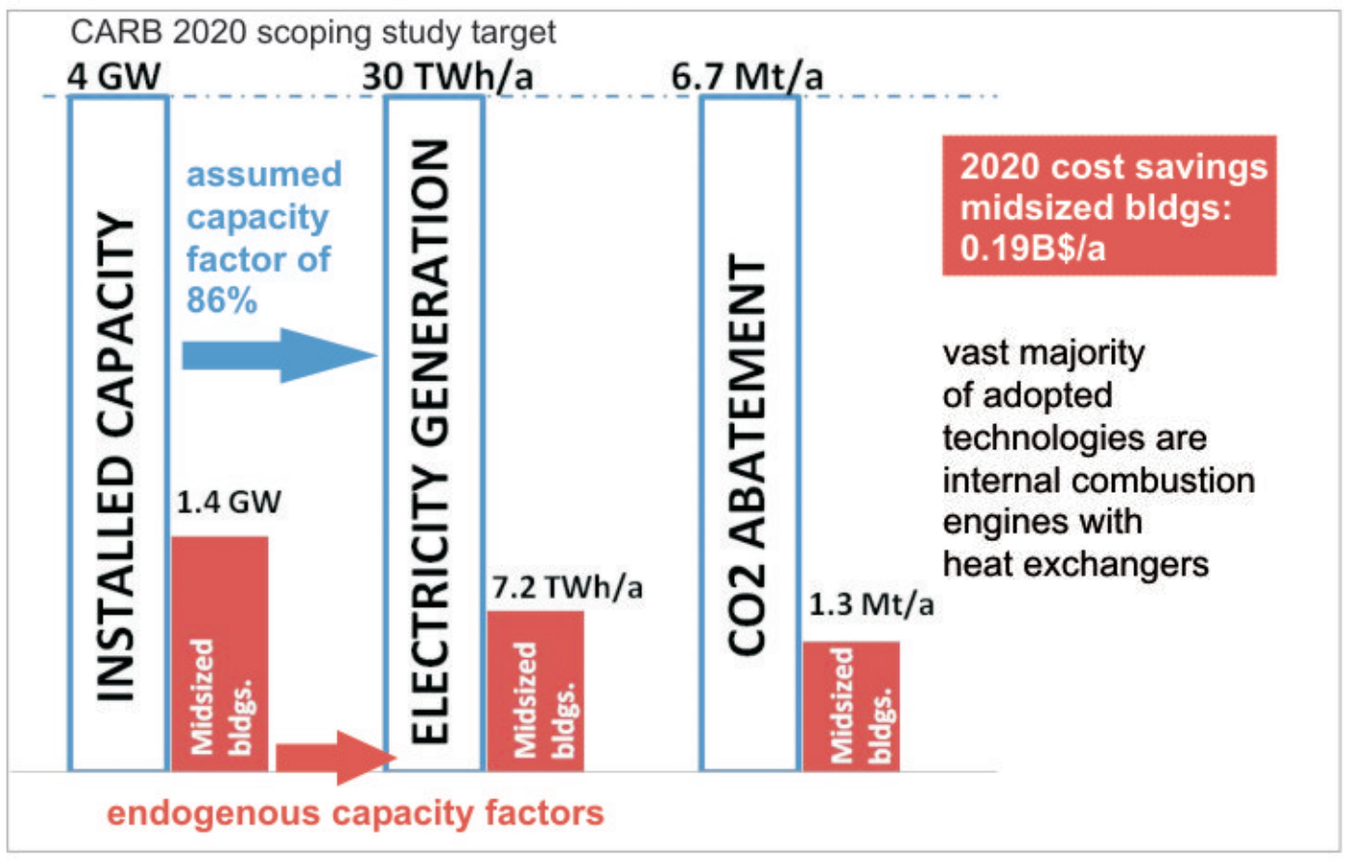
- 12 building types, e.g. schools, colleges, hotels, warehouses, etc.
- 12 forecasting Climate Zones (FZ); using 10 year normalized weather sample; containing simulated hourly estimates of end-use electricity and natural gas consumption
- eQUEST simulations (frontend tool for DOE2)

35% of commercial electric demand considered

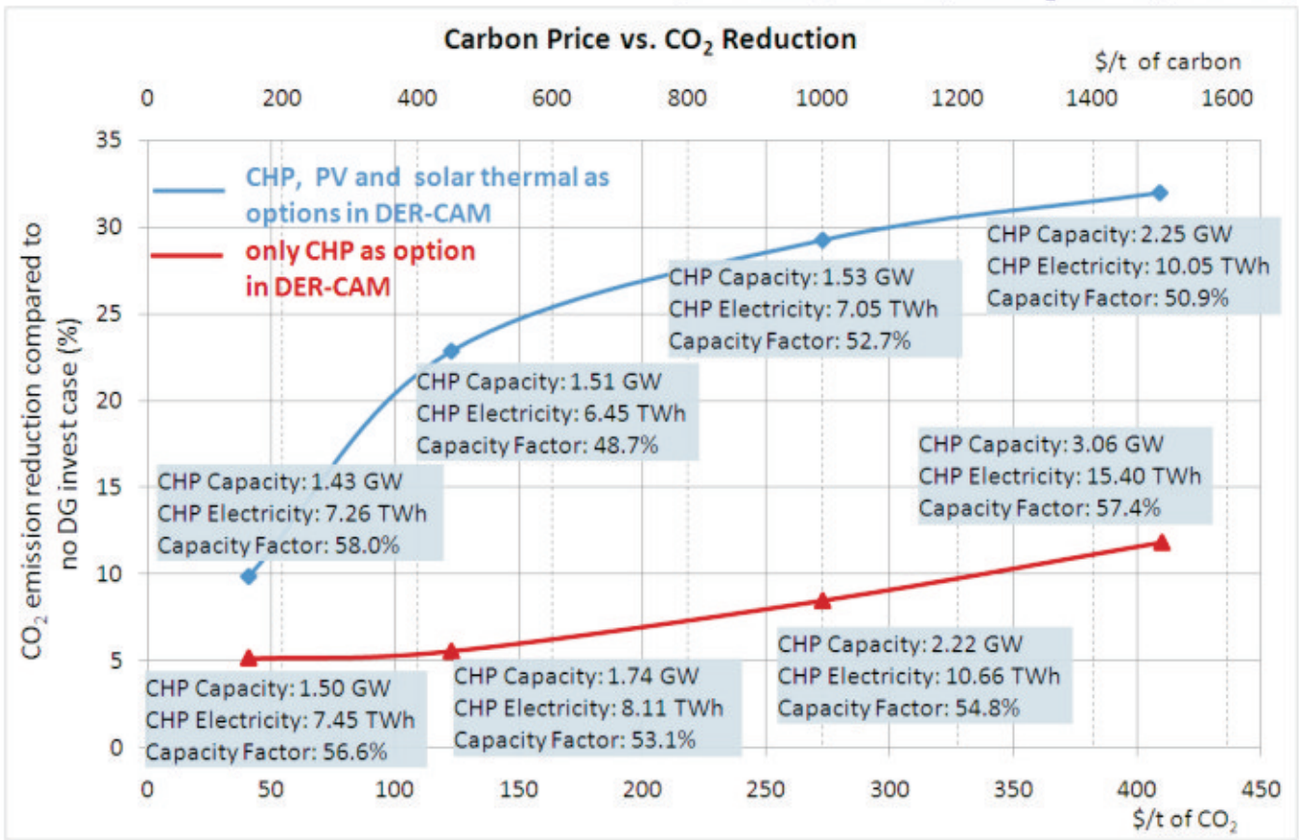
- buildings between 100 kW and 5 MW electric peak load are considered
- no miscellaneous building types
- SMUD and LADWP are not considered



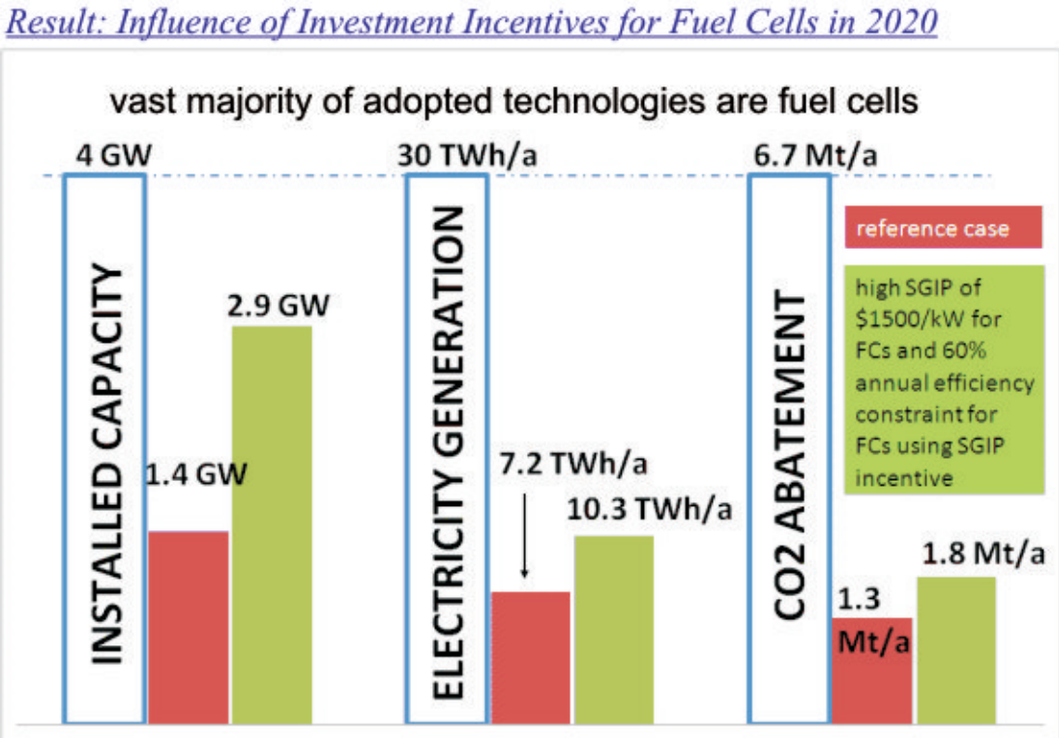

## *Result: Reference Case in Comparison to California Air Resources Board's (CARB) 2020 Goal*




## *Result: Influence of a $CO_2$ Pricing Scheme*




## *Result: Influence of Investment Incentives for Fuel Cells in 2020*

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Project contacts:
Chris Marnay, Project lead, C_Marnay@lbl.gov
Michael Stadler, Technical Lead, MStadler@lbl.gov, http://der.lbl.gov
Tim Lipman, telipman@berkeley.edu, www.chpcenterpr.org

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