Household Energy Consumption Effects of PG&E's Electrical Efficiency Rebate Program

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Working paper

Carnegie Mellon University
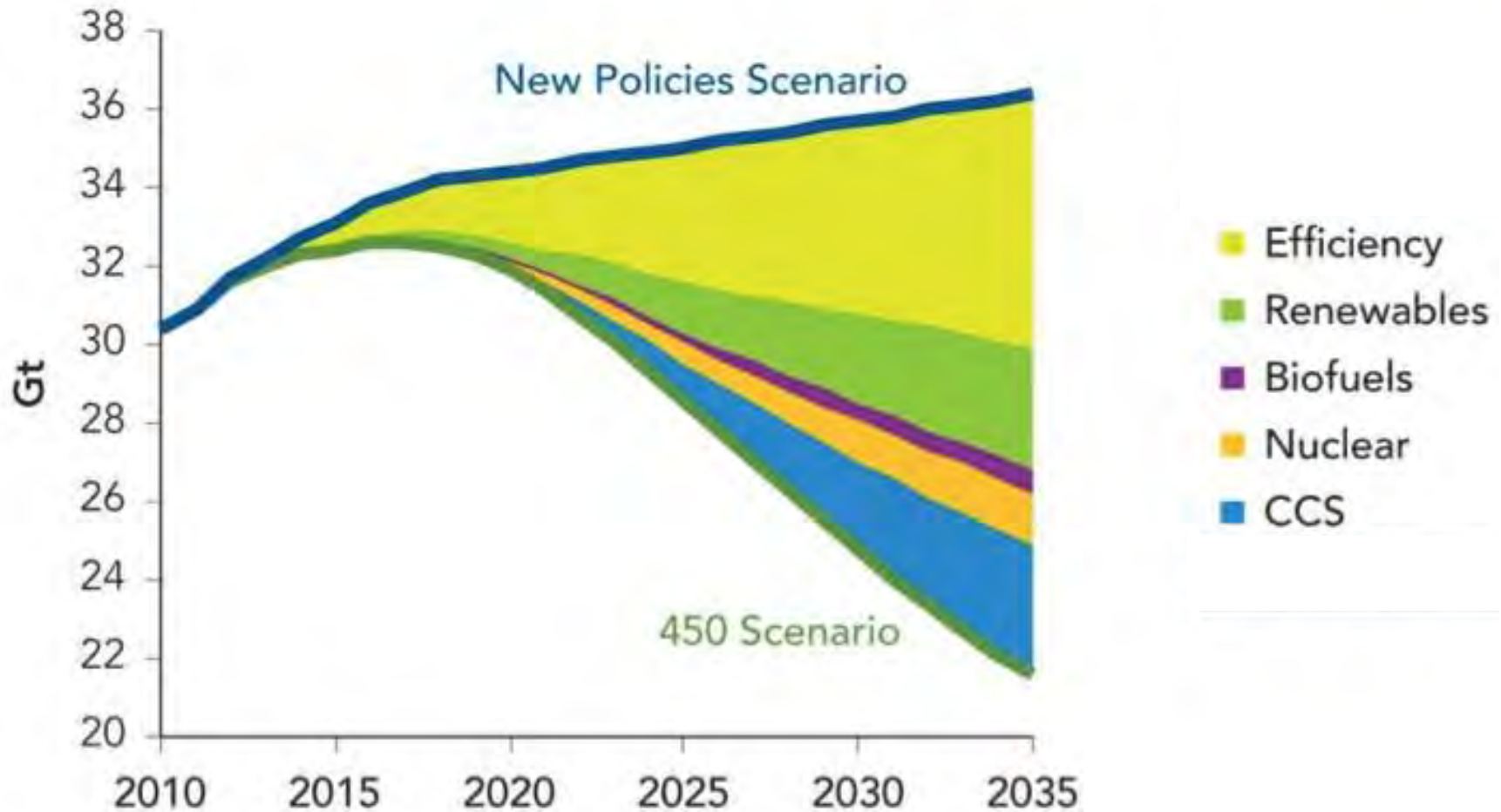STEINBRENNER INSTITUTE
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Do rebates for efficiency measures reduce energy consumption?

?

We need efficiency, and lots of it

Source: IEA, 2013, Energy Efficiency Market Report

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EE rebates can backfire

Source: us-machine.com

- Many utilities subsidize efficiency measures through rebates
- Sometimes this is very effective
  - Refrigerators (Davis et al 2014)
- Sometimes not
  - Air conditioners (Davis et al. 2014)
- We find that EE rebates are associated with increased energy consumption for a broad range of EE measures

Source: greenlivingideas.com

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Panel of AMI data from PG&E

- 30,000 randomly-selected households
  - 10,000 from Coast, Central Valley, and Inland Hills
- Hourly electricity consumption
- Rebate application, approval
- Program enrollment
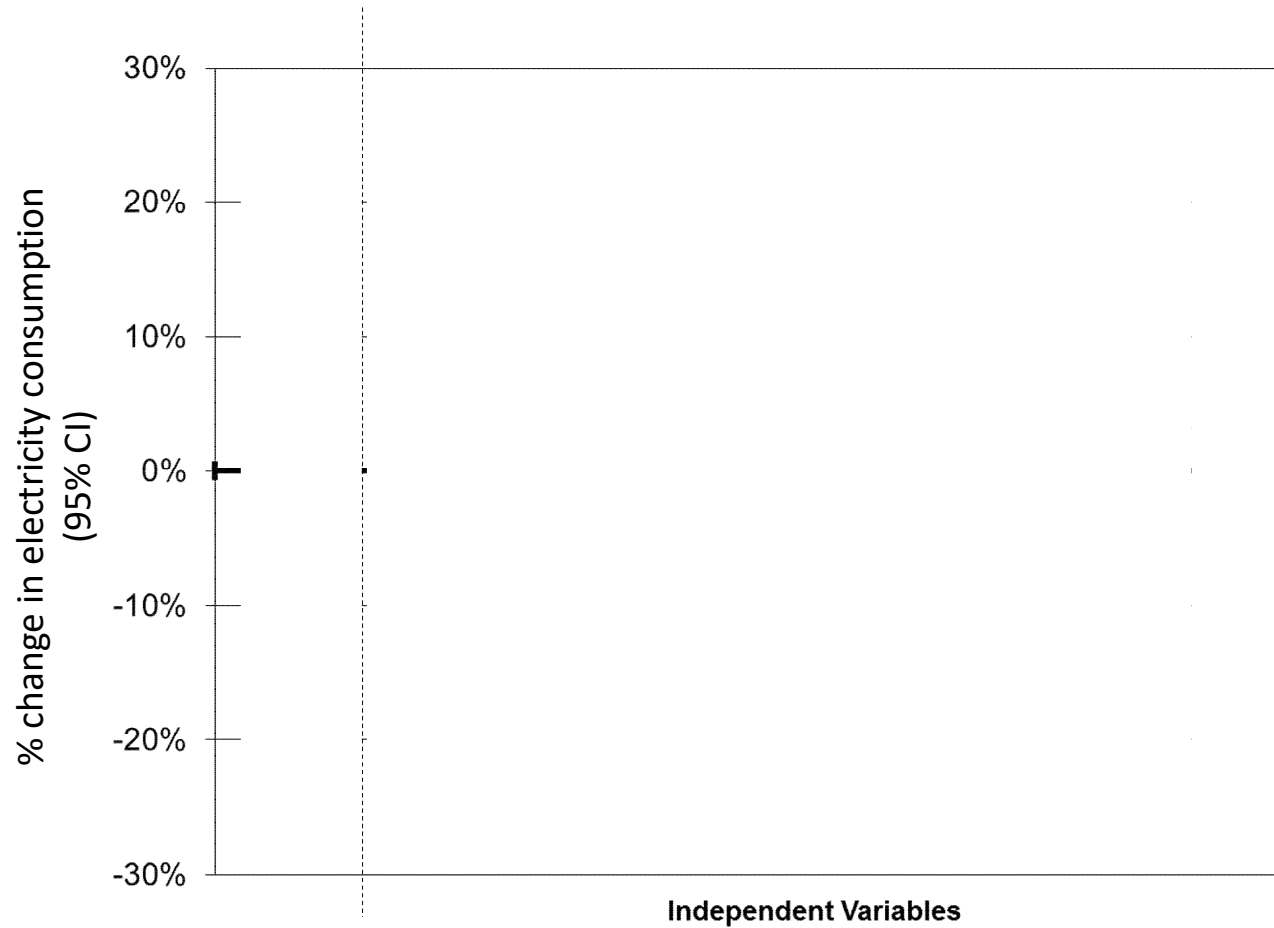- Census block: Temperature

Climate Zones
Coastal
Inland Hills
Central Valley

Source: Wharton Consumer Analytics Initiative

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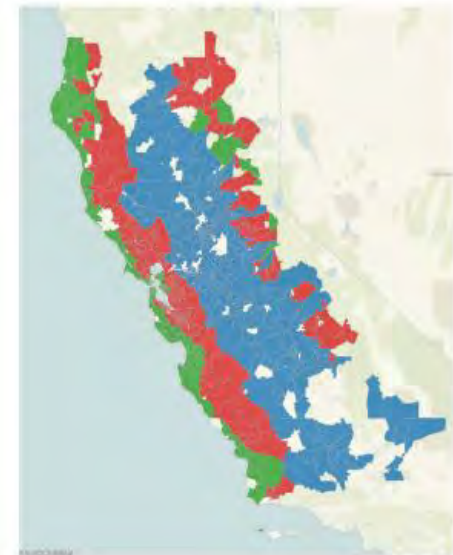
Household-level fixed-effects model

Rebates correlate with higher energy consumption

Design incentives carefully and evaluate!

- Avoid subsidizing new energy services.
  - Recycling requirements can help avert this.
- Careful evaluation of EE programs is critical.
- Ex-post evaluations can help us learn from the past.
- More RCT studies would be ideal.
- Pay-for-performance using AMI data can ensure only performing EE measures are compensated.

Acknowledgments

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Works Cited

- Energy Efficiency Market Report. International Energy Agency. 2013
- Davis, Lucas W.; Fuchs, Alan; Gertler, Paul J. Cash for Coolers: Evaluating a Large-Scale Appliance Replacement Program in Mexico", American Economic Journal: Economic Policy, vol. 6, no. 4, November 2014 (pp. 207-38).

PG&E Smart Meter Program

- PG&E began the roll out of smart meters to residential consumers in early 2008.

- Smart meters communicate 15-minute energy readings back to a base station, from which they are then relayed back to PG&E.

- There was no option to allow customers to opt-out of having a smart meter installed over the period of the data set.

- There were no dropouts in the program other than for households in which the customer moved.

- Households are identified by a service point id (for the location) and an account id (for the customer).
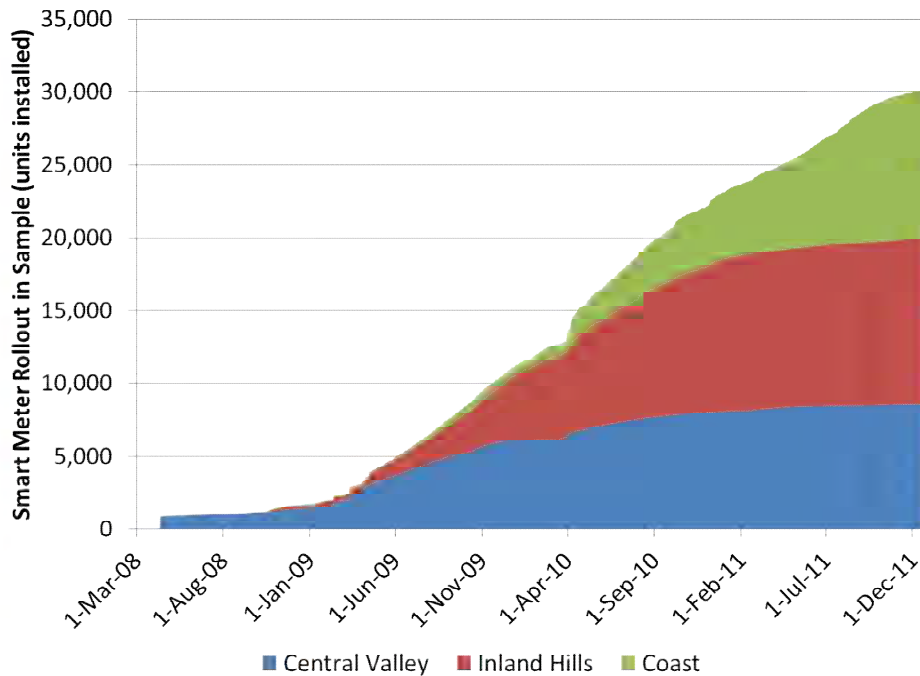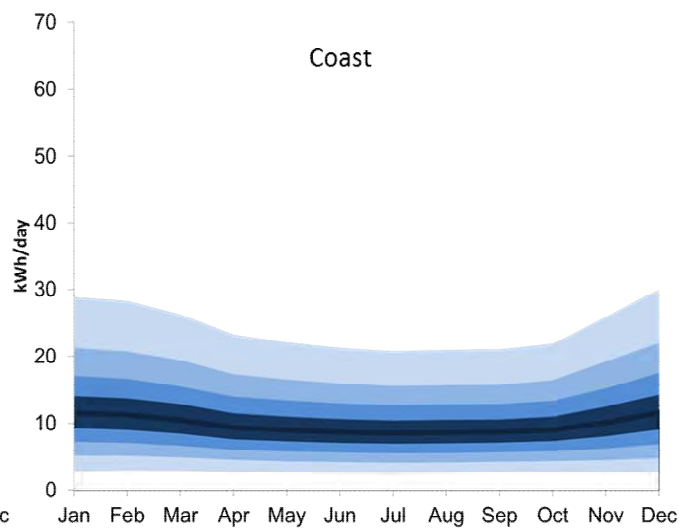
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Smart meter data

Climate Zones
Coastal
Inland Hills
Central Valley

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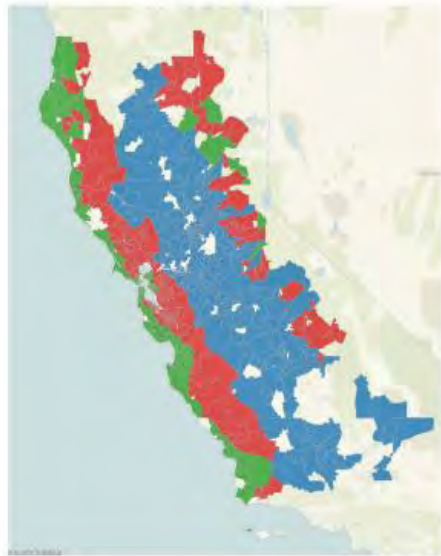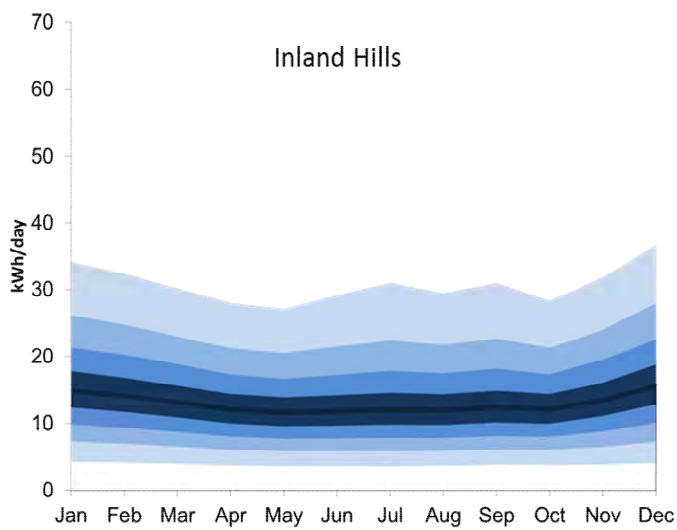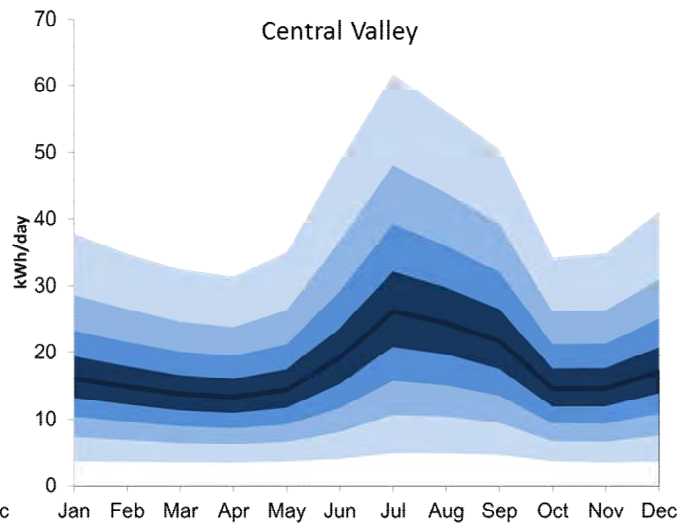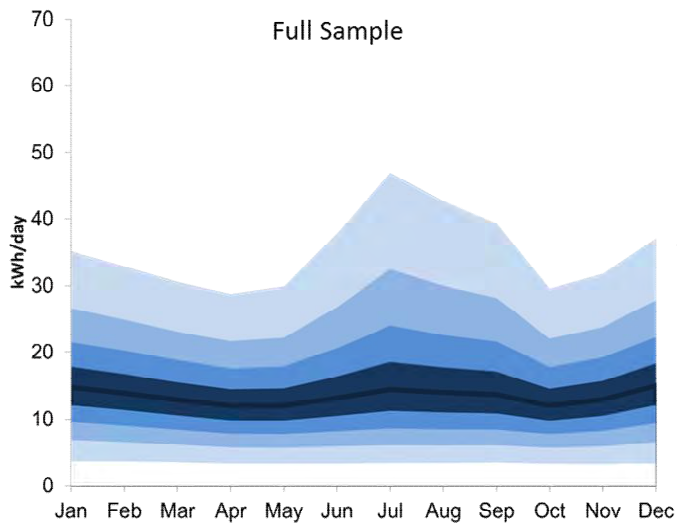
The rebate program

- Efficiency rebates are awarded following the purchase of qualifying equipment and application by the customer to PG&E.

- Rebate program existed before and during our entire observation period.

- PG&E makes applications available to its customers on its website as well as via a mail-in form.

- The rebates are funded via a "public goods charge", which is included in the electric rate base by the California Public Utilities Commission.

- Households are eligible to participate in the rebate program multiple times.

|	Rebate Code	Product	Catalog Page #	Install Date	Product Information		Quantity Installed (A)	Rebate per Unit (B)	RebateTotal (A x B)
Appliances	B34	**High Eff. Clothes Washer** CEE Tier 3, MEF ≥ 2.2, WF ≤ 4.5	1		Manufacturer _____	Model # _____	_____ unit(s)	$50 per unit	$
	DW03	**High Eff. Dishwasher** ≤ 324 kWh/yr., ≤ 5.8 gal/cycle	1		Manufacturer _____	Model # _____	_____ unit(s)	$30 per unit	$
	DW06	**Super High Eff. Dishwasher** ≤ 307 kWh/yr., ≤ 5.0 gal/cycle	1		Manufacturer _____	Model # _____	_____ unit(s)	$50 per unit	$
	H169	**ENERGY STAR® Room Air Conditioner**	1		Manufacturer _____	Model # _____	_____ unit(s)	$50 per unit	$
	H722	**Natural Gas Tank Water Heater Level 1** (EF = 0.62 to 0.64)	2		Manufacturer _____	Model # _____	_____ unit(s)	$30 per unit	$
	H721	**Natural Gas Tank Water Heater Level 2** (EF ≥ 0.65)	2		Manufacturer _____	Model # _____	_____ unit(s)	$50 per unit	$
	H154	**Electric Storage Water Heater** EF ≥ 0.93	2		Manufacturer _____	Model # _____	_____ unit(s)	$30 per unit	$

Energy efficiency rebate applications over time
## About **3500** households applied for at least one rebate.
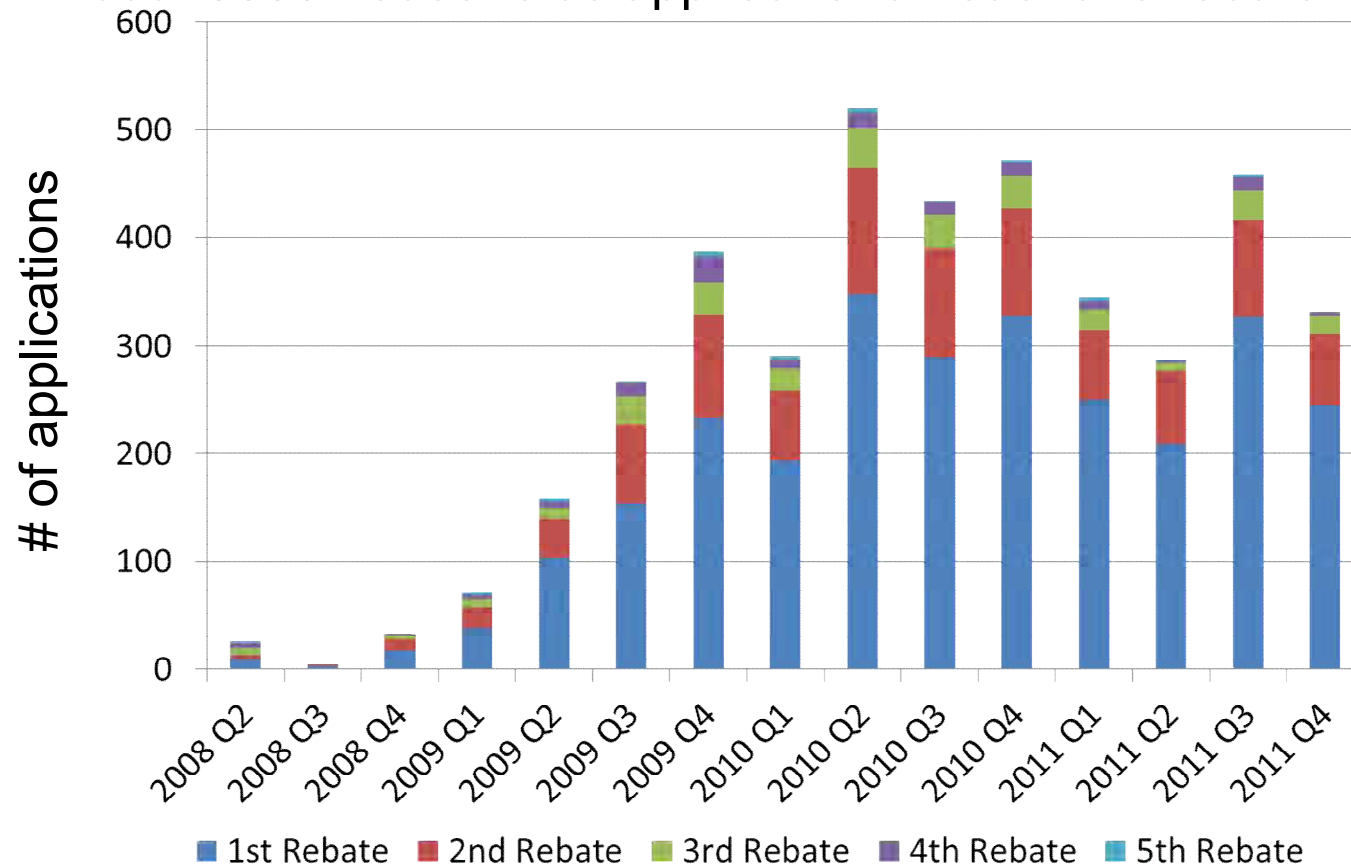
Other programs

Program	Max Part.	Description
BPP	2,407	Balanced Payment Plan: Provides a bill smoothing service, in which PG&E calculates the household's average monthly utility bill and the customer pays a flat amount for each monthly billing cycle. This value is an average annualized value
CARE	10,137	CA Alt. Rates for Energy: Provides subsidies to household's monthly energy bills based on income and occupant criteria.
Climate Smart	148	Households can voluntarily opt-in to purchasing carbon-offsets through PG&E with their monthly utility bill
Direct Access	668	Allows customers to purchase their electricity from alternative (non-PG&E) power providers, using PG&E as the distribution company (New customers have not been able to join the Direct Access program since the California energy crisis in 2001, though existing customers have been able to remain in the program)
Smart AC	1,069	Allows customers to voluntarily opt-in to a central AC curtailment program during peak-load events during the summer cooling season.
Smart Rate	154	Lower average electricity tariff (¢/kWh reduction) in exchange for accepting a higher rate (60¢/kWh) during peaking hours in some days during the summer cooling months. (these days are communicated to the consumer a day ahead via text, email, or by phone)

Estimating energy consumption effects
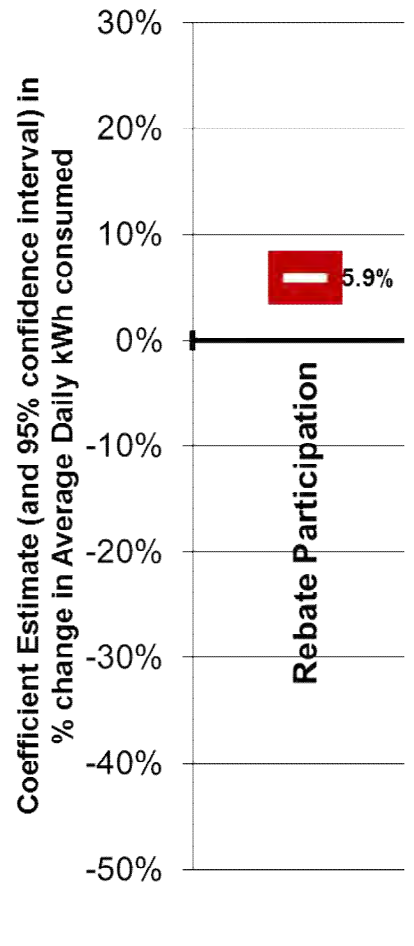
Estimating energy consumption effects
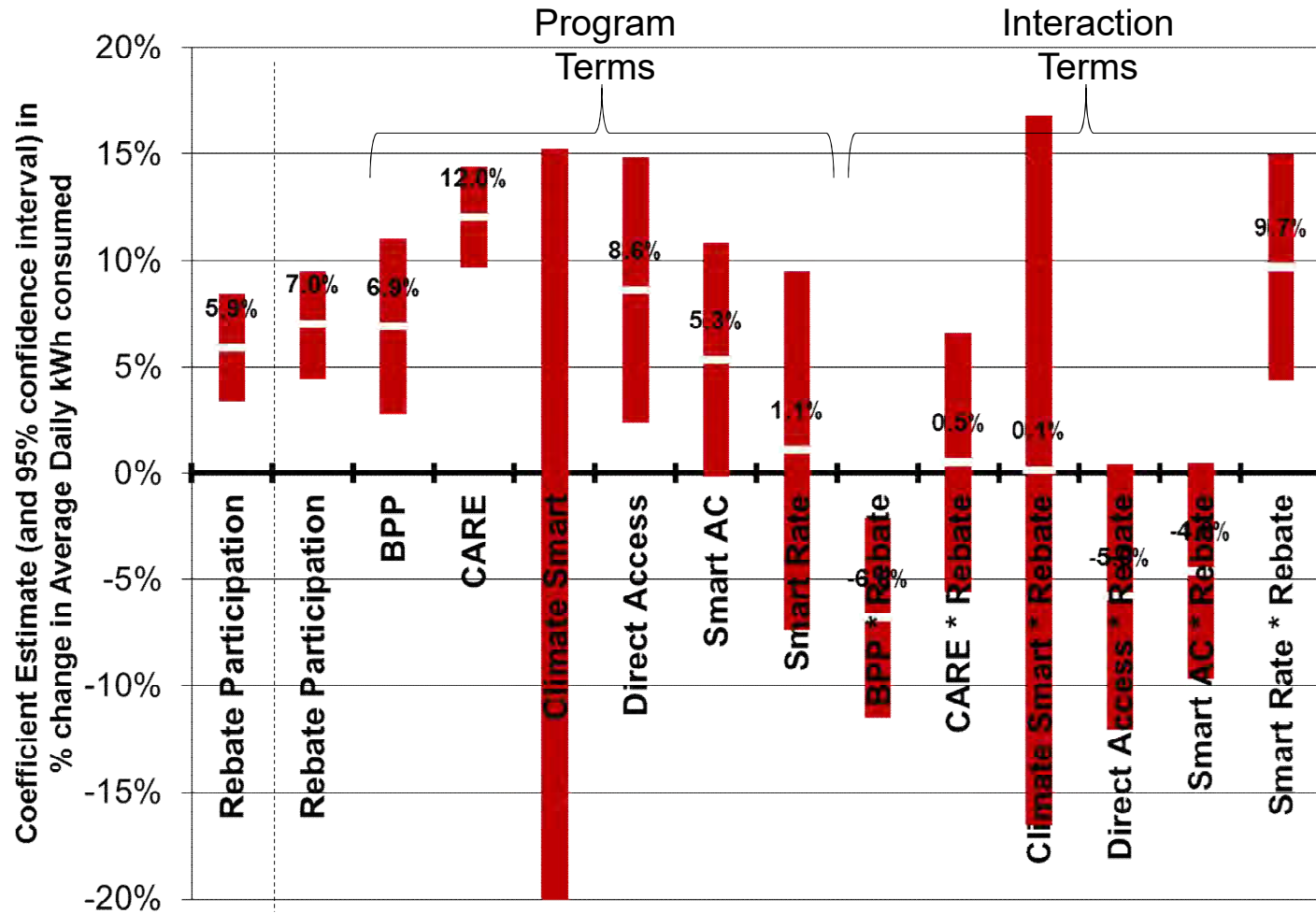
Estimating energy consumption effects
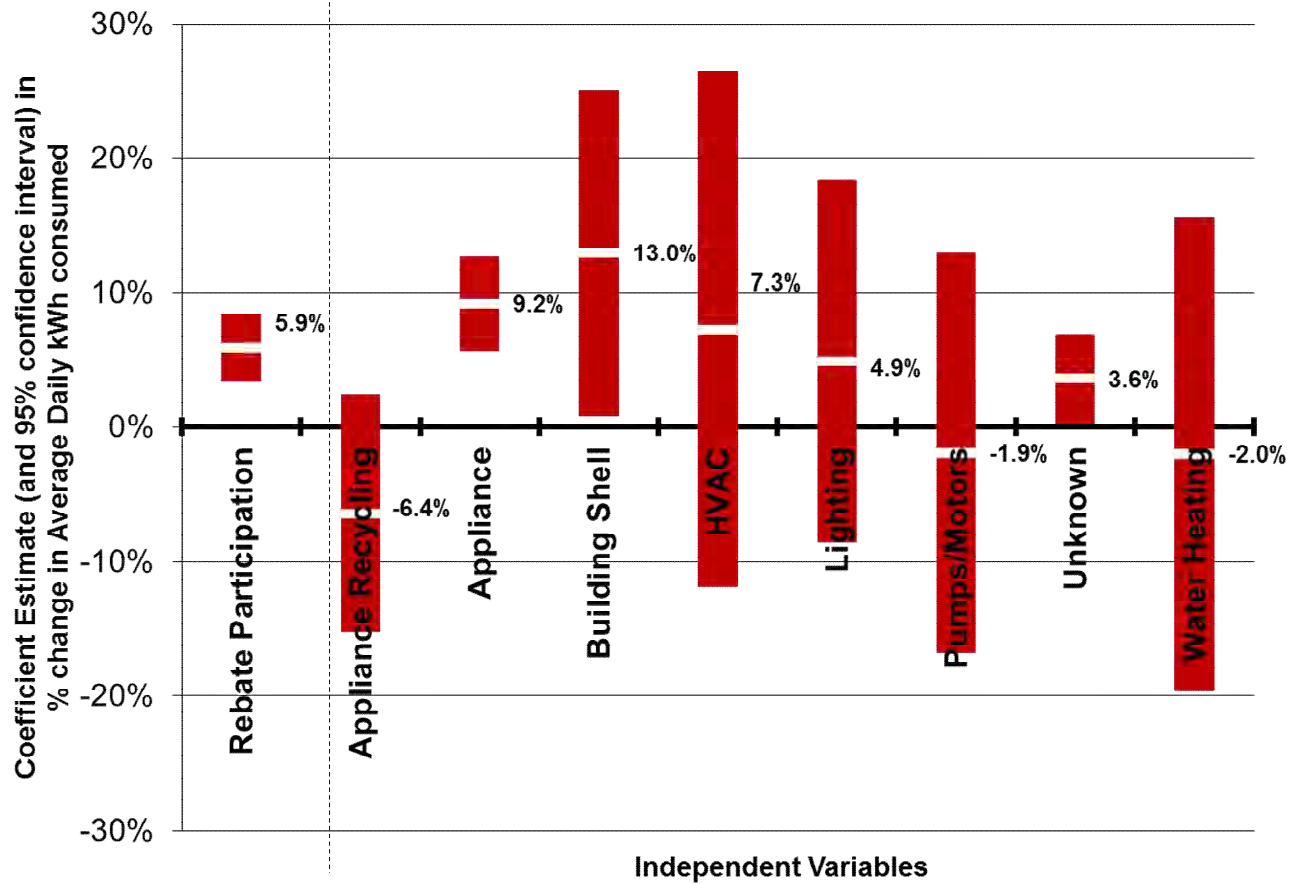
Findings

- Participation in the efficiency rebate program seems to be associated with a subsequent *increase* in household electricity consumption.
  - "Appliance" rebates seem to be driving this result.
  - Because (most) rebates are not associated with mandated equipment retiring, these rebates are likely associated with the delivery of a new energy service to the household.

Wrapping up

- Energy efficiency and behavior programs and strategies are key to achieve greenhouse gas emissions mitigation, to move towards a sustainable energy system, and are very much needed.

- However, we need to assess how different programs work, to ensure that we get needed the energy savings and GHG reductions.

- More work is needed in this space, and much of it will be enabled by the collection of data from smart meters, coupled with dig data analytics, and with proper experimental design.
  - In our work, for example, we suffer from the limitation of not having household specific demographic information.
  - Complementing big data analysis with other strategies: for example, in this case, we would like to interview PG&E costumers to understand who applied for rebates and why.

Independent Variable	Dependent Variable is ln(kWh/day) Coefficient and standard error
Rebate	7.0×10^{-2}***
	(1.3×10^{-2})
BPP	6.9×10^{-2}***
	(2.1×10^{-2})
CARE	1.2×10^{-1}***
	(1.2×10^{-2})
Climate Smart	-2.2×10^{-1}
	(1.9×10^{-1})
Direct Access	8.6×10^{-2}***
	(3.2×10^{-2})
Smart AC	5.3×10^{-2}*
	(2.8×10^{-2})
Smart Rate	1.1×10^{-2}
	(4.3×10^{-2})
Rebate * BPP	-6.8×10^{-2}***
	(2.4×10^{-2})
Rebate * CARE	5.0×10^{-1}
	(3.1×10^{-2})
Rebate * Climate Smart	1.3×10^{-1}
	(8.5×10^{-2})
Rebate * Direct Access	-5.8×10^{-4}*
	(3.2×10^{-2})
Rebate * Smart AC	-4.6×10^{-2}*
	(2.6×10^{-2})
Rebate * Smart Rate	9.7×10^{-2}***
	(2.7×10^{-2})
Linear Time Trend	-2.1×10^{-5}**
	(7.8×10^{-6})
Daily Temperature Controls	Included
Month Dummies	Included
Day of Week Dummies	Included
Intercept	2.7***
	(9.6×10^{-3})
Observations	18,306,105
# of groups, total	30,349
# of groups with rebate	2,768
R^2 within	0.058
R^2 between	0.032
R^2 overall	0.046

Robust and clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$