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Electrification Cost-Effectiveness, and Current Programs at SMUD

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Residential Space Heating can be Cost-effectively Electrified Immediately

House size	Electrification savings	Pre-code	1978+	1992+	2001+
1500 sf	Source energy (MMBtu, %)	24, 37%	16, 38%	16, 40%	14, 39%
	Annual cost ($, %)	$162, 17%	$114, 18%	$113, 20%	$102, 20%
2100 sf	Source energy (MMBtu, %)	33, 39%	22, 38%	21, 40%	19, 40%
	Annual cost ($, %)	$263, 21%	$171, 19%	$172, 21%	$156, 21%
2700 sf	Source energy (MMBtu, %)	42, 36%	25, 36%	24, 38%	20, 37%
	Annual cost ($, %)	$280, 16%	$180, 16%	$176, 18%	$153, 18%

CBECC Res analysis. Assumptions shown in a separate slide. Analysis conducted by TRC Energy; details available from SMUD upon request. Conversion from MMBtu to lbsCO2e not available at time of writing.

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Residential Water Heating can be Cost-effectively Electrified Immediately

Water Heater Type	Annual Operating Cost	Annual GHG emissions (lbs)	Installation cost (parts and labor excl. incentive)	Equipment replacement cost (parts and labor excl. incentive)
Gas storage	$ 239	2225	$1,400	$800
Gas tankless	$136	1270	$2,000 base (est.)	$900
Heat Pump	$107	558	$2,800 base	$1,300

8760 Analysis based on Title 24 2016 HARL equation and findings from SMUD 2016 heat pump water heater field study. Prices based on analysis of SMUD customer invoices and survey of plumbers. Assumptions shown in a separate slide. Details available from SMUD upon request.

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Current SMUD Electrification Programs

All-Electric New Homes Program

Up to $5,000 per home

- $500 for pre-wiring (required)
- $1,500 for HPSH
- $1,500 for HPWH
- $1,500 for induction cooktop

Discussion of whether program will require no gas to site

Electrification Focus in Home Performance Program (existing homes)

Up to $13,750 per home

- $2,500 for wiring and panel upgrades
- $2,500 for HPSH
- $3,000 for HPWH
- $250 for induction cooktop
- $3,000 for insulation and sealing

...and miscellaneous items

Midstream HPWH program under development

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Local Electrification Ordinances—A New Model for Utility Involvement

Whereas:

- Municipalities are seeking cost-effective ways to meet their Climate Action Plan requirements.
- Mandatory electrification ordinances would save GHGs and be cost-effective over the life of the measure.
- Ordinances would also impose high and variable initial costs on residents that might make them politically impossible
- Ordinances expire at the end of each three-year Title 24 code cycle
- Utilities typically do not incentivize measures that are mandated by code

Utilities may:

- Make a three-year commitment to provide incentives, which would minimize customer price risk and therefore make an ordinance politically feasible.

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Summary

- Electrification provides a magnitude of GHG reduction that cannot be matched by energy efficiency measures.
- E3 Pathways calls for 50% of new water and space heating by heat pumps by 2030; this requires changes in markets and customer perception that take time to achieve.
- California is wasting money every day by continuing to build homes with gas infrastructure that will have to be retrofitted.

- HPWH (and HPSH in new construction) can fulfill AB2514 requirements for energy storage (50 gallon water heater is a 1.05 kWh/450W battery)
- The SB350 process does not yet provide a clear path for utilities to claim electrification savings.

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Assumptions for Heat Pump Space Heating Analysis

- Single-zone HVAC in homes
- Retrofit heat pump HSPF is Federal minimum 8.2; baseline furnace is Federal minimum
- HVAC equipment sized at 700sf per ton
- Home envelope performance is consistent with code at construction date, plus some insulation and window upgrades
- Site to source ratio of 1.7, i.e., power is derived from new sources composed of RPS% renewables, plus (100-RPS)% gas-fired combined cycle plants.
- Electricity priced at SMUD 2017 Time of Day rates
- Gas priced at $1.25 per therm

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Assumptions for Heat Pump Water Heater Analysis

- Energy Factor of tankless gas water heater 0.82
- Energy Factor of gas storage water heater 0.575
- Energy Factor of heat pump water heater 3.5
- Energy factor of heat pump water heater reduced to 2.85 to reflect real-world conditions, per SMUD field study. Same proportional reduction applied to gas storage water heater EF, but not to gas tankless.
- Cost of Natural Gas $1.25/therm
- Tank water temperature 124 Fahrenheit
- Conditioned floor area 1964 Square feet
- Thermal storage model assumes tank losses (UA) 3.7 Btu/hr/degF
- Tank capacity 50 gallons
- Off-peak electricity GHG emissions 525 lbsCO2/MWh
- On-peak electricity GHG emissions 695 lbsCO2/MWh
- Summer Super Peak GHG emissions 865 lbsCO2/MWh
- Natural gas GHG emissions 11.7 lbsCO2/therm

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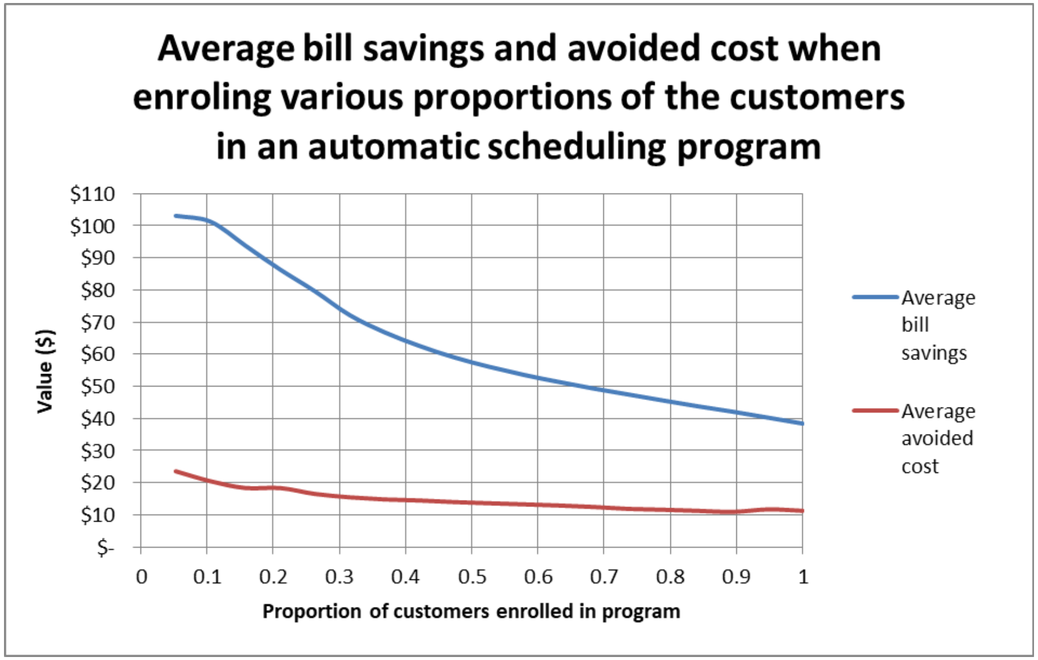
Cost-Effectiveness of Automatic Load Shifting with Thermal Storage HPWHs

<u>Costs</u>:

- $80 for thermostatic mixing valve
- $20 labor to install the mixing valve
- $50 for a wifi or CTA 2045 controller



<u>Calculation assumes:</u>

- *Automated predictive load shifting per customer, 50 gallon HPWH with water storage up to 150F.*
- *Future state in which 30% of water can be heated at times of zero or negative wholesale power price*
- *SMUD 2017 Time of Day rate.*

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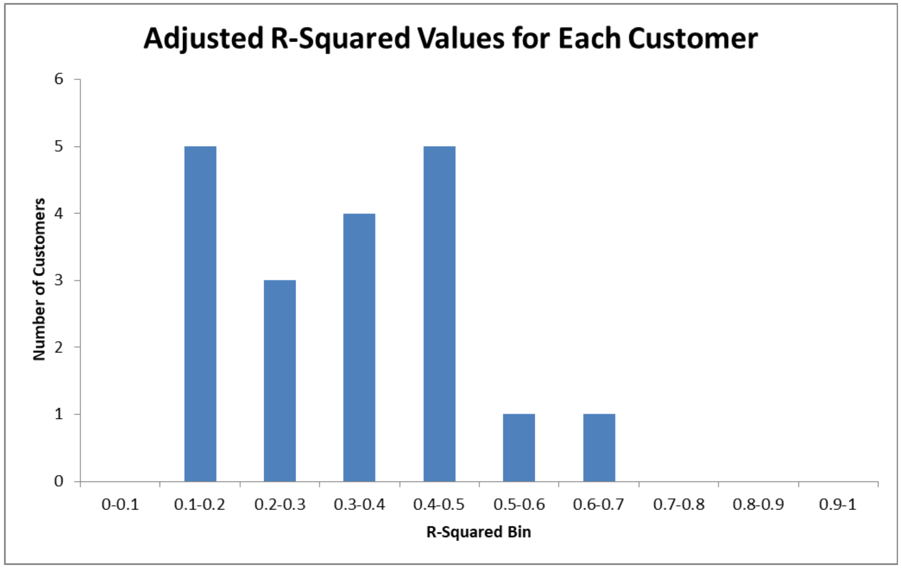
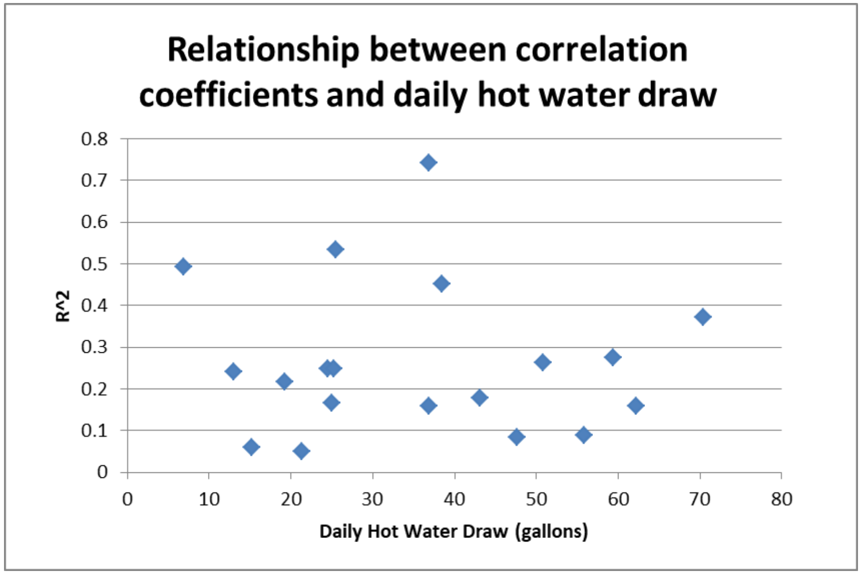
Analytic Background to HPWH Load Shifting—Predictability of Hot Water Draw





- Load Shifting aims to heat enough water each morning to meet that day's evening draw. Insufficient heating may result in electric resistance element use; excessive heating results in storage losses.
- Multivariate analysis was used to predict each customer's evening draw using their draws from six preceding time periods (two days). A few customers were highly predictable (high R-squared); most were not. Predictability was not related to draw magnitude. In practice over-prediction results in minimal energy loss.

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