Trials and Tribulations of Home Electrification

January 5th - 12:00pm - 1:00pm

Profiles in Electrification

The Realities of De-Carb Efforts: Challenges & Opportunities

Outline:

1. Profile of home
2. Background of De-Carb efforts
3. Future plans
4. Challenges
5. Recommended strategies

Format:

- 3 Speakers, 15 min/each
- 15 min Q&A

Dale Sartor: Background of De-Carb effort

1. *1980's 1470 sq ft, single story w/ attic and crawl space.*
2. *100 Amp panel and underground service.*
3. *Electric range, 40 Amp w/ 50 Amp circuit breaker (CB).*
4. *Electric dryer (electric resistance), <17 Amp, 30 Amp CB.*
5. *Level 2 EV charger, 32 Amp, 40 Amp CB:*
   - This is the big hit, but a flexible load.
   - On/off Control by Sonoma Clean Power (SCP).

Heat Pump Water Heater

- Rheem, 15 Amp, 80 gallon.
- BTU/H: 4200 (HP) + 7670 electric resistance.
- “Middle” Amp (lower 120V model not available).
- Resistance backup good for a larger family.
- Large storage for flexible off peak “charging.”
- Cost $6K (simple install) somewhat driven by a small number of utility rebate approved contractors. Rebates and tax credits $2K, net $4K (~2x cost of replacement gas heater).
- SCP wants to control, but wants to overheat water (to 160 F) and mix (I set to 120F).
- WiFi controller/monitor very disappointing.
- Noise not an issue.
- Standby losses greater than hoped.

Future Plans:

1. *Replace gas furnace with heat pump:*
   - Mini split: 2 ton with 3 zones ($13.5K - $2.9K rebates).
   - Ducted split: $15K + $8K for duct replacement (?).
   - Sanden 15 KBTU/H (+ $8.5K +).
   - + Double attic insulation and seal house ($4.8K - $1.2K)
2. *Replace electric dryer with HP (free up Amps):*
   - Note HP and condensing dryers are not the same.
3. *EV controller (variable charging based on total house draw - see subsequent slide).*
4. *Smart House controls to optimize scheduling and flexibility as well as grid response.*

Start with HomeIntel: Save.hea.com

Energy Profile Report

116 Countrywood Ct, Petaluma, CA 94954

August 2021

Report generated on September 10, 2021
A service provided by Home Energy Analytics Inc.

Household Summary

Number of Occupants:	2.0	Rent/Own:	Owner
Year Home Was Built:	1981	Pool:	No
Size of Home:	1,473 sqft.	Standalone Hot Tub/Spa:	No
Type of Home:	Single Family	Fountain, pond, etc.:	No
Activation Date:	September 08, 2021		

Energy Consumption Trends

based on last bill covering August, 2021

Annual Energy Cost
$2,093

0%

since you registered on 9/8/21

Energy cost of your household in the past 12 months. Percentage change is based on comparison to the benchmark, which is the year prior to your registration.

Home Idle Load
88 Watts

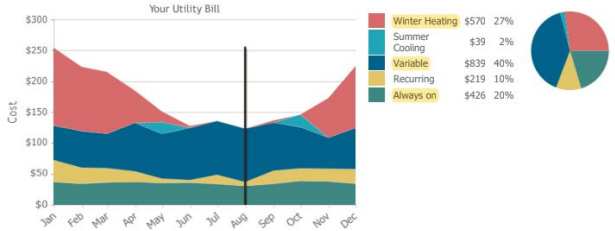
0%

since you registered on 9/8/21

The amount of electricity your home consumes every hour of every day.

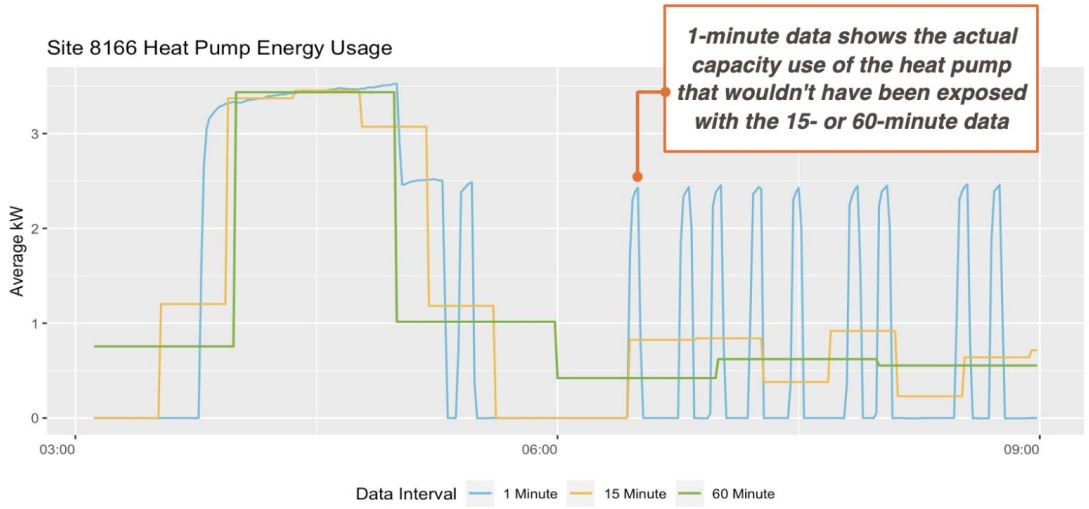
Energy Profile

based on past 12 months



Granular Data vs. Hourly Data

1-Minute Data Provides Acute Insight to Electricity Use



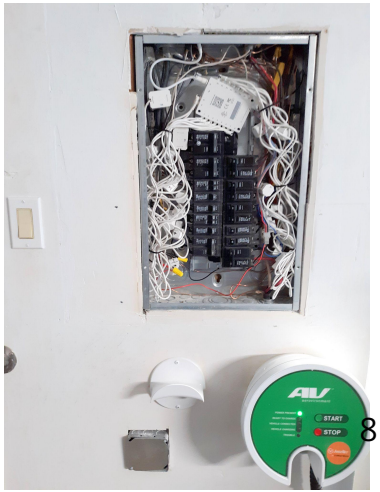
Source: Evergreen Economics

Add Circuit Level Metering

emporiaenergy.com/

$170

Load	Energy %	Peak 15 min Watts
EV Charger	14	7210
Dryer	13	5330
Range	10	2670
Coffee pot and dishwasher	10	1310
General lights & outlets incl. furnace & exhaust fans	36	1216
Other kitchen outlets	3	728
Bath outlets	<1	489
Fridge and hood	9	406
Heat pump water heater	9	406
Washer	1	257
Whole House	105	8100 (~34 A)



Challenges:

1. *Hard to get bids.*
2. *High cost and slow transactions inhibit mass deployment.*
3. *To achieve scale, must overcome above, provide additional value, and maintain level of service/utility.*
4. *100-Amp panel limitations (?):*
   - $4,425 bid to replace panel, much more to replace underground service.
   - But closer scrutiny of actual hourly load showed we never went over 10 kW in 2021.

Recommended Strategies:

1. *Use heat pumps for dryer, space, and water heating. If resistance used, more sophisticated controls required to avoid upgrade of 100-Amp service.*
2. *Level 2+ EV charging is <u>the</u> big hit when electric capacity constrained, but charging can be variable and schedule can be flexible (along with water heating and perhaps other appliances).*
3. *Study actual peak loads, not circuit breaker sizes, but need to address code compliance issues.*

4. *Don't forget efficiency - our water heater losses > use.*
5. *Need a path to scale (sexy smart devices/controls key - the next Nest).*

Alan Meier

(April 2020 - Dec 2021)

The house

- ➔ 3000 ft2, (built ~1925 in stages), 4 levels including a studio apartment
- ➔ lots of knob and tube wiring
- ➔ Panel was a dangerous Federal Pacific (100 amps)
- ➔ 4 gas furnaces, 2 gas stoves, gas DHW, gas dryer

RETROFIT SEQUENCE WAS CRUCIAL

Prius died … → EV acquisition … → **panel upgrade (200 amps) and EV level 2 charger …** → 3 of 4 gas furnaces died … gas water heater died and immediately replaced with same → …

… → upgraded all wiring, some lighting → dead gas dryer replaced by electric →

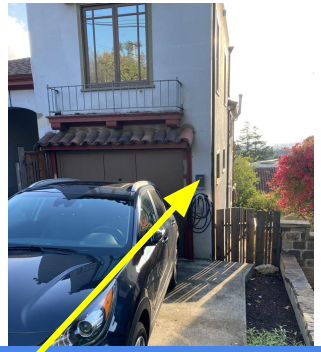
… → asbestos removal … → **4** dead furnaces replaced with 1 large HP with 3 heads & 1 mini-split **… → PV (7.6 kW) + 16 kWh battery installed** … → chimney removed … → **wall & attic insulation**

Still to do:

- Induction stoves (2)
- HP water heater
- HP clothes dryer
- Washlets (2)

7.6 kW PV

Note capped and stabilized chimney



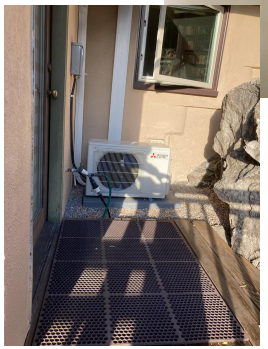
EV charger was tail that wagged the dog ..

Inverter & 16 kWh battery

HVAC

Direct unit in remote bedroom & wall insulation holes

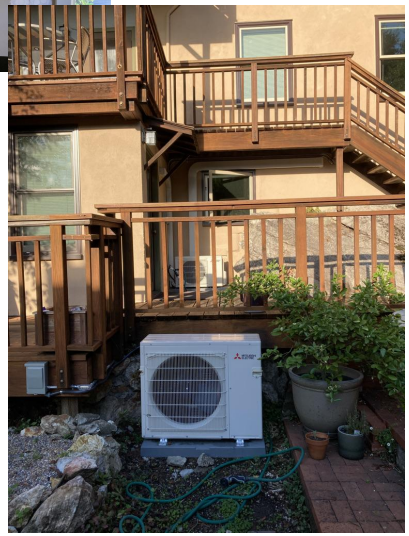
3 thermostats (proprietary) operate independently



←
Mini-split for ADU

One of 2 air handlers

Our “grand canyon” of insulation in attic



Main outside unit -- 36 kBtu/hr -- with ADU mini-split in background

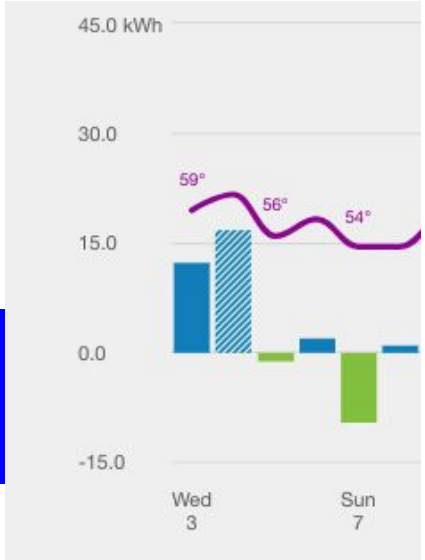
Not shown: 3 new windows

Many, many contractors to coordinate!

1. Berkeley Electric (EV charger, panel, wiring) $$$
2. Ally Solar $$$
3. Aarvaks HVAC $$$$
4. McHale's insulation $$
5. Synergy Enterprises (asbestos removal) $$
6. International Masonry Specialists (chimney removal/stabilization) $$
7. Galvin appliances (electric clothes dryer)
8. Roemer Painter/Plasterer $$$

Meet the General Contractor: my wife (Harvard-trained)

Exporting power! Nov 5, 2021



Stratton-Lee DIY House


Chris Stratton
Wen Lee
WERNER

House basics

Built 1963

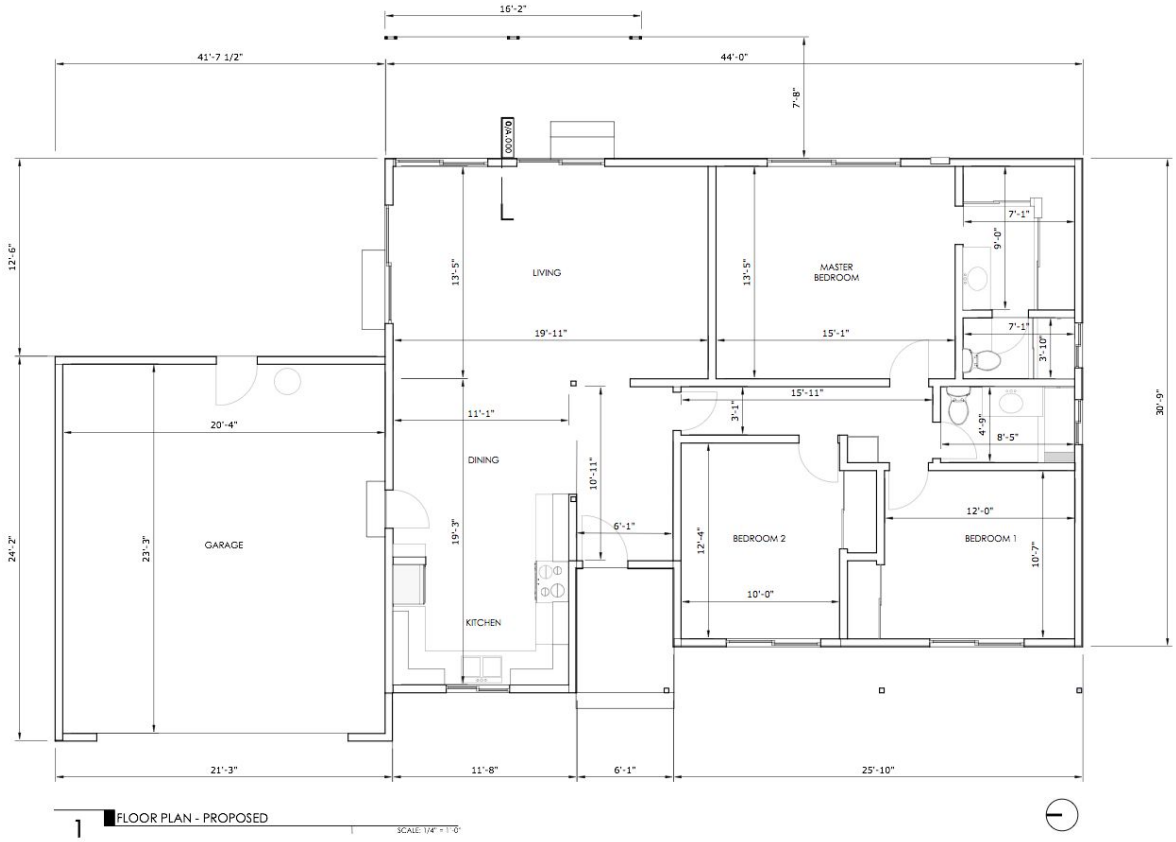
1400 square feet

3bed/2bath

5000 square foot lot

Suburban SoCal location

(walk score: 56)

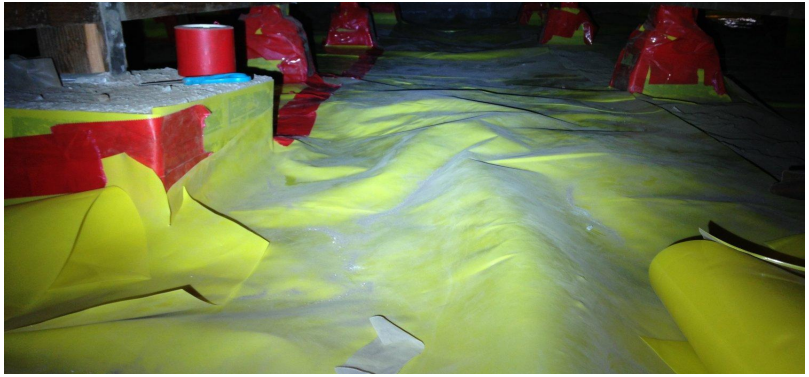


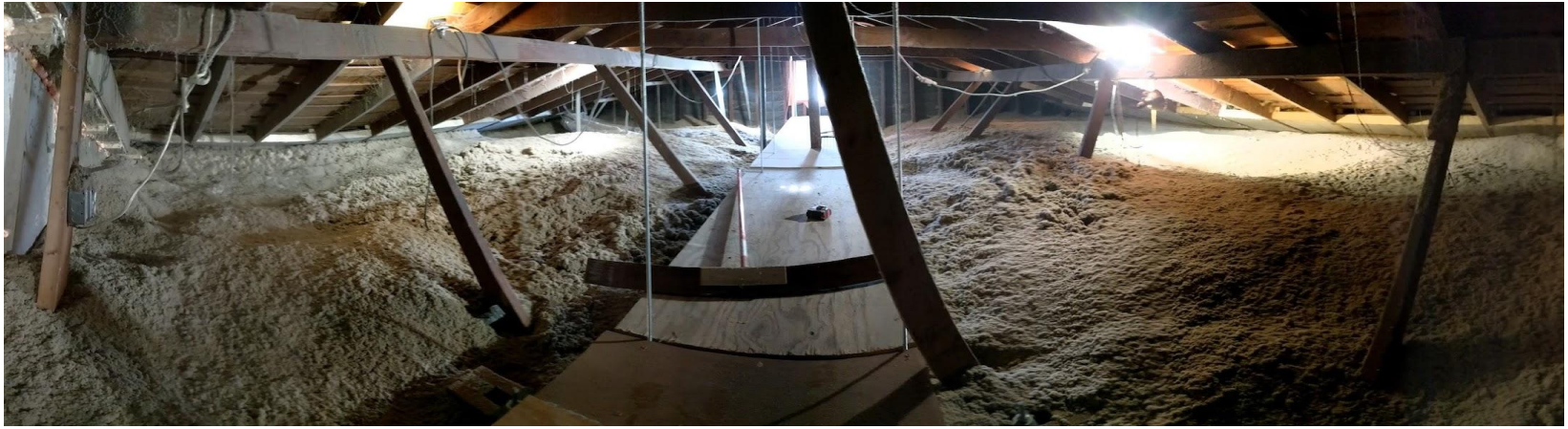

Before

After

Insulation + Air Sealing

Insulation + Air Sealing



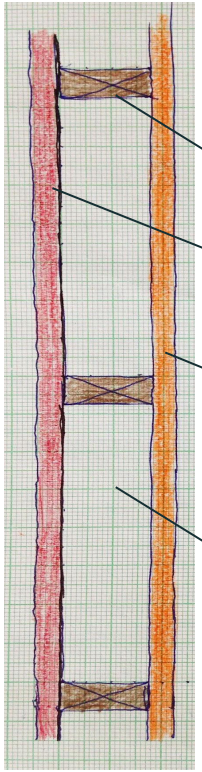


Ventilation

Electrification

Wall Assembly

Before



2x4s 16” on center

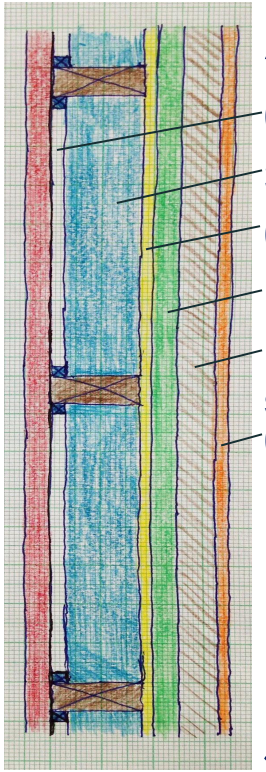
stucco

0.5” plaster,
0.5” drywall

uninsulated cavities

~R-4

After



0.5” air gap for drying

3” polyisocyanurate foam

0.5” structural plywood

1” polyisocyanurate foam

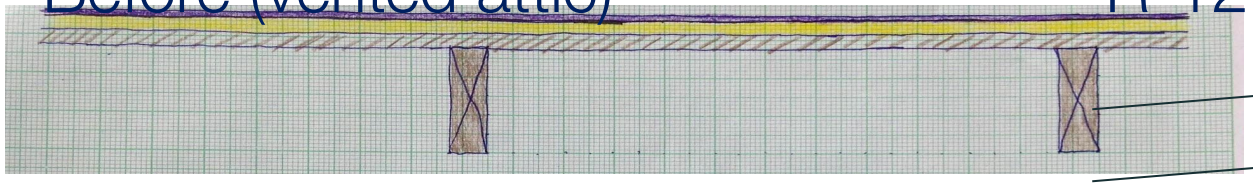
1.5” service cavity (2x3s spaced 24” on center)

0.5” drywall

~R-27

Vaulted Ceiling Assembly

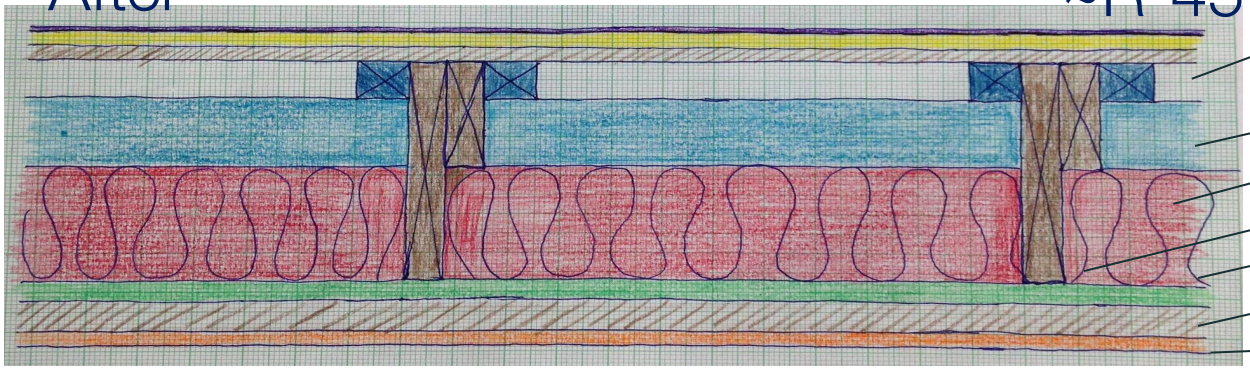
Before (vented attic) ~R-12



2x6 rafters, 24” on center

~5” of blown fiberglass on attic floor

After ~R-45



2” roof deck vent (eave and ridge vents)

3” polyisocyanurate foam

5.5” fiberglass batt

sistered 2x12 rafters

1” polyisocyanurate foam

1.5” service cavity

0.5” salvaged T&G flooring

Envelope Leakage

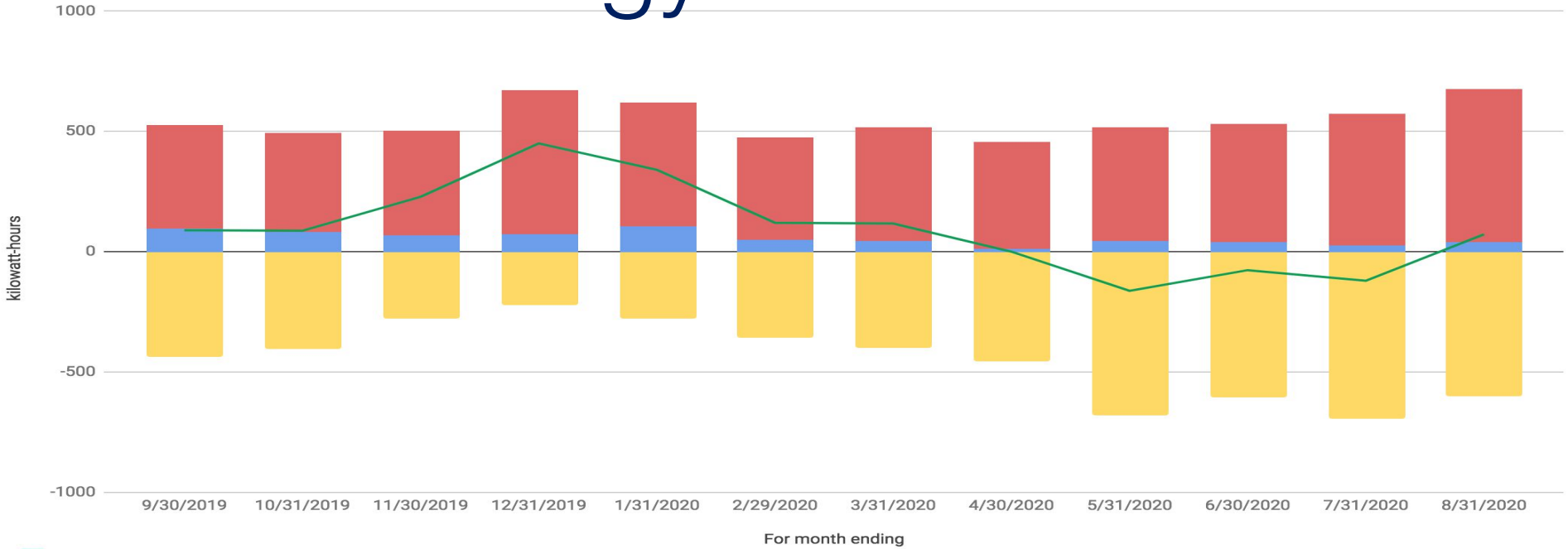
BEFORE:

18.3 ACH_{50}

AFTER:

3.5 ACH_{50}

Recent Energy Performance



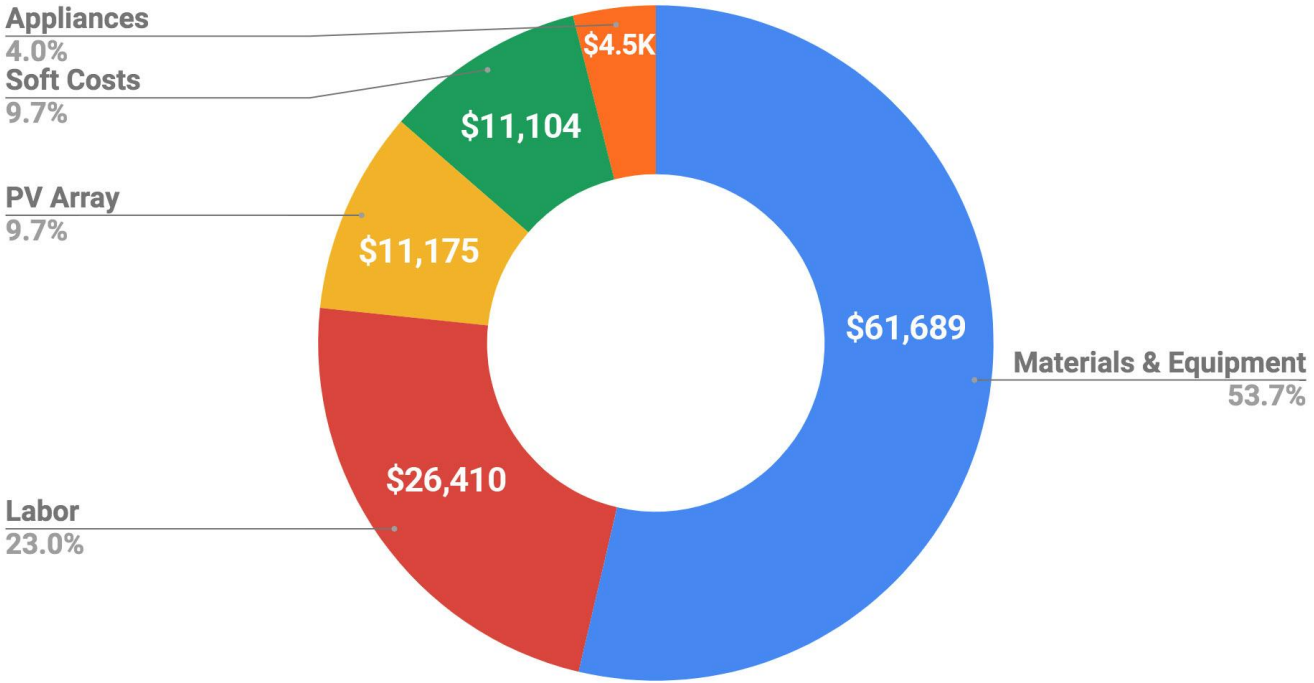
net consumption
production
home consumption
electric vehicle consumption

Pre vs. Post Retrofit

		NATURAL GAS		ELECTRICITY		**TOTAL**	
		Consumption	Cost	Net Consumption	Cost	**Consumption**	**Cost**
PRE RETROFIT	Jan 2014 – Dec 2014	7,032 kWh	$176	4,007 kWh	$970	**11,039 kWh**	**$1,146**
POST RETROFIT	Sep 2019 – Aug 2020	-	-	1,142 kWh	$66	**1,142 kWh**	**$66**
							$1,080 Yearly Savings

Note: Cost calculations done using 2020 energy prices

Renovation Costs



Total cost: $114,925

Labor costs mitigated by ~4,800 hours of “sweat equity” labor by building owner

Lessons learned/barriers to replication

Initial cost -

- deep retrofits are a bad financial investment right now
- per LBNL work, lighter retrofits (+PV?) a better investment

No guarantee that home value will increase (it did in our case)

- Home sold in June 2020 (hard to parse hot market v. upgrade premium)

Difficult to find contractors who were competent/knowledgeable (Hence DIY)

Fossil gas is still way too cheap (we desperately need a price on carbon)

Location is more important than efficiency

- we need density/walkability and MORE HOUSING (we're moving!)


Chris Stratton
Wen Lee
frugalhappy.org

Questions & Answers

Speaker Contacts + Web Link

1. Dale Sartor - dasartor@lbl.gov

2. Alan Meier - akmeier@lbl.gov

3. Chris Stratton - christratton@gmail.com

Weblink

https://homes.lbl.gov/decarbonizing-homes