

Deep Energy Retrofit Case Studies: Lessons Learned.

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Alliance for Residential Building Innovation
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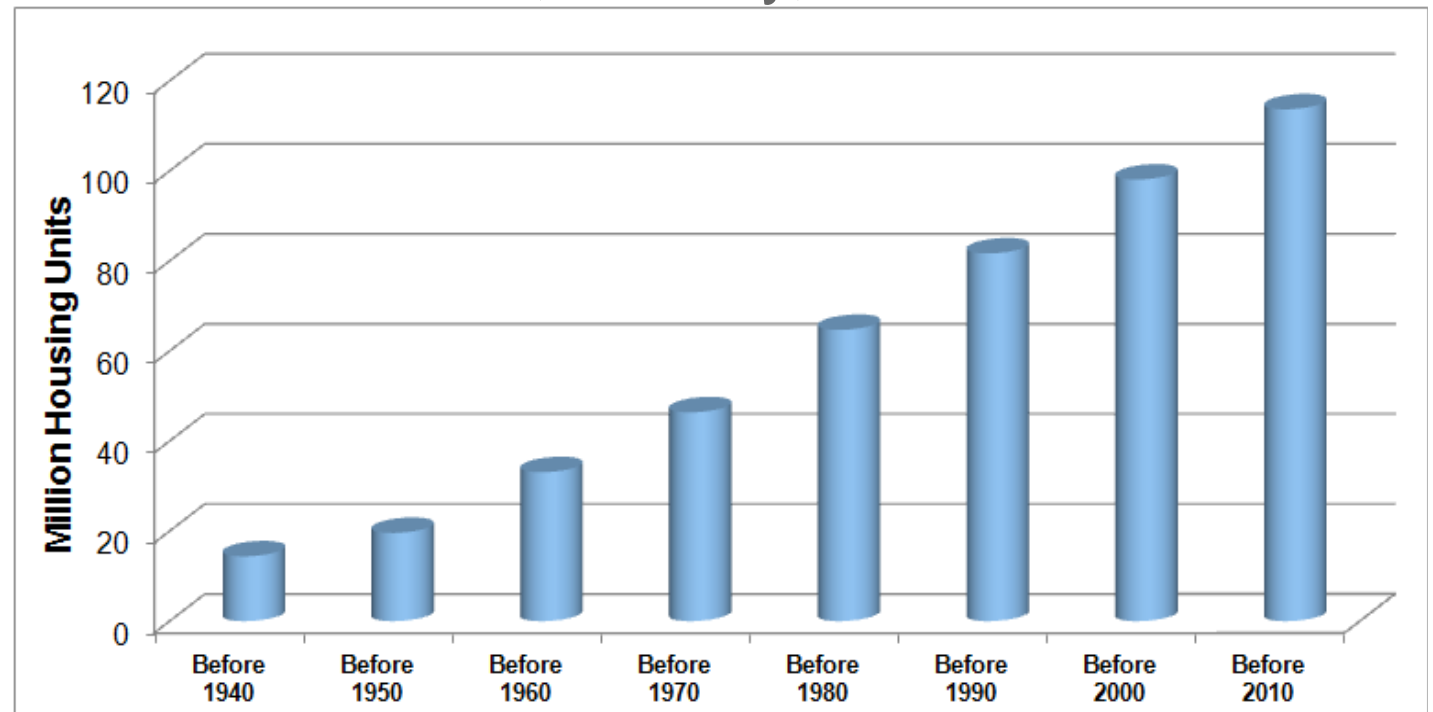
Agenda

- Background / motivation
- Results from 3 CA retrofits
 - Sonoma Passive House Retrofit
 - Stockton Hot Dry Retrofit
 - Sunnyvale Marine Deep Retrofit



Background

- >60 million homes in the U.S. over 30 yrs old
- Huge potential
 - Energy savings
 - Provide more comfortable, healthy, durable homes

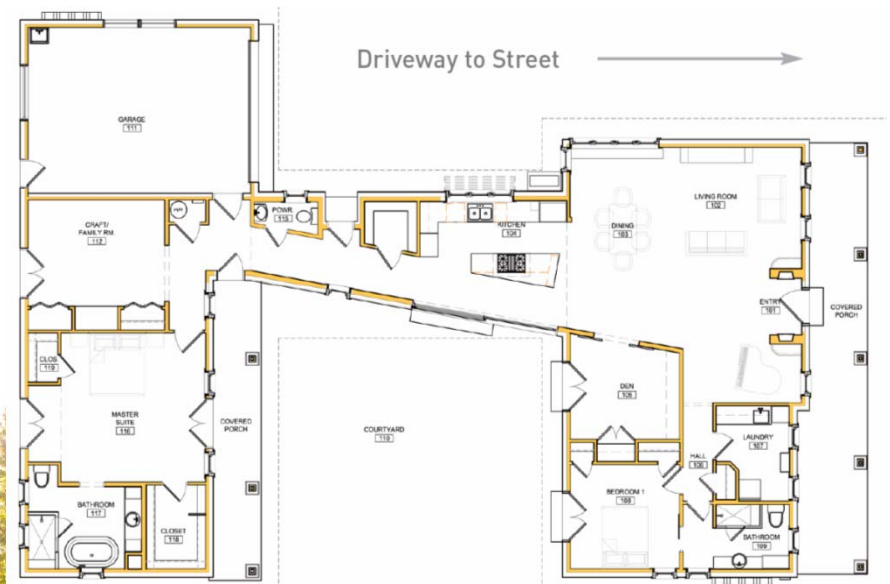


Data source: 2009 Residential Energy Consumption Survey



Sonoma Passive House

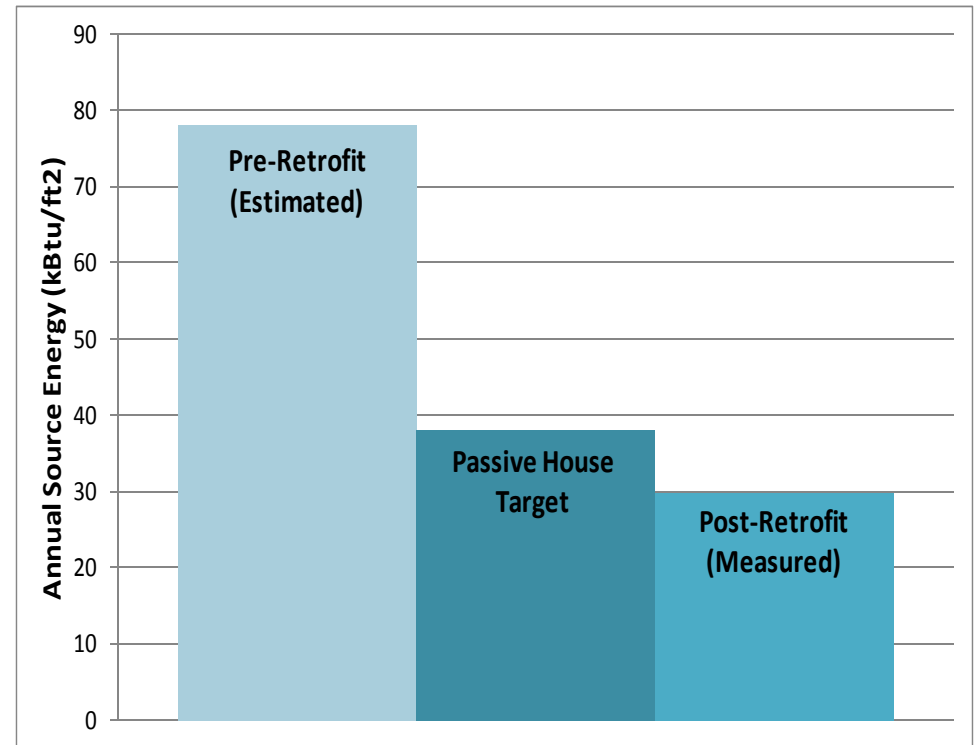
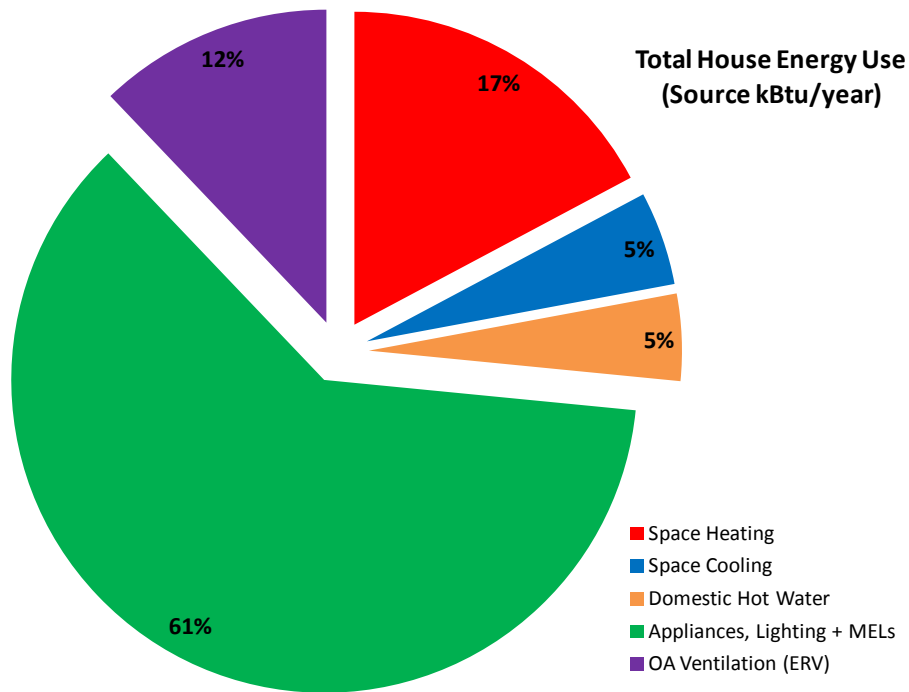
- 1,975 ft² home; vintage 1960s
- Originally two structures
 - Enclosed Breezeway connects two structures
 - New CFA: 2,380 ft²



Results

High cost items:

- Windows - \$90k
- Ltg - \$62k
- Walls - \$39k



Lessons Learned

- Cost reductions
 - Simplified wall assemblies - double stud walls
 - Standardized air sealing
 - Eliminate solar thermal space heating
 - Dual pane windows
- Temperature distribution can be inadequate with non-ducted mini-splits
 - Distribution important even with tight homes



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Stockton Hot-Dry Retrofit

- 2,152 ft² home; vintage 1939
- Homeowners motivated by
 - Comfort
 - High energy bills



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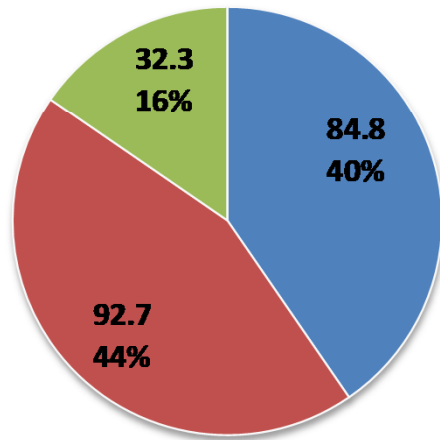


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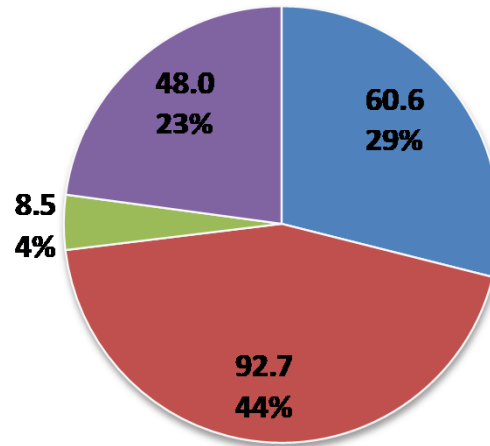


Results

**Pre Retrofit
Source Energy Usage
(209 MMBtu/Year)**



**Post Retrofit
Source Energy Usage
(162 MMBtu/year)**



- HVAC
- House Base Load + Garage/Spa
- Water Heating
- Savings

	Annualized Cost (\$)	Source Energy Savings (MBtu)	Savings (\$)	Annual Cash Flow
Base Package	\$266	11.1	\$ 196	(\$ 70)
Deep Retrofit Package	\$ 944	41.6	\$ 837	(\$ 107)



Lessons Learned

- High costs of retrofits + low energy costs make cost effectiveness difficult
- A “standard package” of retrofit measures proved more cost effective but still difficult to justify
 - Window upgrades
 - Tankless water heater
- Energy models not always good predictors of energy use in older homes (over-predicted savings by 100%)



Sunnyvale Marine Deep Retrofit

- 1,658 ft² home; vintage 1957
- Homeowners motivated by
 - Comfort
 - Indoor air quality
 - Mold & condensation

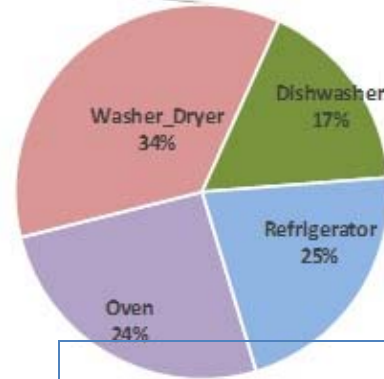
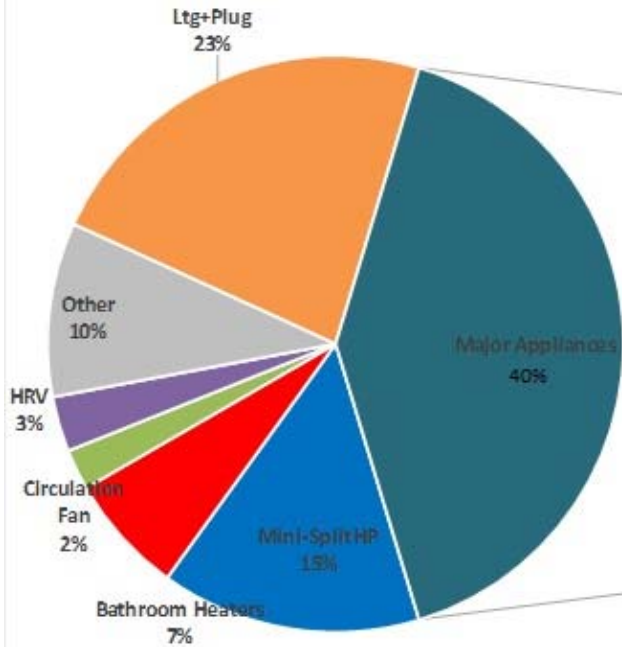
Before



After



Results – Energy Savings



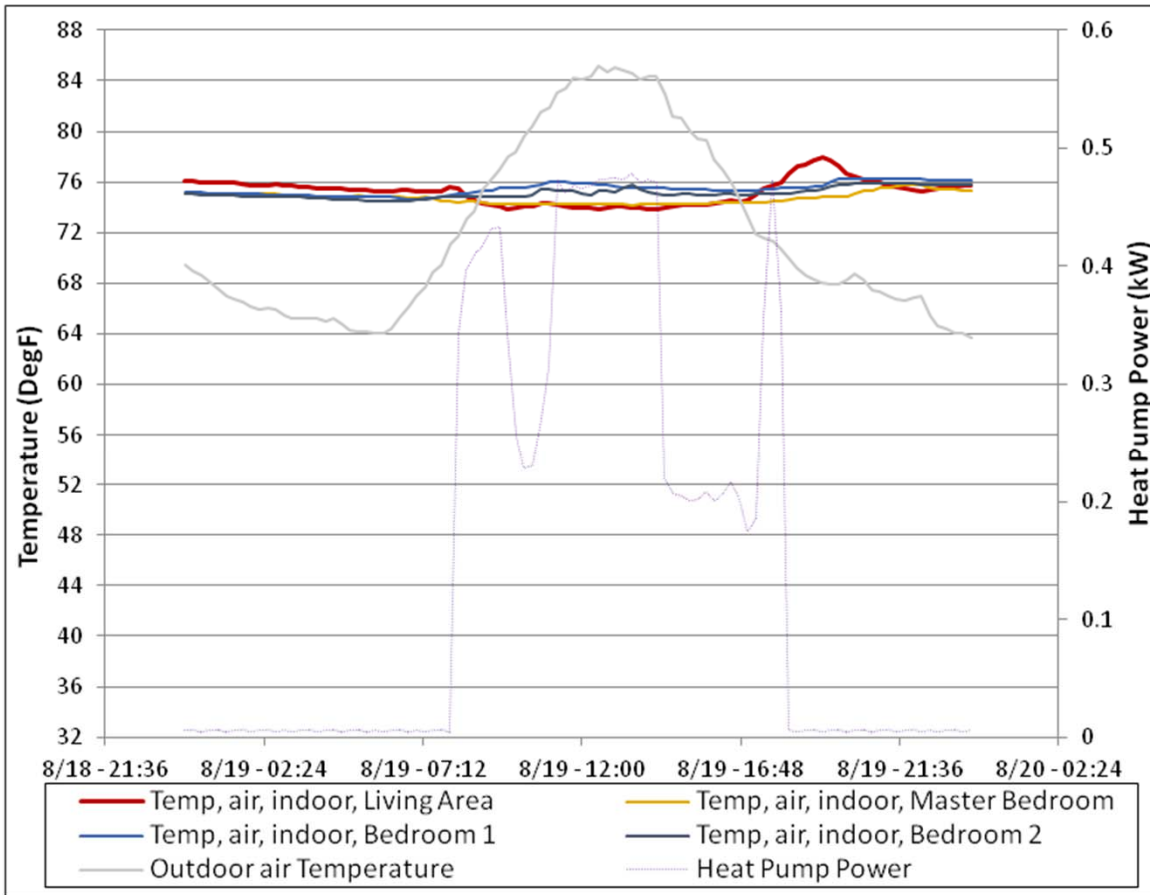
Post Retrofit Electricity Use

	Pre Retrofit	Post Retrofit	Annual Savings
Electricity			
Space Heating (kWh/yr)	510	718	-208
Space Cooling (kWh/yr)	0	90	-90
Total Electricity (kWh/yr)	5,636	5,765	-129
Natural Gas			
Space Heating (therms)	510	0	510
Total Natural Gas (therms)	654	150	504
Source Energy (MMBtu/yr)¹	132	78	54
Utility Cost²	\$1,473	\$974	\$499

\$500 Annual Savings – not enough to offset costs



Results – Distribution System



\$3,500 first-cost savings vs. split heat pump

	Space Cooling	Space Heating
ACCA Manual RS	Max 6°F Avg 3°F	Max 4°F Avg 2°F
Measured Avg.	0.90	1.72
% Failure - Avg	2%	3%
Measured Max.	6.9	8.2
% Failure - Max	2%	3%
Measured Min.	0	0



Lessons Learned

- The distribution strategy is a cost effective means of providing comfort with mini-splits in small- to medium-size low load homes
- Energy models not always good predictors of energy use in older homes and homes in mild climates



Conclusions

- Costs need to come down or energy needs to be valued more highly
- Focus on early adopters – motivated homeowners
- Comfort and health are important non-energy benefits

Retrofit as an opportunity to provide a comfortable and healthy environment and reduce owner risk.



Thank you!

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