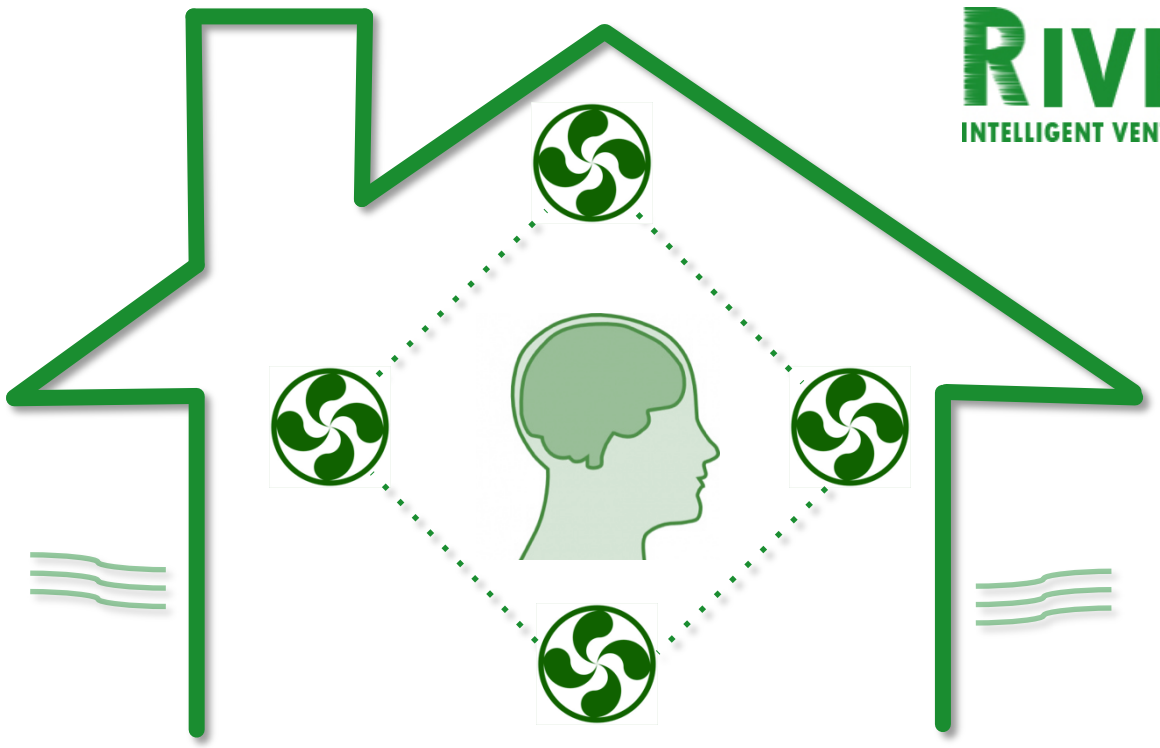

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INTELLIGENT VENTILATION

Residential Integrated Ventilation Energy Controller (RIVEC)

UC Berkeley Cleantech-to-Market
May, 2011

Outline

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- The Team
- The Need
- The Market
- The Solution
- Path to Market
- Recommendations
- Appendix

The Team

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Adam Boscoe, MBA 2012

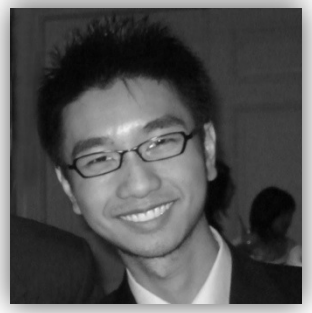
- Oil & Gas Consultant, PFC Energy
- Master's Energy Economics, ITBA
- Financial Analyst

Alex Pederson, JD, MBA 2012

- Former CFO of renewable start-up
- Practiced as a tech-focused transactional attorney

Serge Stanek, MBA 2012

- International management consulting experience emphases in sales, marketing and corporate growth strategies



Kelvin So, EE PhD

- Technical expertise in software development and hardware integration

LBNL Scientist Team:

- Iain Walker, PhD, Staff Scientist
- Max Sherman, Phd, Senior Scientist

Post-Doc Assistants:

- Darryl Dickerhoff
- David Faulkner

Air exchange is crucial to indoor air quality, but ventilation accounts for a large chunk of energy use

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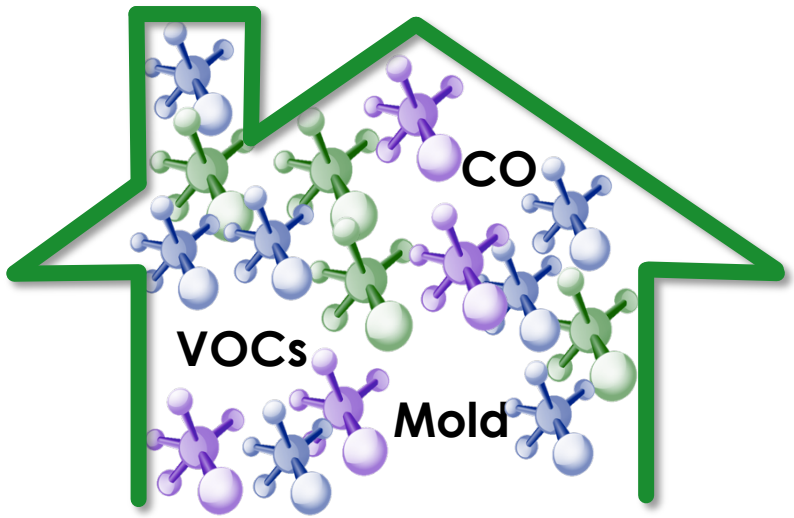
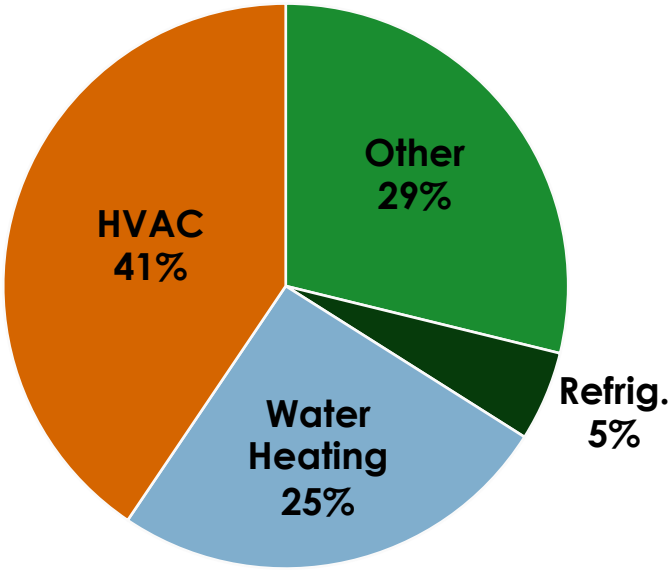


Residential Energy Use



Source: DOE, "2009 Buildings Energy Data Book".

Energy efficiency improvements come at a cost to indoor air quality

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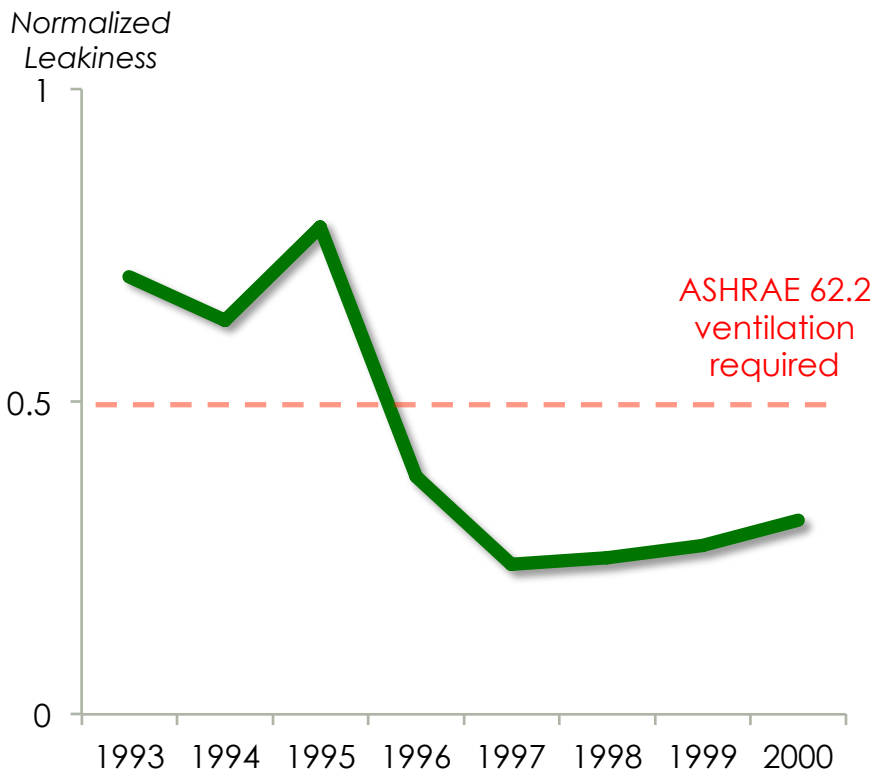
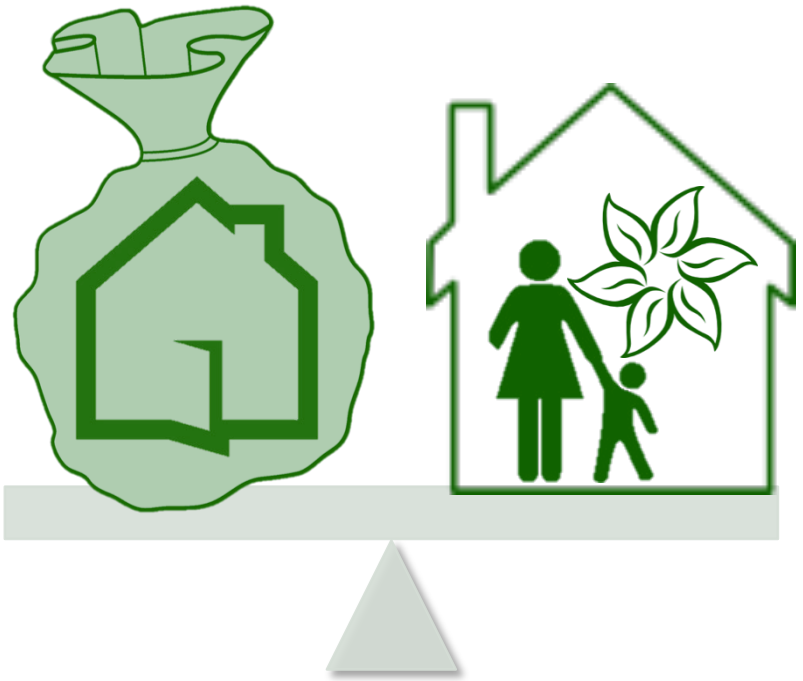
Trend



Source: Sherman & Matson (2002)

Challenge

Efficiency **Air Quality**



ASHRAE 62.2: New standard that mandates minimum ventilation standard beyond windows

Economics of the technology are driven by regulatory compliance with ASHRAE 62.2 rollout across US

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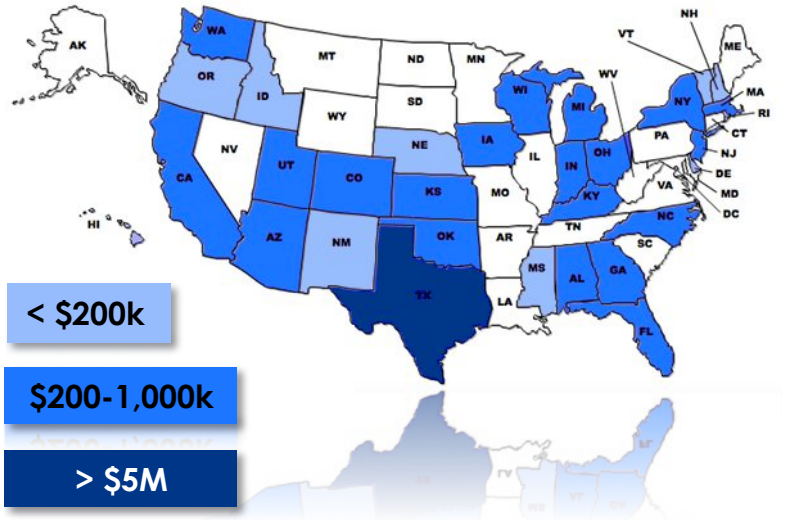
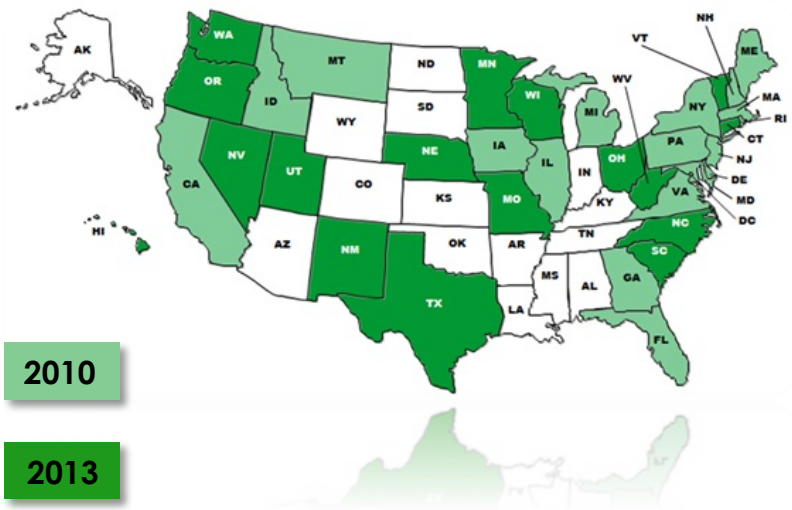
Energy Star New Homes (2009)



ASHRAE 62.2 Adoption



- ~64,000 new builds in states without ASHRAE adoption (2009)
- Market Size: $10-30M

- > 800,000 new builds subject to ASHRAE requirements by 2013
- Market size: $100-300M

- **Texas example:**
  - Largest Energy Star market (29,000 new builds in 2009)
  - 120,000 new homes subject to ASHRAE beginning 2013

RIVEC reduces ventilation energy usage while maintaining indoor air quality

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Inputs

Secondary Ventilation Activity

House Characteristics

- Size
- # Fans/Capacity
- Climate

RIVEC Software

Outputs

Primary Fan
(eg. Bathroom)

Pathway to market could be standalone hardware, or software integrated into existing controls or HEMS

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Standalone hardware

+ Add-on to existing ventilation
– Manufacturing complexity

Software ("RIVEC inside")

Environmental Controls

+ One provider for ventilation
– Require communication with sensors

RIVEC inside

Home Energy Management

+ Hardware setup allows for easy implementation
– Infant market

Potential partners are fragmented and don't offer dual value proposition of efficiency and air quality

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Home Environment Controls

- Adjusts for temp. (not ventilation)
- Large players with manufacturing & distribution capabilities
- No dominant players (incumbents < 30% of market)

YORK
Carrier
BROAN
A NORTEK COMPANY
Johnson Controls
Honeywell
Panasonic

Home Energy Management

- Infant market
- No clearly dominant player
- Open communications standard
- No ventilation control

CISCO
ALERT ME
TENDRIL
The Power is Yours
Control 4

Software solution overcomes initial capital barriers and creates a competitive advantage in a highly competitive/undiversified market

Potential to install in both new homes and retrofits, but new builds are more attractive path to market

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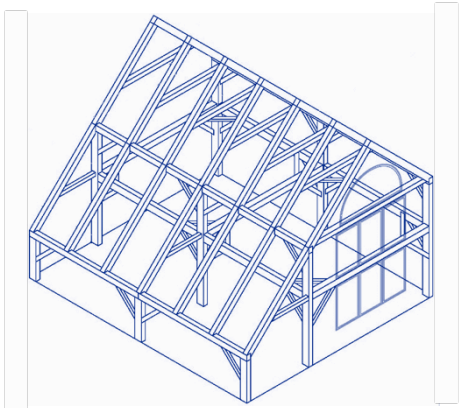

New Builds

VS.

Retrofits

	Home Builders	Home Owners	
Buyer		*> 15 years old*	*< 15 years old*
Installation	🟢	🔴	🔴
Market Size	🟢	🔴	🟡

Most common solution for meeting minimum ventilation levels has operating cost and efficiency disadvantages

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	Common Solution	VS.	RIVEC
How	Primary fan running constantly		Ventilate only when needed (no over-ventilation)
Purchase Price	**Low**: Meet standards with cheapest components		**Low**: Low marginal cost
Operational Cost	**Moderate**: Uses 20% more energy		**Low**: Saves homeowner 20% of ventilation cost

Home builders favor cheaper, less efficient systems, transferring costs to the homeowner/utility

Analysis of value chain indicates that minimum viable product must tap home-builder interests

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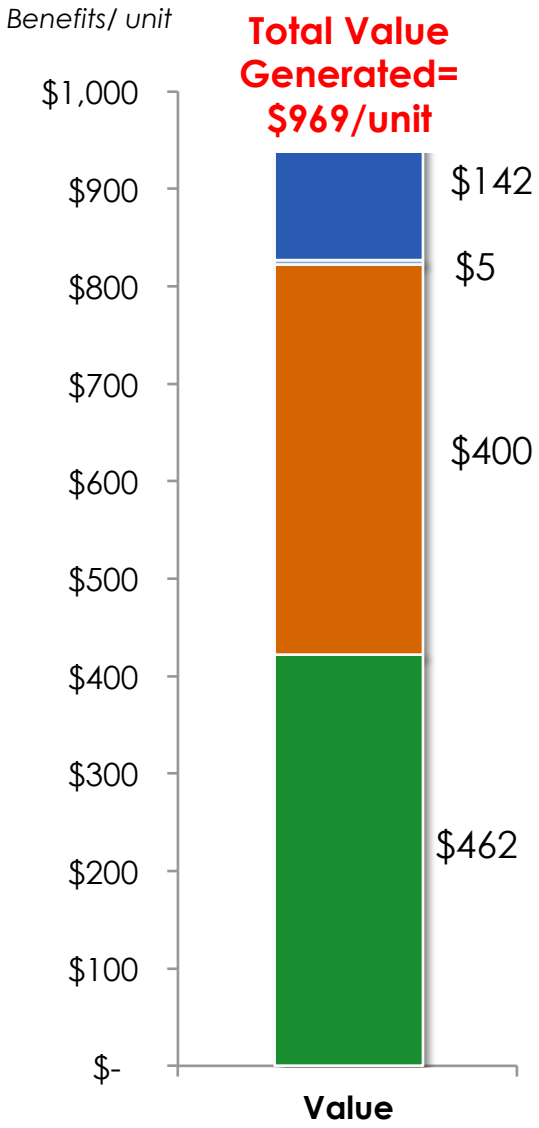

Participant	Benefit
Home Owners	• 20% reduction of ventilation energy usage • Air quality control
Ventilation Manufacturers	• Packaged Benefit
Home Builders	• Comparable HVAC efficiencies achieved currently for Energy Star
Utilities	• Utilities benefit from energy efficiency (avoided cost) and peak demand shifting

Homebuilders have high costs for energy efficient HVAC equipment – RIVEC offers better value proposition

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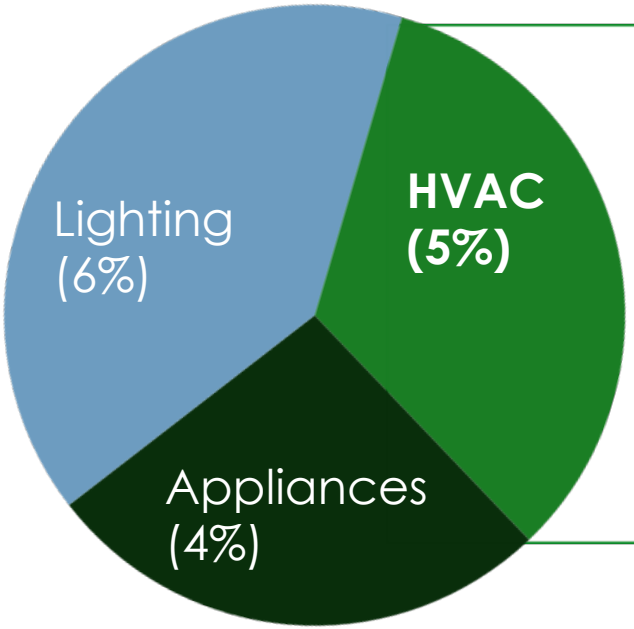
= 15% reduction vs. energy code



Average cost of upgrade to energy efficient central cooling unit= **$400**

RIVEC → 2% Reduction

RIVEC can reduce investment in expensive cooling equipment

Summary & Next Steps

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What have we learned?

1. Most promising segment: new homes in markets with tighter envelope specifications and ASHRAE 62.2 adoption
2. Value-add relies on capturing builder benefits (EnergyStar compliance)
3. Path-to-market: most promising is software integration into existing hardware

Development Timeline

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Thank You!

Thanks to our sources:

Pulte Homes
ENERGY STAR
PG&E
CLAREMONT CREEK VENTURES
LENNOX INTERNATIONAL
GE
BERKELEY LAB
TENDRIL Smart Energy For Life
RICHMOND AMERICAN HOMES With us, it's personal.™
WSGR
Panasonic
Wilson Sonsini Goodrich & Rosati PROFESSIONAL CORPORATION

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Appendix

Sample ASHRAE 62.2 whole-building ventilation label

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*To maintain minimum levels of outside air ventilation required for good health, the fan control **should be on at all times** when the building is occupied, unless there is severe outdoor air contamination.*

-California Energy Commission Indoor Ventilation Minimum Best Practices Guide

Closer Look: RIVEC Value to Utilities

-Rebate paid to home owners much less than true value to utilities

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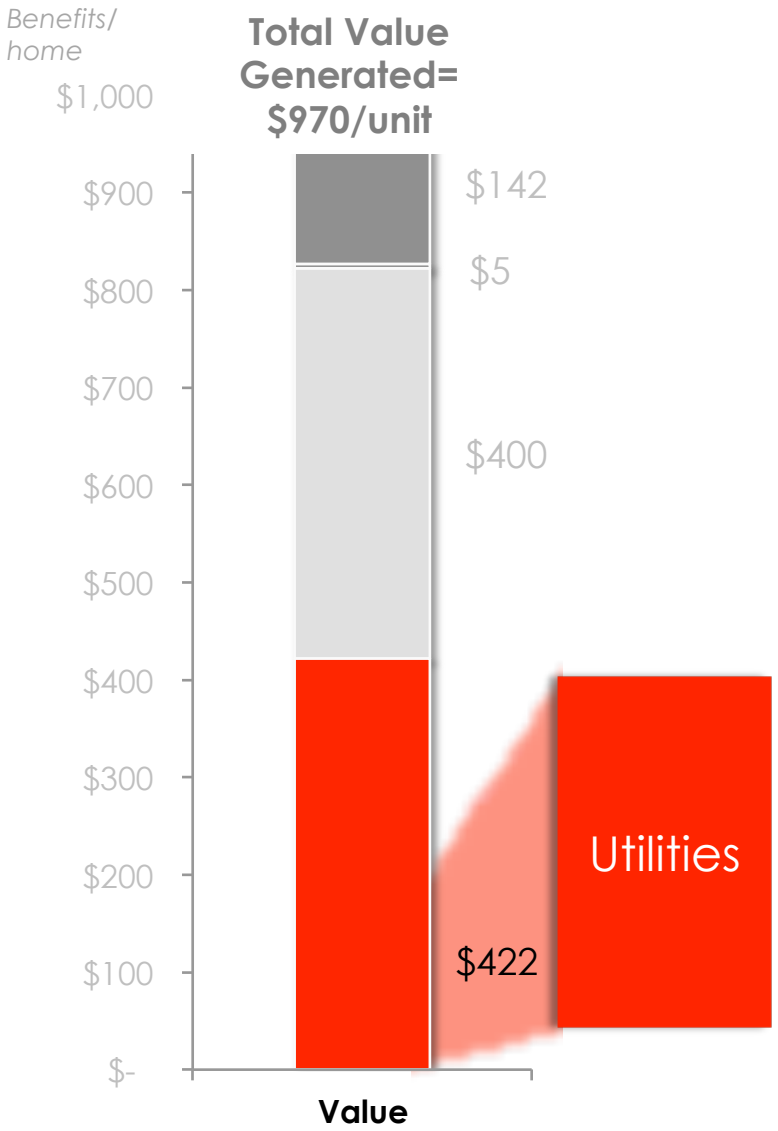

RIVEC → **Save 560 kWh/year, shift 0.2 kW**

Total value to utilities: $422*

Efficiency avoided cost value: $57
Peak permanent load shifting (PLS): $365*
*Utilities benefit from peak load shifting ($500/peak kW - $2,500/peak kW), but do not currently have regulatory approval to pay for non-thermal residential load shifting

Amount passed to home owners for comparable energy efficiency (rebate): $30-50

China is booming new home market, but for now obstacles outweigh potential for RIVEC

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Market potential

- ☑ Booming residential real estate market
- ☑ ~ 18 million new homes built in 2010
- ☑ Air pollution makes smart ventilation critical
- ☑ Some government focus on energy efficiency

Obstacles

- ☒ No ASHRAE 62.2 equivalent implemented
- ☒ Only 30% of homes compliant with building code
- ☒ No widespread adoption of Energy STAR or comparable standards
- ☒ Real estate "bubble" about to burst?

Energy Star Market

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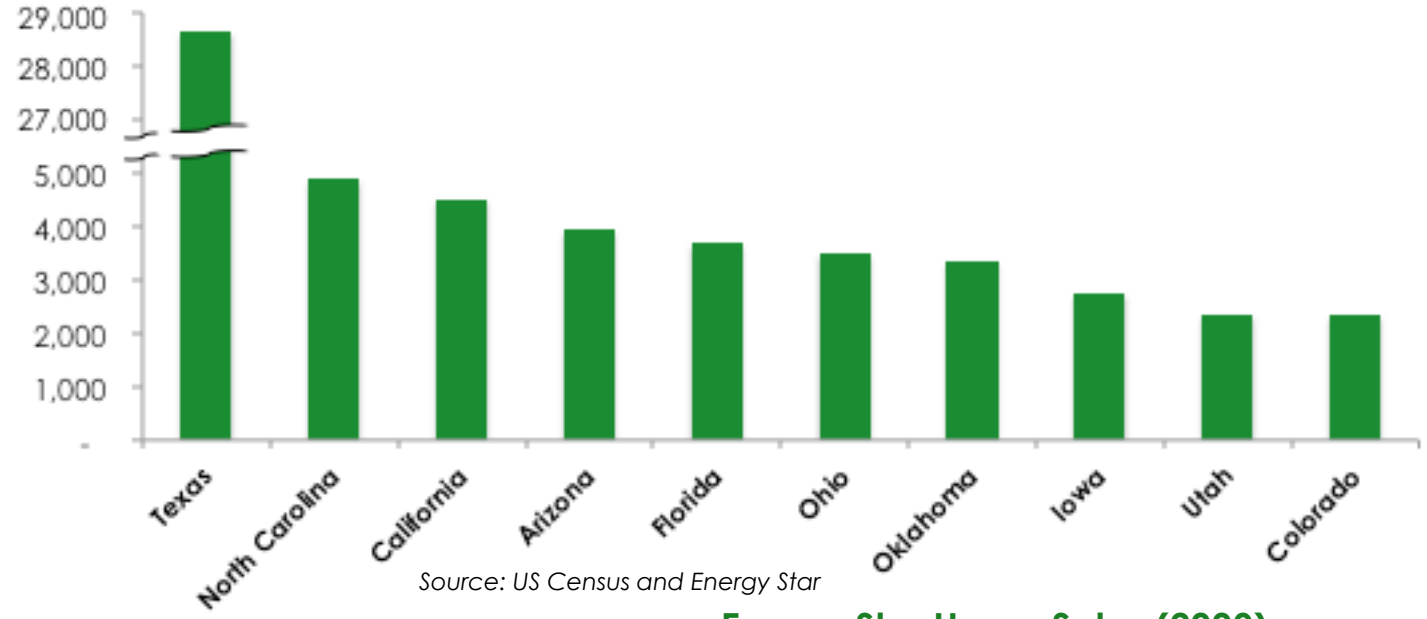
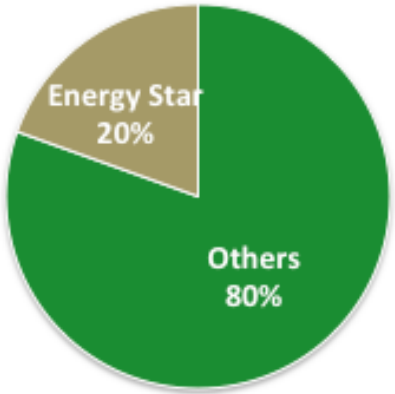
Top 10 Energy Star States by Sales (2009)



Source: US Census and Energy Star

Energy Star Home Sales (2009)



Source: US Census and Energy Star