



Cost-Effective Modeling with ENERGY STAR Homes



Moderator

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Agenda

- The business case for ENERGY STAR
- Modeling Optimization Techniques
- Tips and Tricks
- Example Home

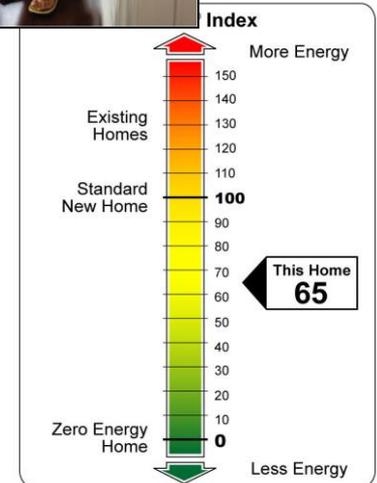


Part 1

The Business Case for ENERGY STAR

The business case for ENERGY STAR

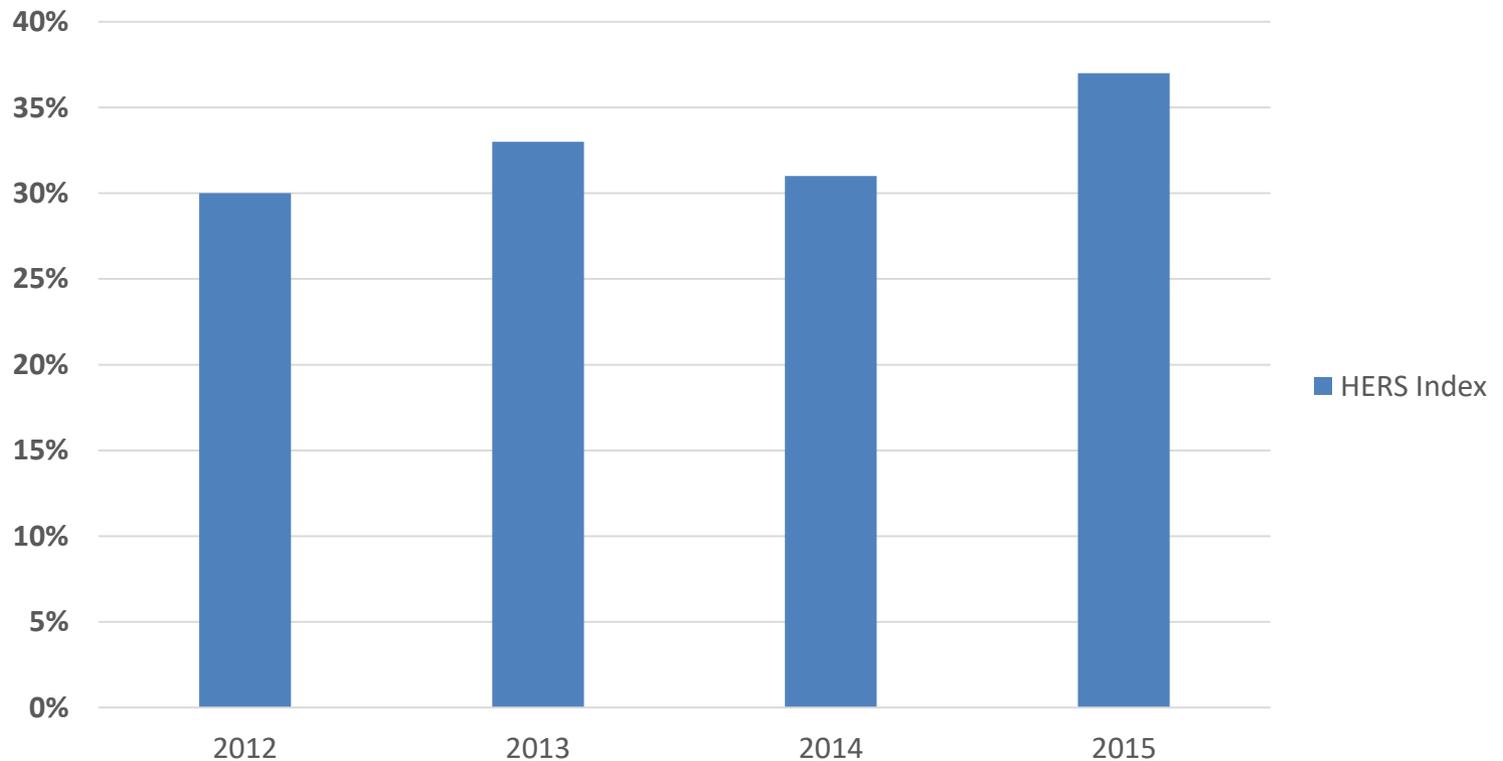
- The ENERGY STAR brand is more recognizable than HERS and other energy rating programs
 - The ENERGY STAR label is recognized by 87% of consumers
 - 92% say that it influences their purchasing decisions





Market penetration of HERS Ratings

- Compared to virtually every other subcontractor, Raters are the lowest cost subcontractor
- But there is still a long way to go for the HERS Index to become the norm when building a new home on the U.S.





The business case for ENERGY STAR

- But what about marketability to **Builders**?
- A builder's decision to build ENERGY STAR homes beyond just HERS rated homes often comes down to two questions:
 - “will this be hard?” and
 - “will the extra effort pay off?”



Assess the costs associated with the HERS Index

- The national average HERS Index over for 2013 was 64, in 2014 was 63, and as of right now it was likely somewhere in the mid to low 60s
- The average HERS Index for a home to meet ENERGY STAR v3.0 ranges from 75 to 68 and for v3.1 is also in the 60s.
- Takeaway: ENERGY STAR requires few, if any, additional HERS points.



What if you could

- Brand recognition, code preparation, and quality assurance are obvious benefits ENERGY STAR offers beyond a HERS score, but adding cost savings makes an even stronger case
- What if you could pass along significant cost-cutting opportunities on a per house basis when rating an ENERGY STAR home as opposed to pursuing just a HERS score?
- Let's identify some commonly missed cost-cutting opportunities that meet ENERGY STAR program requirements



Part 2

Optimization Techniques



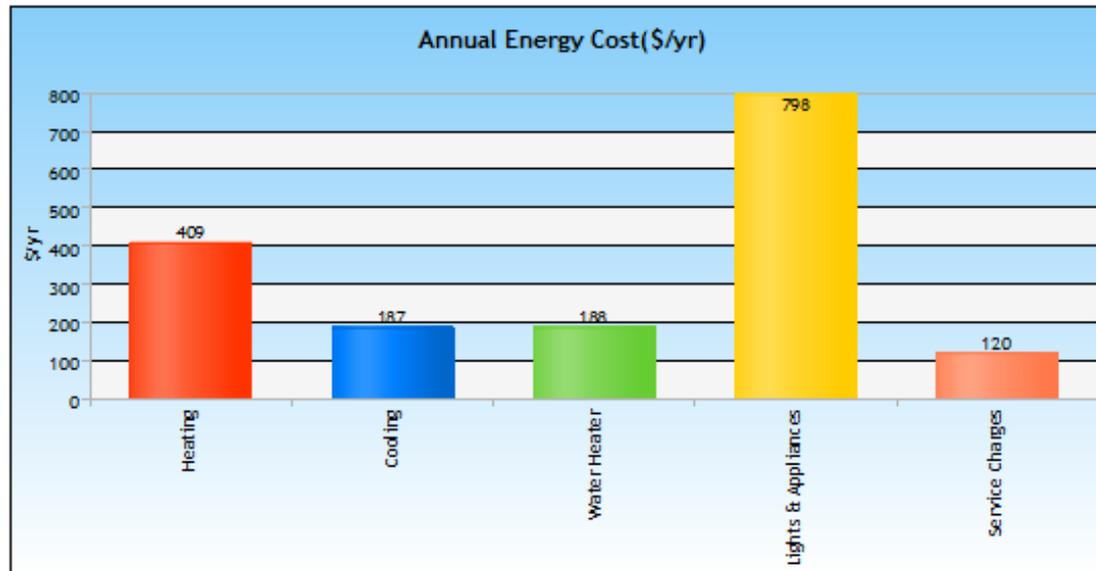
Optimization Techniques

- Understand *how* a model is using energy
- Understand *why* a model is using energy in those ways
- Dial in on upgrades that will have outsized savings



Look for Energy Hogs

- Look at loads, consumption or cost to understand where most energy is going
- More energy = more savings potential





Understand Heating vs. Cooling Load

- Might surprise you
- In general heating can be bigger than expected
- Example from Dallas home with heat pump

Annual Loads (MMBtu/yr)	
Heating	20.1
Cooling	41.1
Water Heating	12.4
WH w/out Ta...	8.9
Annual Consumption (MMBtu/yr)	
Heating	9.0
Cooling	12.7
Water Heating	16.3
Lights and App...	28.6
Photovoltaics	-0.0
Total	66.6
Annual Energy Costs (\$/yr)	
Heating	211
Cooling	298
Water Heating	81
Lights and App...	608
Photovoltaics	-0
Service Charge	120
Total	1318



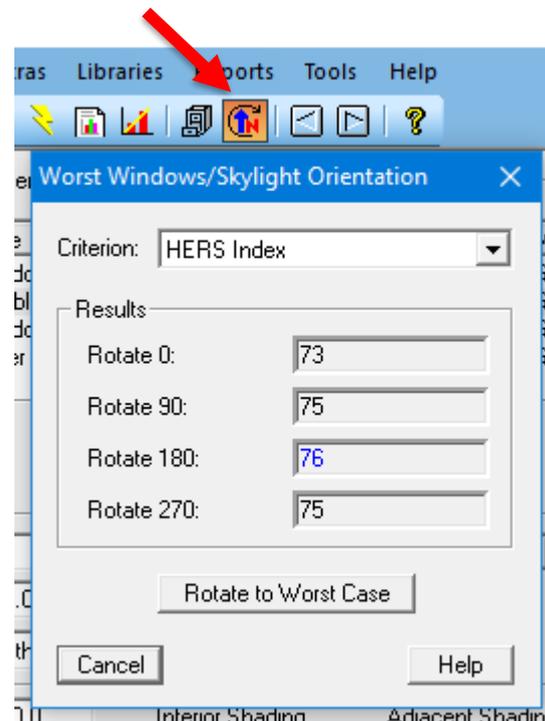


Understand Load vs. Consumption

- Loads reflect (mostly) envelope specifications
- Consumption takes into account loads + equipment efficiencies
- Pattern is very different for electric resistance, heat pump and gas furnaces, for example:
 - Electric Baseboard = 1.0 COP
 - Heat Pump = ~3.0 COP
 - Gas Furnace = ~0.8 COP

How Important is Orientation?

- If there's a large variation, consider orientation-specific targeted upgrades





Compare to the ENERGY STAR Reference Design

- Look at difference in loads, consumptions, and input specifications
- If worse than Reference Home, consider for an upgrade
- If better than Reference Home, is it a cost-effective upgrade? Might there be a more cost-effective alternative?

Compare to the ENERGY STAR Reference Design

Report Selection: ENERGY STAR V3.1 Reports

Group of Reports to Consider: All

Unselected Reports To Consider:

- Action Report (1)
- Air Leakage (1)
- Building File Report
- Component Design Loads
- Emissions
- Equipment Sizing Summary
- Lights & Appliances Summary
- Performance Factors
- Source Energy & Emissions (1)
- 2005 EPAct Tax Credit (1)
- Oklahoma Tax Credit (1)
- Utility Bill Analysis (1)
- DOE Zero Energy Ready Home Certificate (1)
- DOE Zero Energy Ready Home Verification (1)
- Energy Code Inspection Checklist (1)
- ENERGY STAR Inspection Checklist (1)
- ENERGY STAR V2 Home (1)
- ENERGY STAR V2 Summary (1)
- ENERGY STAR V2.5 Home (1)
- ENERGY STAR V2.5 Summary (1)

Note: (1) = 1 Bldg Report Only

Building Selection:

- ENERGY STAR V3.1 Reports
- 1 Building Reports
- 2 Building Reports...
- HERS Reports
- Tax Credit Reports
- ENERGY STAR V2 Reports
- ENERGY STAR V2.5 Reports
- ENERGY STAR V3 Reports
- ENERGY STAR V3.1 Reports**
- ENERGY STAR V3 HI Reports
- LEED For Homes Reports
- DOE Zero Energy Ready Home
- IECC 98 Reports
- IECC 00 Reports
- IECC 01 Reports
- IECC 03 Reports
- IECC 04 Reports
- IECC 06 Reports
- IECC 09 Reports
- IECC 12 Reports
- IECC 15 Reports
- NY-ECCC 2010 Reports
- ECC of NV Reports
- FE PA Savings Reports
- FE PA Qualif Reports
- Iowa 2012 Reports
- Illinois 2015 Reports
- IndECC Reports
- Michigan 2015 Reports
- Minnesota XCEL Reports
- NV Energy Plus Reports
- North Carolina 2012 Reports
- North Carolina HERO
- NC Texas COG Reports
- NGBS Reports

Buttons: Add >>, Add All >>, << Remove, << Remove All, Use A Group, OK, Cancel



Compare to the ENERGY STAR Reference Design

Component Loads

Property: TX, Organization: Elliot Selbert, HERS Projected Rating: 2017-03-01, Weather: San Antonio, TX, San Antonio, C22 Step 0.btg, Builder: ID:

Heating Season(MMBtu/yr)	ENERGY STAR V3.1	San Antonio	Savings	%Saved
Ceilings/Roofs	1.7	1.7	0.0	2.0%
Rim/Band Joints	0.2	0.1	0.0	22.9%
Above Grade Walls	6.5	6.0	0.5	7.8%
Foundation Walls	0.0	0.0		
Doors	0.3	0.3	-0.0	-9.0%
Windows/Skylights	4.0	5.5	-1.6	-39.9%
Floors	1.1	0.8	0.2	20.2%
Crawl Space/Unht. Bemt	0.0	0.0		
Slab Floors	6.5	6.1	0.4	6.5%
Infiltration	1.4	1.4	0.0	0.2%
Mechanical Ventilation	3.0	3.0	0.0	0.2%
Ducts	0.0	2.3	-2.3	
Active Solar	0.0	0.0		
Sunspace	0.0	0.0		
Internal Gains	-8.0	-7.9	-0.1	-0.7%
Total	16.5	19.3	-2.8	-16.6%

REhRate - Residential Energy Analysis and Rating Software v15.3
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Performance Report

Property: TX, Organization: Elliot Selbert, HERS Projected Rating: 2017-03-01, Weather: San Antonio, TX, San Antonio, C22 Step 0.btg, Builder: Rater ID:

Annual Load(MMBtu/yr)	ENERGY STAR V3.1	San Antonio	Savings	%Saved
Heating	16.5	19.3	-2.8	-16.6%
Cooling	36.2	47.3	-11.1	-30.6%
Water Heating	11.9	12.2	-0.3	-2.3%
Water Heating w/out Tank Loss	8.1	8.1	-0.0	-0.1%

Annual Consumption(MMBtu/yr)	ENERGY STAR V3.1	San Antonio	Savings	%Saved
Heating	21.3	21.6	-0.4	-1.7%
Cooling	9.6	10.3	-0.7	-7.3%
Water Heating	14.9	15.2	-0.3	-2.3%
Lights & Appliances	24.8	25.7	-1.0	-3.8%
Photovoltaics	-0.0	-0.0		
Total	70.5	72.9	-2.4	-3.4%

Annual Energy Cost (\$/yr)	ENERGY STAR V3.1	San Antonio	Savings	%Saved
Heating	177	182	-5	-2.7%
Cooling	337	361	-25	-7.3%
Water Heating	113	116	-3	-2.3%
Lights & Appliances	871	905	-33	-3.8%
Photovoltaics	-0	-0		
Service Charges	120	120		
Total	1619	1684	-65	-4.0%

Design Loads (kBtu/hr)	ENERGY STAR V3.1	San Antonio	Savings	%Saved
Space Heating	26.4	40.5	-14.1	-53.5%
Space Cooling	24.9	39.1	-14.2	-56.9%

Utility Rates	2017 TX Electric****	2017 TX Gas*****
Electricity		
Gas		

REhRate - Residential Energy Analysis and Rating Software v15.3
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Compare to the ENERGY STAR Reference Design

Energy Features	ENERGY STAR V3.1	San Antonio
Ceiling w/Attic	N/A U=0.030	R-38 Blown, Attic***** U=0.026
Sealed Attic	None	
Vaulted Ceiling	None	
Above Grade Wall	N/A U=0.082	R-15***** U=0.076
Foundation Walls (Cond)	None	
Foundation Walls (Uncond)	None	
Doors	N/A U=0.170	Steel-urth w/brk U=0.187
Windows	UDRH Std U=0.400	0.53/0.35 U=0.530
Floors	N/A U=0.064	R-19***** U=0.050
Slab Floors	N/A U=0.365	Uninsulated U=0.365
Infiltration	Htg: 4.00 Clg: 4.00 ACH50	
Infiltration Measure	Blower door test	
Mechanical Ventilation	Supply Only: 69 cfm, 24.6 watts.	Exhaust Only: 69 cfm, 38.2 watts.
Interior Mass	None	
Mechanical Equipment 1	Heating: Fuel-fired air distribution, 50.1 kBtuh, 80.0 AFUE.	Heating: Fuel-fired air distribution, 64.0 kBtuh, 92.0 AFUE.
Mechanical Equipment 2	Cooling: Air conditioner, 49.5 kBtuh, 15.0 SEER.	Cooling: Air conditioner, 60.0 kBtuh, 19.0 SEER.
Mechanical Equipment 3	Water Heating: Conventional, Gas, 0.61 EF.	Water Heating: Conventional, Gas, 0.60 EF.
Programmable Thermostat	Heat=Yes; Cool=Yes	
Ducts	Uninsulated/Conditioned space	R-8.0Attic, exposed
Duct Leakage to Outside	0.00 CFM25 / CFA	0.04 CFM25 / CFA



Compare to the ENERGY STAR Reference Design

Select report(s):

<input type="checkbox"/> HERS Certificate	<input type="checkbox"/> NGBS 2015 Performance	<input type="checkbox"/> IECC 2006 Fuel Summary Comparison Fed. M...
<input type="checkbox"/> ENERGY STAR V3 Home Report	<input type="checkbox"/> 2005 EPAct Energy Efficient Home Tax Credit...	<input type="checkbox"/> MassSave 2017 Fuel Summary Comparison
<input type="checkbox"/> ENERGY STAR V3.1 Home Report	<input type="checkbox"/> Air Leakage Report	<input type="checkbox"/> MassSave 2016 Fuel Summary Comparison
<input type="checkbox"/> IECC 2015 ERI	<input type="checkbox"/> Emissions Summary	<input type="checkbox"/> Building Summary
<input type="checkbox"/> IECC 2015 Performance Compliance	<input type="checkbox"/> HERS Emissions Comparison	<input type="checkbox"/> HERS Rated Home Summary
<input type="checkbox"/> IECC 2012 Performance Compliance	<input type="checkbox"/> ENERGY STAR V3.1 Emissions Comparison	<input type="checkbox"/> HERS Reference Home Summary
<input type="checkbox"/> IECC 2009 Performance Compliance	<input type="checkbox"/> IECC 2006 Emissions Comparison	<input type="checkbox"/> IECC 2015 Proposed Home Summary
<input type="checkbox"/> IECC 2006 Performance Compliance	<input type="checkbox"/> IECC 2009 Emissions Comparison	<input type="checkbox"/> IECC 2015 Reference Home Summary
<input type="checkbox"/> 2015 IECC Building UA Compliance	<input type="checkbox"/> IECC 2012 Emissions Comparison	<input type="checkbox"/> IECC 2012 Reference Home Summary
<input type="checkbox"/> 2012 IECC Building UA Compliance	<input type="checkbox"/> IECC 2015 Emissions Comparison	<input type="checkbox"/> IECC 2009 Reference Home Summary
<input type="checkbox"/> 2009 IECC Building UA Compliance	<input type="checkbox"/> Fuel Summary	<input type="checkbox"/> IECC 2006 Reference Home Summary
<input type="checkbox"/> 2006 IECC Building UA Compliance	<input type="checkbox"/> HERS Fuel Summary Comparison	<input type="checkbox"/> ENERGY STAR V3.0 Reference Home Summ...
<input type="checkbox"/> IECC 2015 Certificate	<input checked="" type="checkbox"/> ENERGY STAR V3.1 Fuel Summary Compari...	<input type="checkbox"/> ENERGY STAR V3.1 Reference Home Summ...
<input type="checkbox"/> IECC 2012 Certificate	<input type="checkbox"/> IECC 2015 Fuel Summary Comparison	<input type="checkbox"/> Tax Credit Reference Home Summary
<input type="checkbox"/> IECC 2009 Certificate	<input type="checkbox"/> IECC 2012 Fuel Summary Comparison	<input type="checkbox"/> Massachusetts Reference Home Summary
<input type="checkbox"/> IECC 2006 Certificate	<input type="checkbox"/> IECC 2009 Fuel Summary Comparison	<input type="checkbox"/> NGBS 2015 Proposed Home Summary
<input type="checkbox"/> IECC 2015 Label	<input type="checkbox"/> IECC 2006 Fuel Summary Comparison	<input type="checkbox"/> NGBS 2015 Reference Home Summary
<input type="checkbox"/> IECC 2012 Label	<input type="checkbox"/> IECC 2015 Fuel Summary Comparison Fed. M...	<input type="checkbox"/> RESNET Standard Disclosure
<input type="checkbox"/> IECC 2009 Label	<input type="checkbox"/> IECC 2012 Fuel Summary Comparison Fed. M...	<input type="checkbox"/> Builder Affidavit
<input type="checkbox"/> IECC 2006 Label	<input type="checkbox"/> IECC 2009 Fuel Summary Comparison Fed. M...	<input type="checkbox"/> Indoor Air Plus Certificate
<input type="checkbox"/> Indoor Air Plus Label		
<input type="checkbox"/> Indoor Air Plus Letter		
<input type="checkbox"/> DOE Zero Energy Ready Certificate		
<input type="checkbox"/> End Use Energy Costs		
<input type="checkbox"/> Component Loads		
<input type="checkbox"/> Component Costs		



Compare to the ENERGY STAR Reference Design

Ekotrope ENERGY STAR Fuel Summary Comparison:

Annual End-Use Consumption	ENERGY STAR V3.1 Ref.	Rated Home	Savings	% Saved
Heating (Gas Therms)	484.2	1,138.7	-654.5	-135.2%
Heating (Electric kWh)	292.8	565.4	-272.6	-93.1%
Cooling (Electric kWh)	346.1	508.1	-162.0	-46.8%
Water Heating (Gas Therms)	225.3	233.0	-7.7	-3.4%
Water Heating (Electric kWh)	0.0	0.0	0.0	0%
Lights & Appliances (Electric kWh)	6,268.1	7,741.1	-1,473.0	-23.5%
Lights & Appliances (Gas Therms)	33.4	33.4	0.0	0%
Total Natural Gas Therms	743.0	1,405.1	-662.1	-89.1%
Total Electric kWh	6,907.0	8,814.6	-1,907.6	-27.6%
Total Onsite Generation kWh	0.0	0.0	0.0	0%

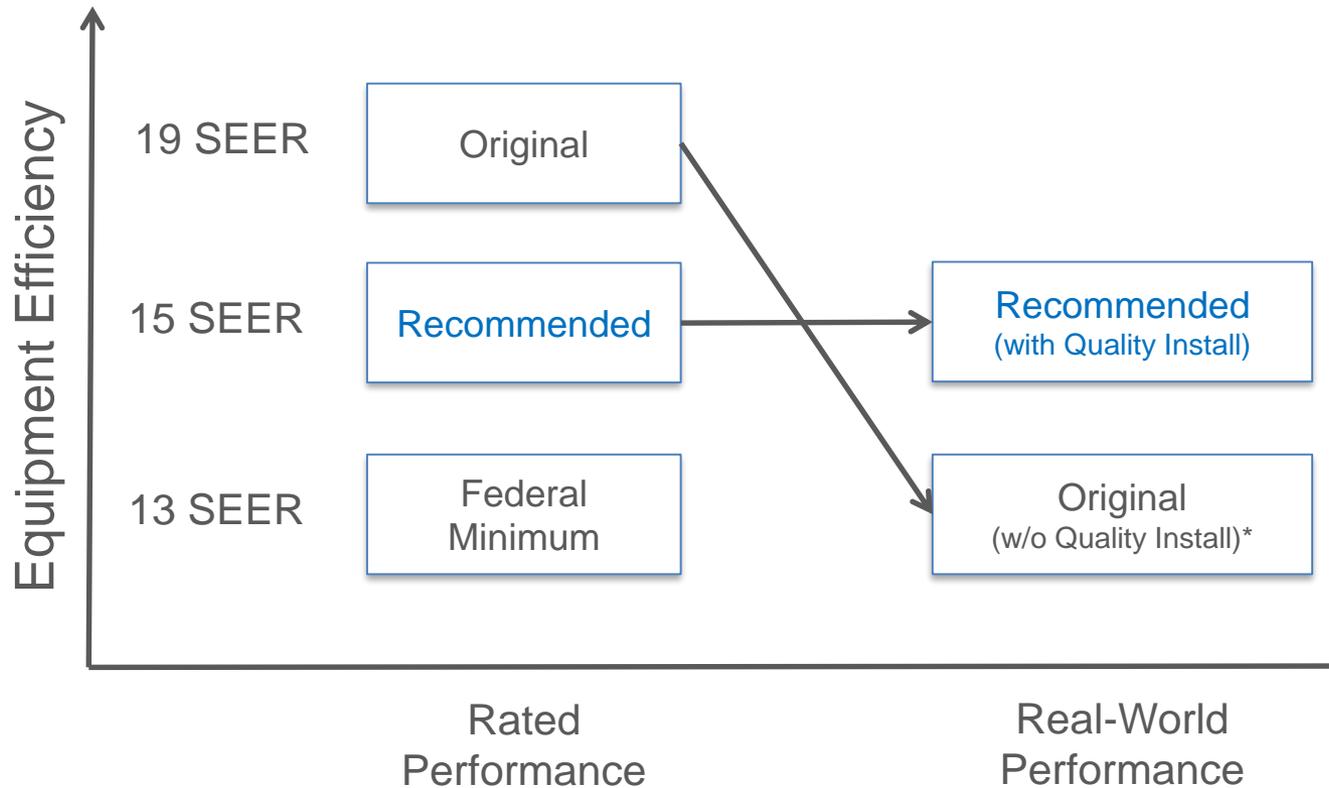


Part 3

Specific Tweaks



Carefully consider equipment efficiency upgrades



*Per NIST study at:

<https://www.nist.gov/news-events/news/2014/11/underperforming-energy-efficiency-hvac-equipment-suffers-due-poor>



Keep tested ventilation 85-100% of design rate

- May be using 115% of design ventilation value for a worst-case template
- Note that in Rev 08 it's not $\pm 15\%$ (or 15 CFM), or 85-115%
- But – you could set at 85-100% if desired

7. Whole-House Mechanical Ventilation System

7.1 Rater-measured ventilation rate is within either ± 15 CFM or $\pm 15\%$ of design value (2.3) ⁴²



Lower ventilation rates where infiltration is higher

- When infiltration is high, check 62.2-2013 rate, which includes and infiltration credit
- For example, here’s a home with 6 ACH50

Air Leakage

Ventilation			ASHRAE	ASHRAE
	Mechanical	Exhaust Only	62.2-2010	62.2-2013
Sensible Recovery Eff. (%)		0.0		
Total Recovery Eff. (%)		0.0		
Rate (cfm)		52	52	36
Hours/Day		24.0	24.0	24.0
Fan Watts		9.0		
Cooling Ventilation		Natural Ventilation		

Vary performance test thresholds by permutation

- Instead of using a development-wide worst-case threshold for blower door and duct leakage, look at historical trends for different permutations
- For example, townhome end-units tend to be tighter than middle units



ENERGY STAR Gas Storage (Tank) Water Heater

- 1-2 HERS points available for moving to ENERGY STAR qualified gas storage water heater, which can be a low marginal cost



Instant (Tankless) Gas Water Heater

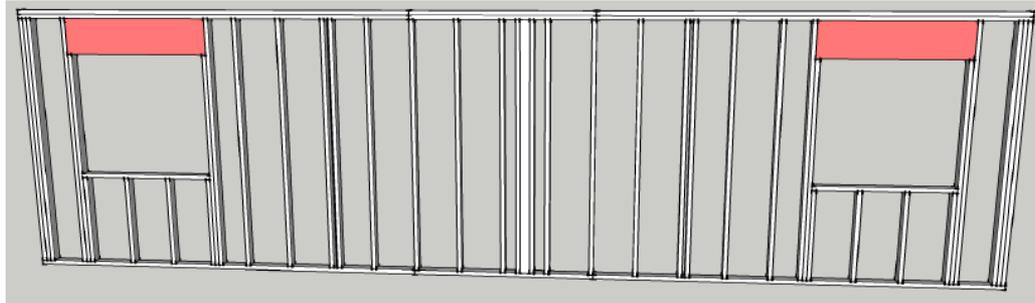
- Even better, upgrade to a tankless water heater, which can yield 4-6 HERS points or more
- Now (or soon) even more savings because the ENERGY STAR Reference Design will use a 50 gallon 0.59 EF, instead of a 40 gallon 0.61 EF, gas storage water heater.



Reduced Framing Factor

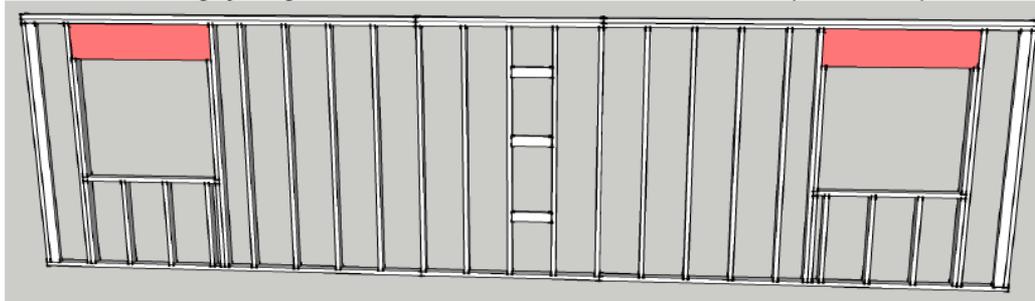
Standard Framing = 23% framing factor

30' Long by 8' High 2x4 16" OC Standard Wall with Two Windows (4'-1" x 3'-8.5")



Advanced Framing = 18% framing factor*

30' Long by 8' High 2x4 16" OC ENERGY STAR Wall with Two Windows (4'-1" x 3'-8.5")



*Per Cost & Savings Estimates at:

https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/EstimatedCostandSavings.pdf



Use Rated Washer Specs

- If a washer is being installed, always use the actual specs
- Don't use defaults if you can help it

Clothes Dryer and Washer

Dryer fuel type

Detailed Inputs

Dryer CEF

Dryer utilization factor

Washer Labeled Energy Rating [kWh]

Washer IMEF

Natural Gas Operating Cost [\$]

Washer Capacity [cu. ft.]

Gas Rate [\$/therm]

Electric Rate [\$/kWh]

Set Washer/Dryer Defaults:

RESNET Defaults	Med. Efficiency
High Efficiency	ENERGY STAR



Low-Flow Water Fixtures

- Maybe ½ point or so, but can combine with other measures

DHW Efficiencies

- All bath faucets & showers \leq 2 gpm
- All DHW pipes fully insulated \geq R-3

Plumbing Design (Enter plan view rectangular distance)

Recirculation:

Farthest fixture to DHW heater (ft):

autocalc vertical, for conditioned floors (ft): +

autocalc vertical, for uncond. bsmt (ft): +

TOTAL Pipelength for longest DHW run (ft):



High-Efficiency Lighting 100% and at Exterior

- Exterior lighting can be 1 HERS point alone
- Consider going to 100% interior if that's what is being used

Lighting	
CFL (%):	<input type="text" value="100.0"/>
Pin-Based FL (%):	<input type="text" value="0.0"/>
Interior Fixtures	
Exterior Fixtures(%):	<input type="text" value="100.0"/>
Garage Fixtures(%):	<input type="text" value="100.0"/>



Part 4

Example Home



Find the difference between ENERGY STAR and HERS Index

House Characteristics:

- Built in Abilene Texas, CZ 3
- Square footage = 2917 sq. ft.
- Bedrooms = 4
- Home type = Single Family Detached
- HERS Index = 66
- Target HERS Index to meet ENERGY STAR = 66



! HERS to ENERGY STAR

Measure	HERS Points
Removed costs associated with flash and batt insulation at the rim joists	No Change
Advanced Framing techniques + Low-flow fixtures	HERS Index down 1 point
16 SEER AC to 14.5 SEER AC	HERS Index up 2 points
Increased lighting from 85% to 100%	HERS Index down 1 point
Total	HERS 66 and ENERGY STAR



\$ Cost Savings

Measure	Costs saved
Removed costs associated with flash and batt insulation at the rim joists	\$400
Advanced Framing techniques	\$150
Low-Flow Water Fixtures	No Cost
16 SEER AC to 14.5 SEER AC	\$600
Increased lighting from 85% to 100%	(-\$50)
Reduce Cooling Size of AC Units	\$250
Total	\$1400



\$ Additional Costs

Measure	Cost over HERS
Credentialed HVAC contractor + ENERGY STAR HVAC Design Report	+\$100
Whole-house ventilation system	+\$250
Comfort Vents	+\$150
Rater Costs	+\$250
Total	+\$750



\$ Net Savings

Measure	Cost over HERS
Total Savings from going from re-optimizing at HERS 66	\$1400
Total Costs going from HERS-only to ENERGY STAR	\$750
Total Savings for the builder	\$650



Summary: How HERS Raters Help Builders

Builders want to save money while meeting customer expectations to keep up sales:

1. **Explain cost-cutting measures.** For example, advanced framing is less expensive AND more comfortable/efficient.
2. **Think of cost savings in dollars and cents.** Trimming a little here and there is an effective and doable approach.
3. **An instantly-recognized, govt.-backed, trusted label is a plus.** Saving money on construction materials helps, but don't forget other value-adds that come with ENERGY STAR partnership: free marketing & educational tools, program support, and brand recognition.



Questions?

Web:

Main: www.energystar.gov/newhomespartners
Technical: www.energystar.gov/newhomesguidelines
Training: www.energystar.gov/newhomestraining
HVAC: www.energystar.gov/newhomesHVAC

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