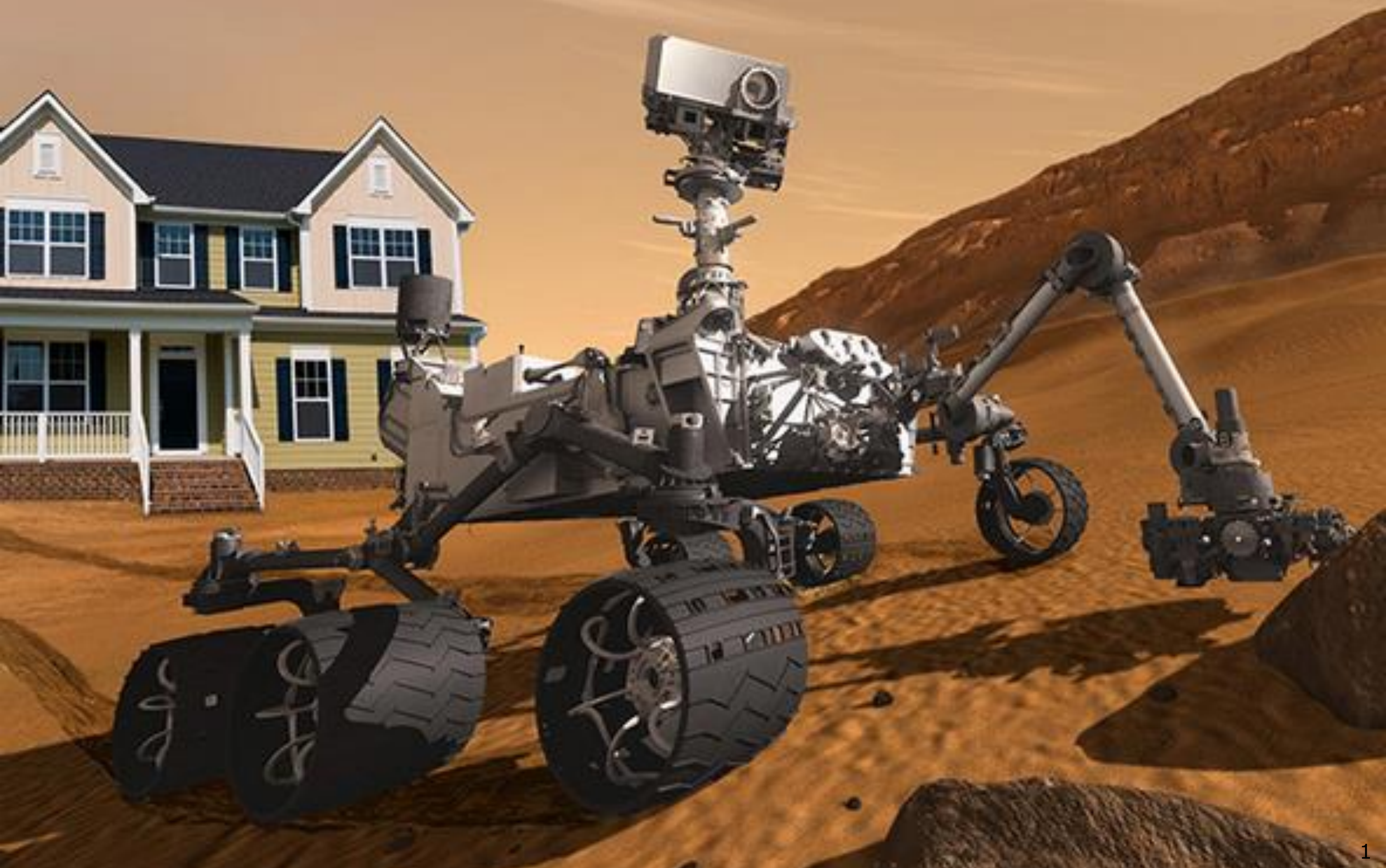
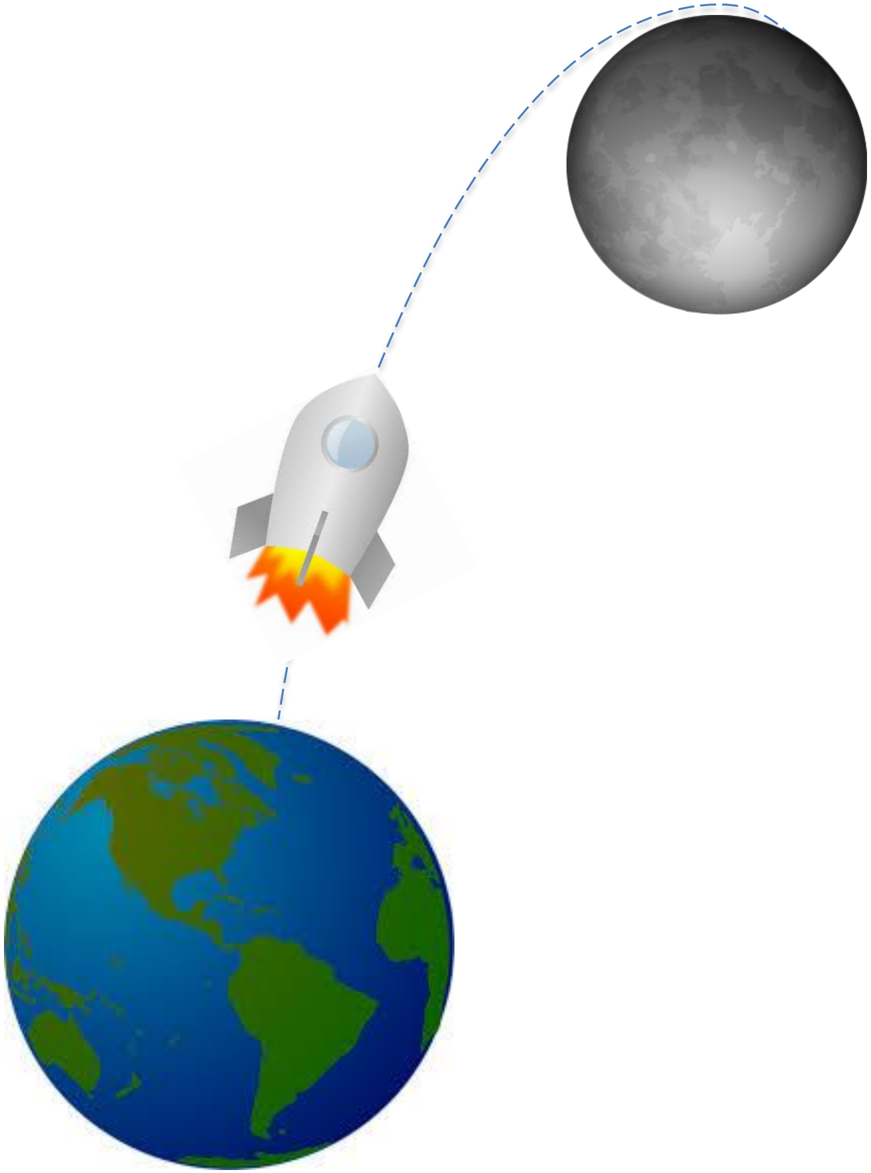
Building a Home *IS* Rocket Science



What is Rocket Science?



- Goal:
  - Successful mission
- Parameters:
  - Weight
  - Size
  - Fuel supply
  - Comm systems
  - Life support
  - Route
  - MANY more

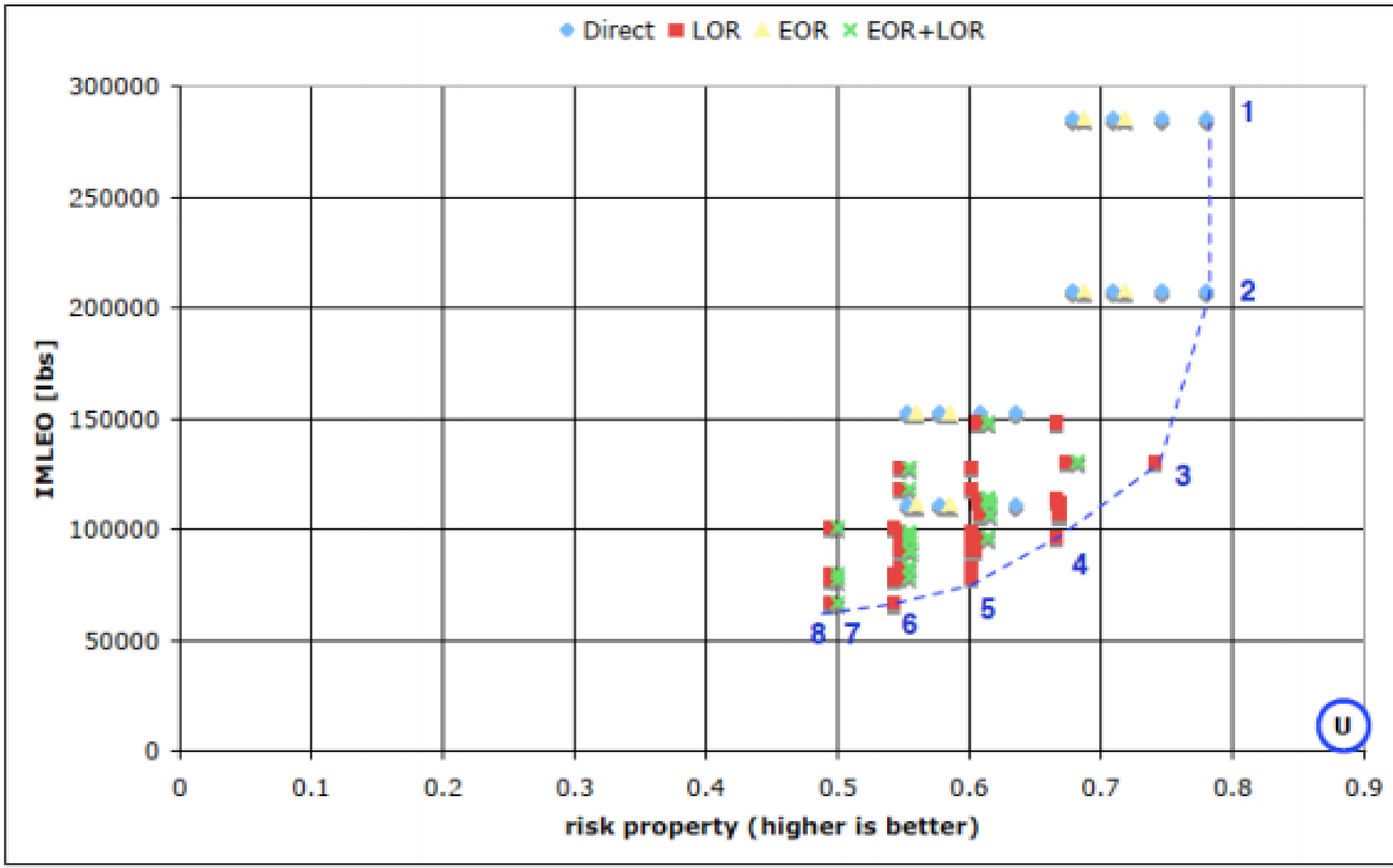
What is Rocket Science?

Literally BILLIONS of
possible designs

How can we choose the
design with the highest
probability of success?

What is Rocket Science?

How can we make smart decisions?



Determine evaluation criteria and simulate all your options.

Rocket Science --> Home Building

Success Criteria

- Mission Success Probability
- Cost (Tax Dollars)
- Crew Safety

?

Decisions to Make

- Spacecraft shape
- Communication system
- Fuel system
- Ground transport system
- Etc.

?

Rocket Science --> Home Building

Success Criteria

- Mission Success Probability
- Cost (Tax Dollars)
- Crew Safety

→

- Cost
- HERS Score
- Comfort Level
- Energy Bills

Decisions to Make

- Spacecraft shape
- Communication system
- Fuel system
- Ground transport system
- Etc.

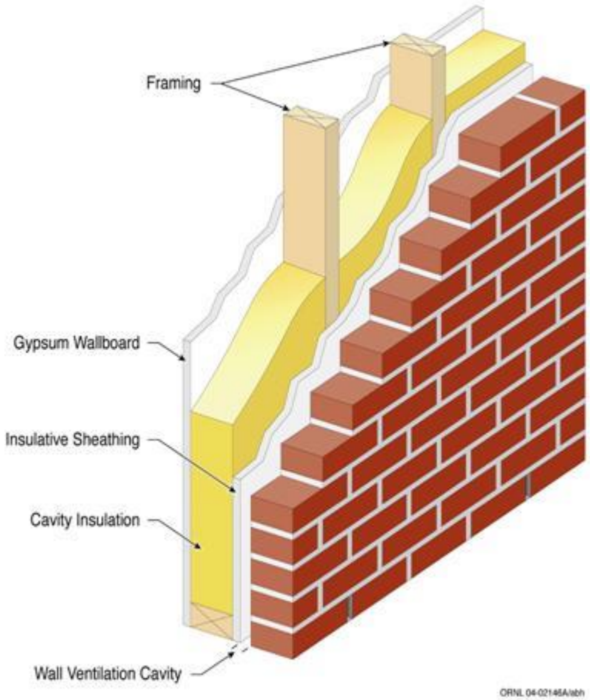
→

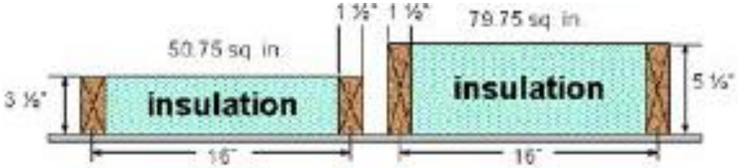
- HVAC efficiency
- Envelope insulation
- Window type
- Ventilation
- Lighting

Building a Home is Complex Too!

Options for Wall Systems

- 2x4 or 2x6 (or more!)
- Advanced Framing
- 16″ O.C. or 24″ O.C.
- Fiberglass or Foam?
- R11, R13, R15, R19, R21…
- Exterior Continuous Insulation





Building a Home is Complex Too!

Options for HVAC

- Furnace/AC or Heat Pump
- 14 SEER or 16 SEER
- 80, 92, or 96 AFUE
- Natural Gas, Propane, Electric?
- Single Speed or Variable?
- Proper sizing

Image from www.mcair.com

Building a Home is Complex Too!

Options for Water Heating

- Tankless, 50G, 80G
- Natural Gas or Electric
- EF (Energy Factor)
- Condensing?

Building a Home is Complex Too!

Claims from Manufacturers

$365

Energy Savings per Year.*

Thousands of competing manufacturer claims.

20-30 percent less energy

save more than $350 million each year

What do they mean?

Who do you trust?

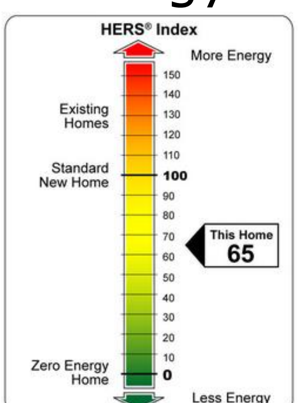
SAVE UP TO $600

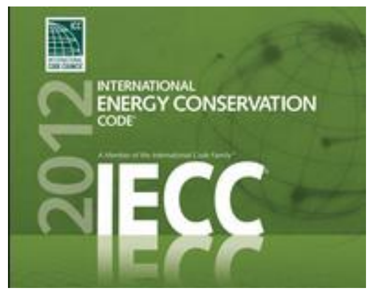
Building a Home is Complex Too!

Other Parameters

Goals:

- ENERGY STAR
- HERS Scores
- EFL
- LEED
- NGBS
- Focus on Energy





Codes:

- IECC
  - Current Code
  - Future Code
- Local amendments
- Many compliance paths

Incentives:

- Rebates
- Tax Credits
- Loans
- RECs

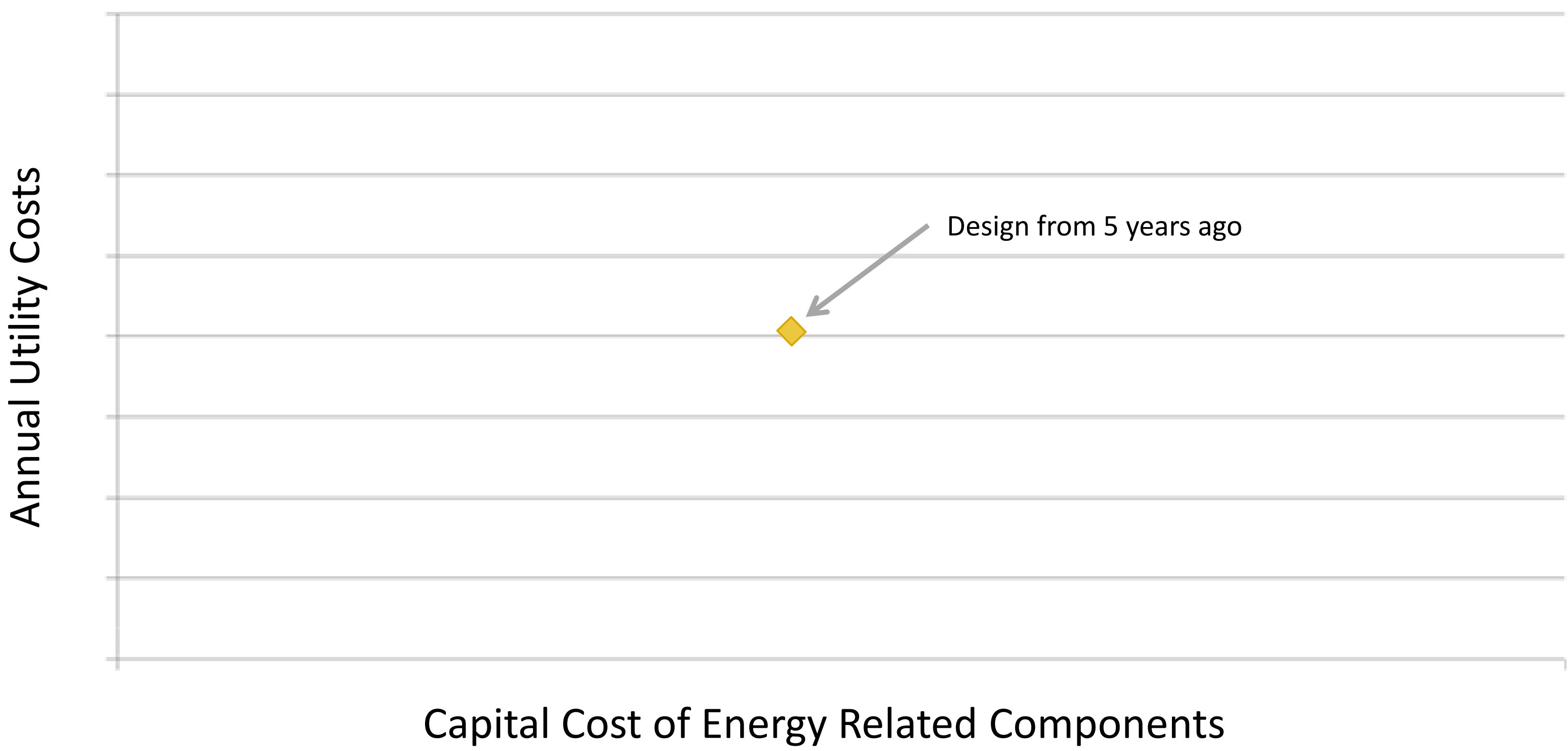
A Possible Solution

1. Upstream energy analysis to integrate it into the design process.

2. Determine key parameters and evaluation criteria.

3. Use computing power to simulate performance and cost to find optimal designs.

How Building Design Process Works Today



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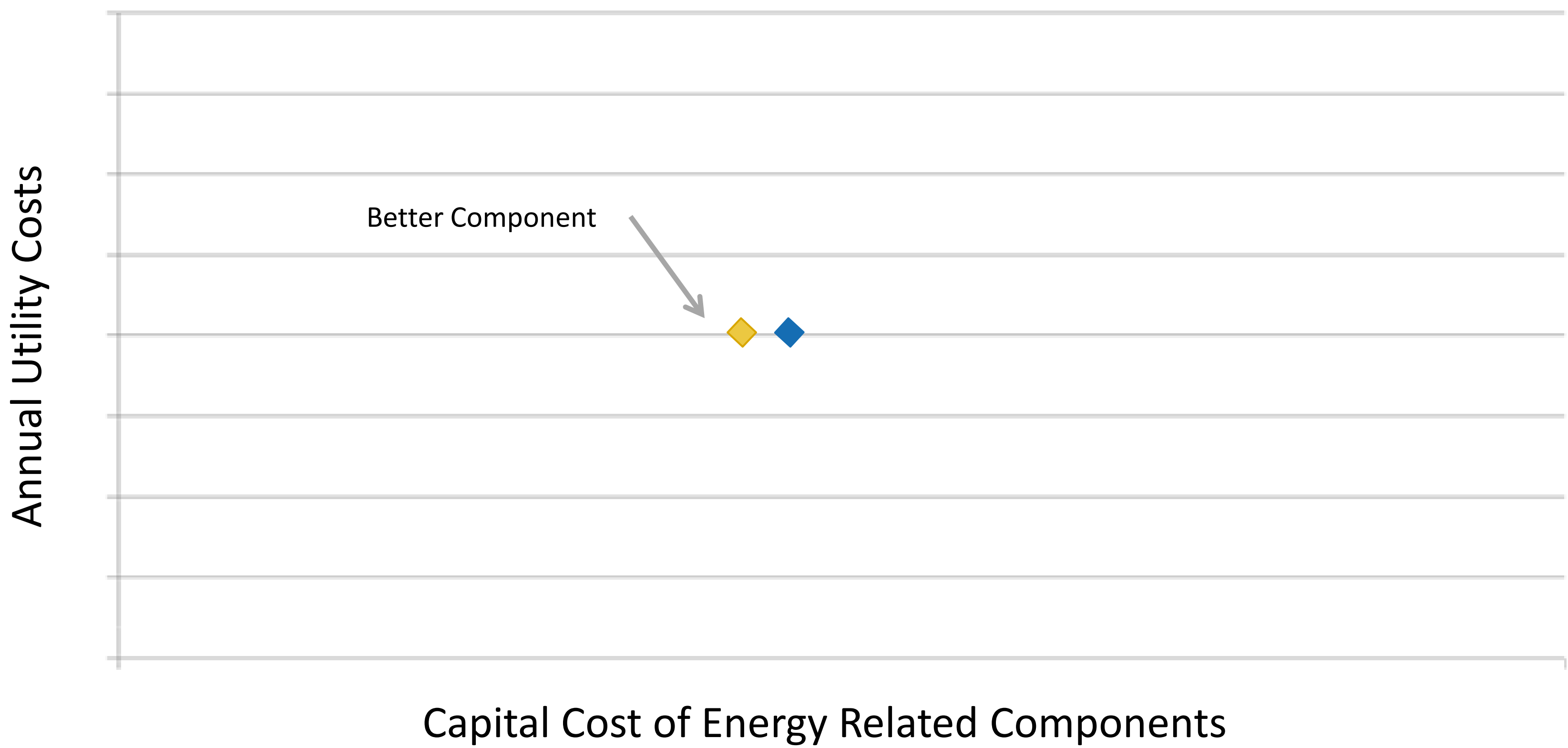

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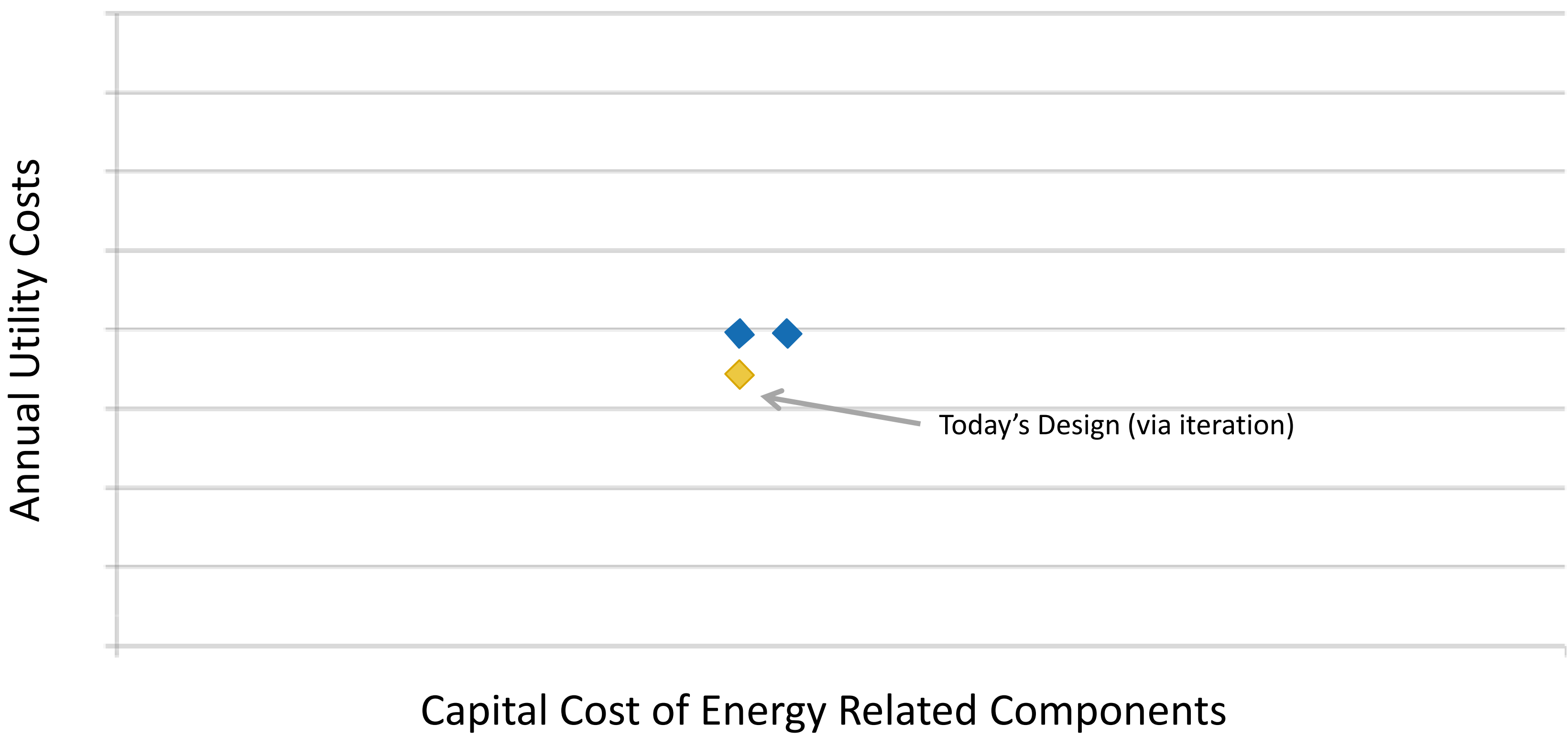
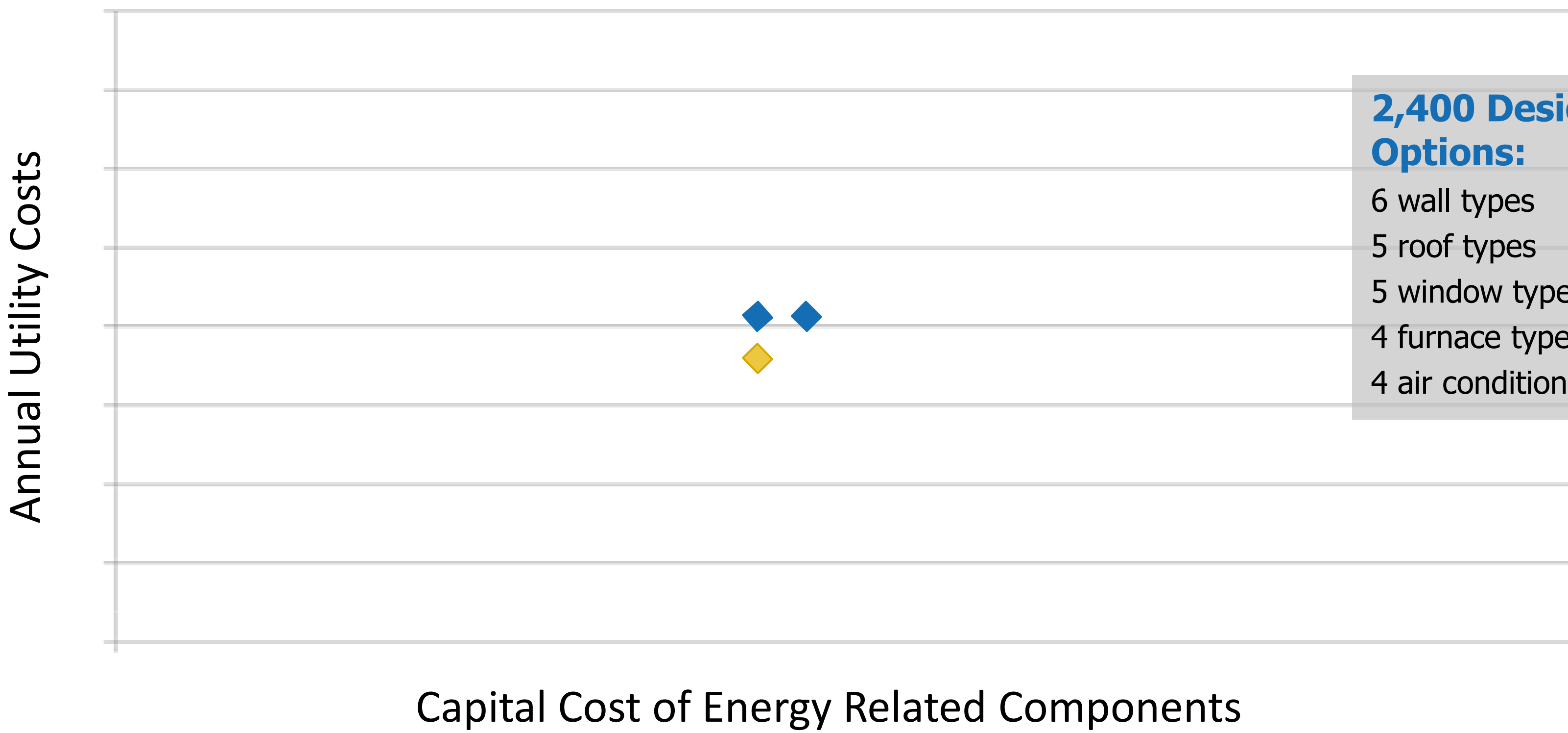


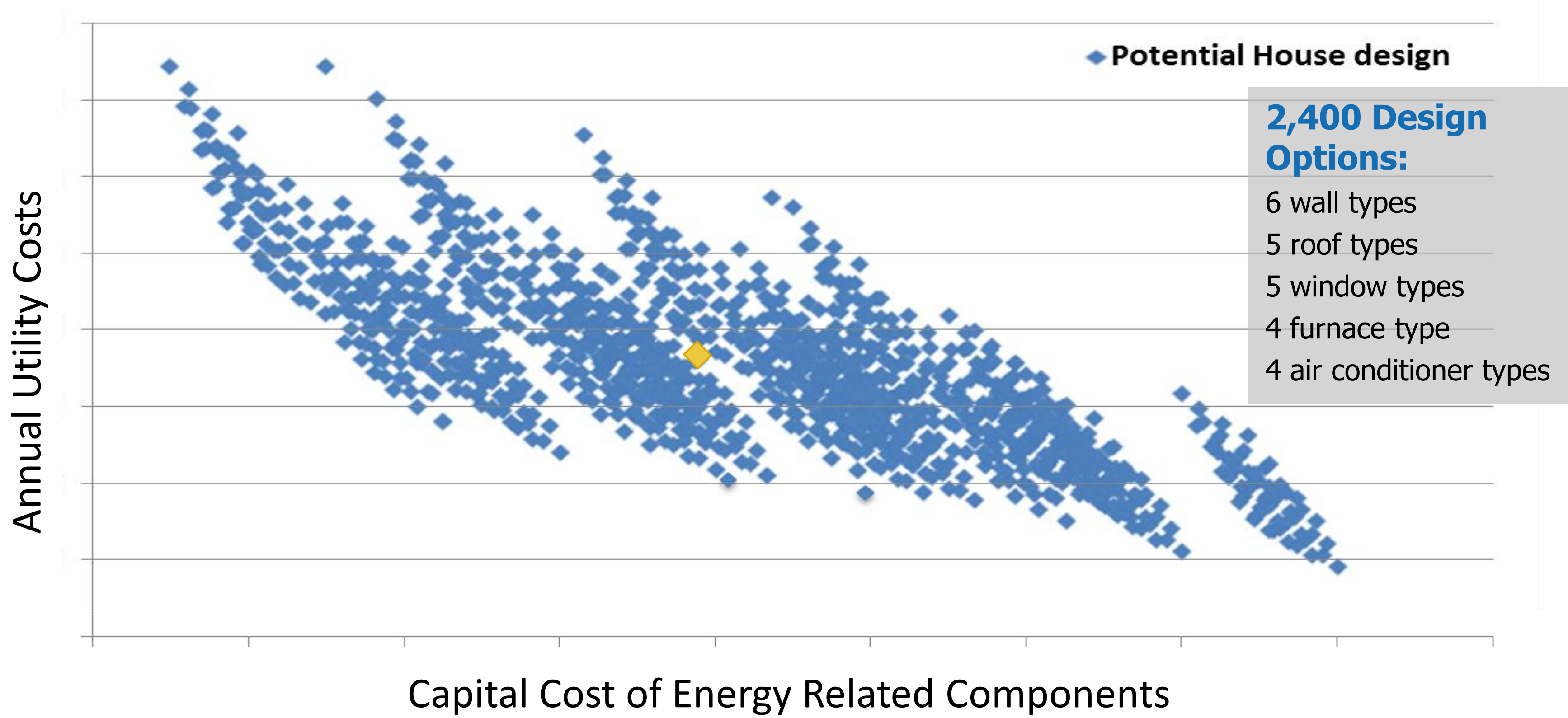
System Optimization Approach



2,400 Design Options:

6 wall types
5 roof types
5 window types
4 furnace type
4 air conditioner types

System Optimization Approach



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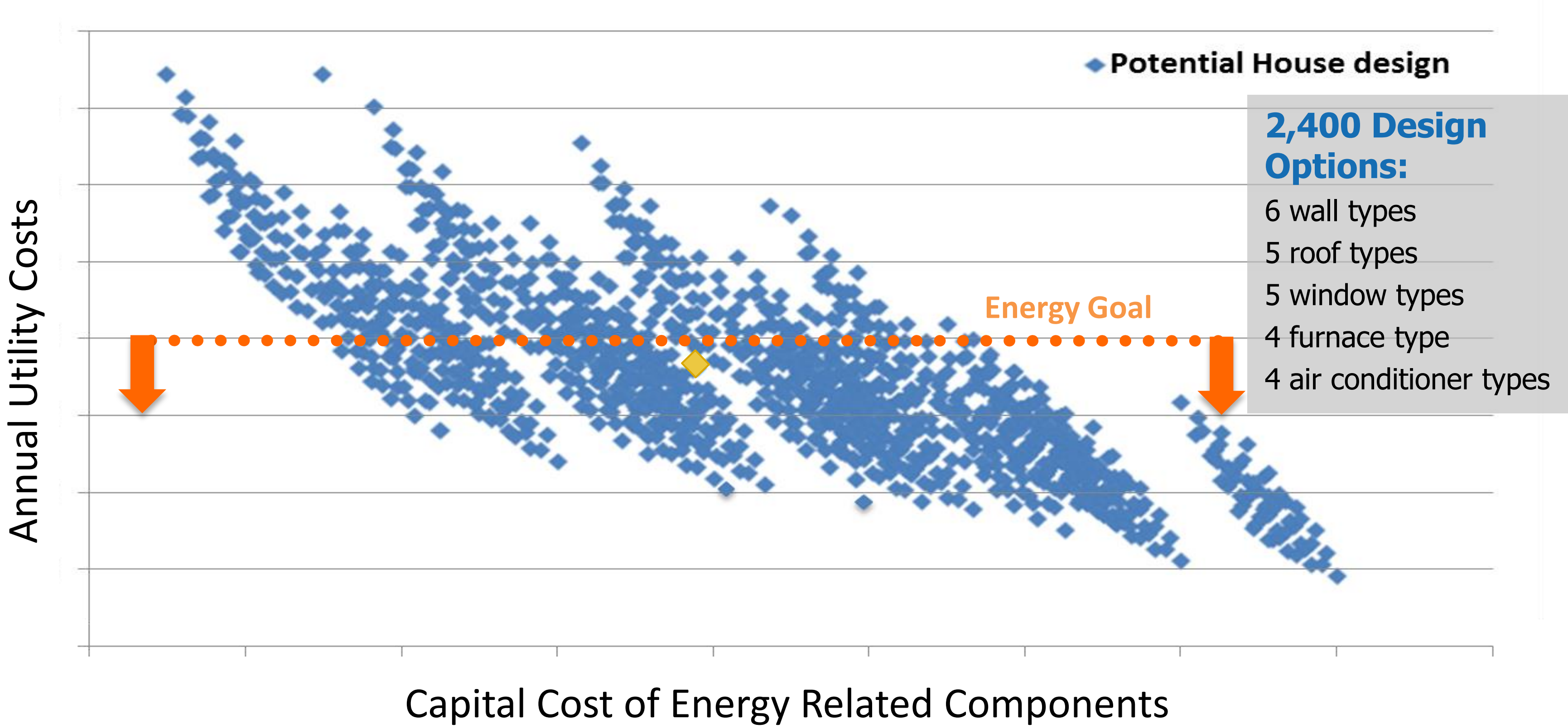

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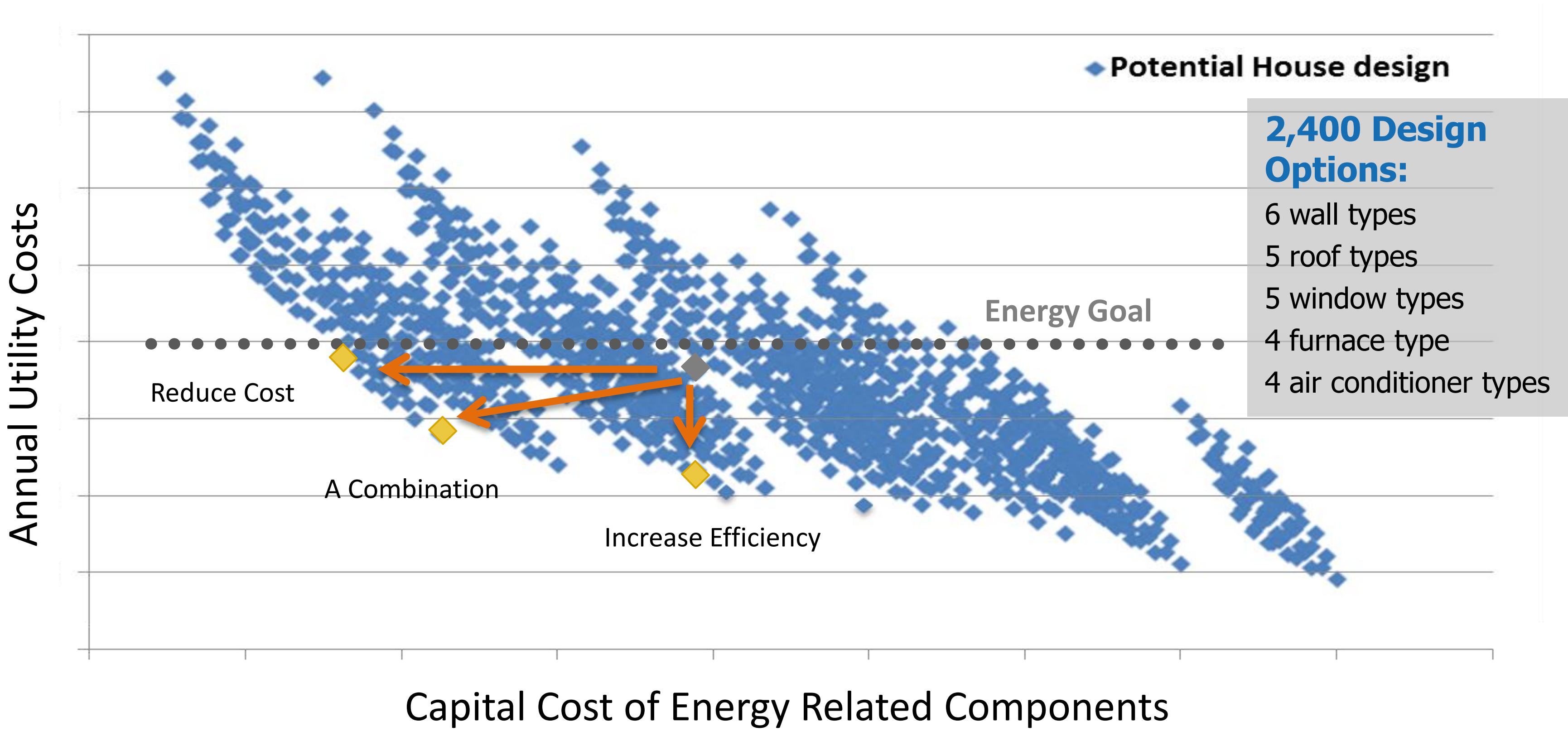

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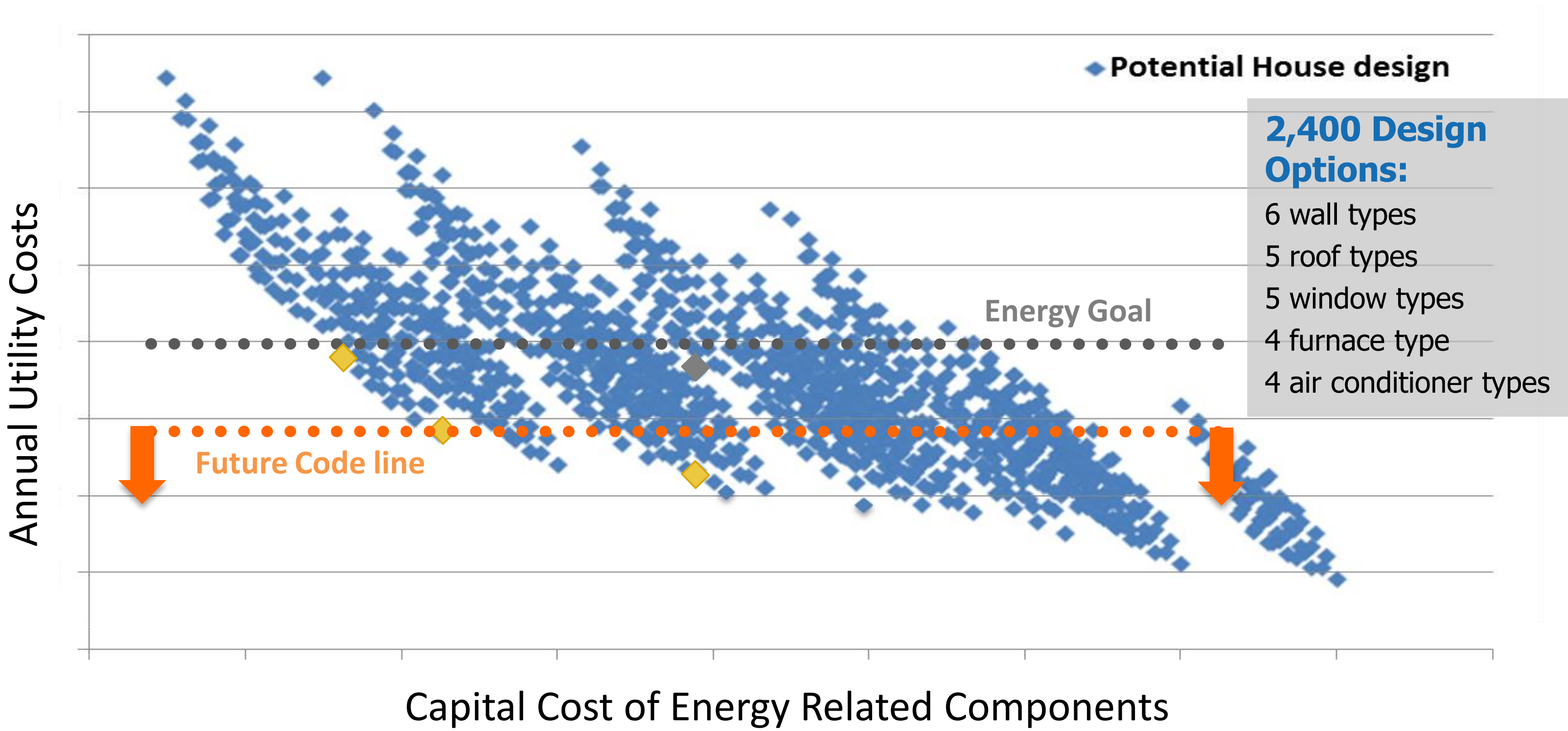


Does this really make a difference?

REAL SCENARIOS

Real Scenarios

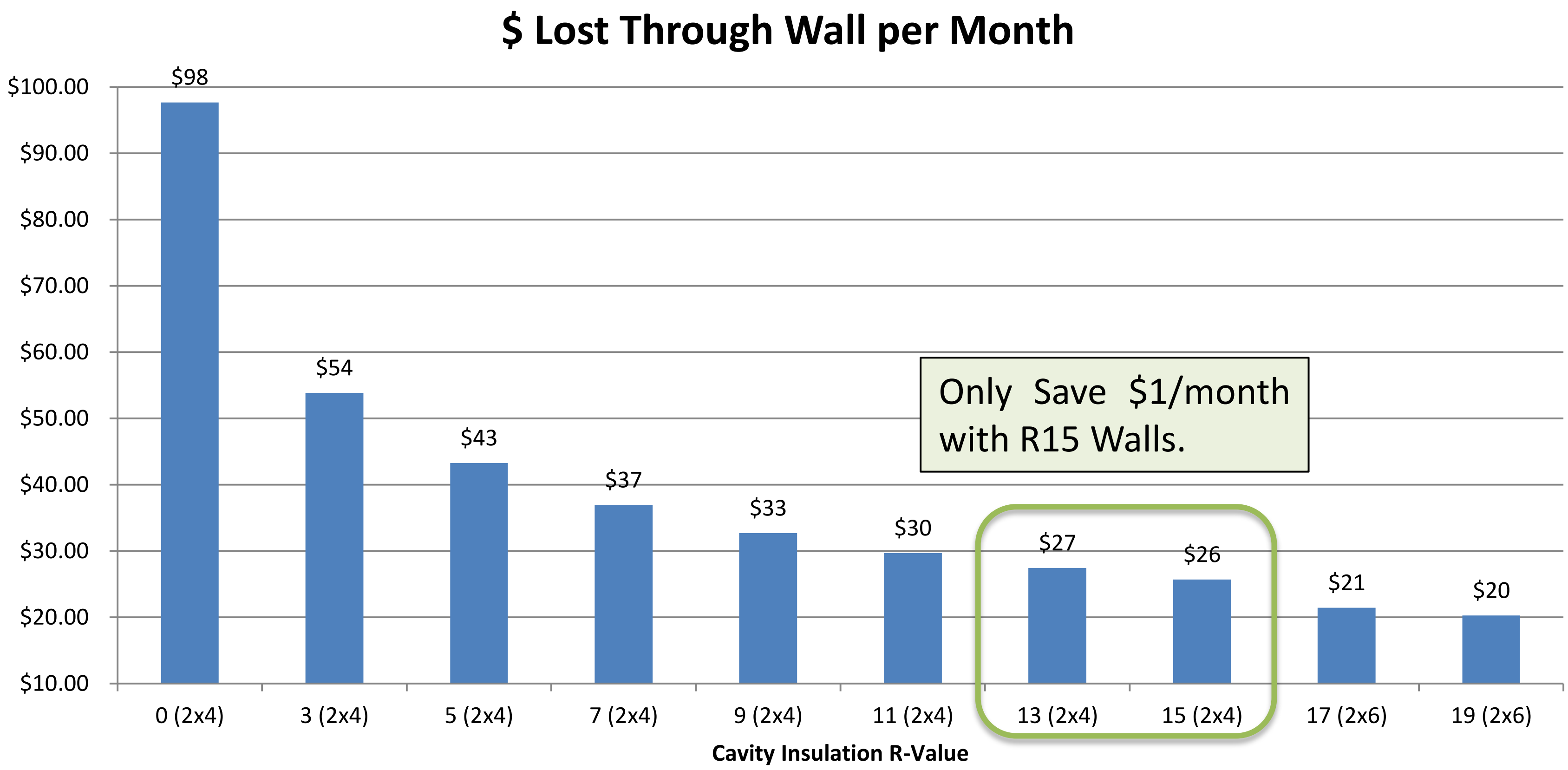
Survey Question

In a 5,000 ft^2 house in Indianapolis, how much does using R15 walls instead of R13 save a homeowner per month?

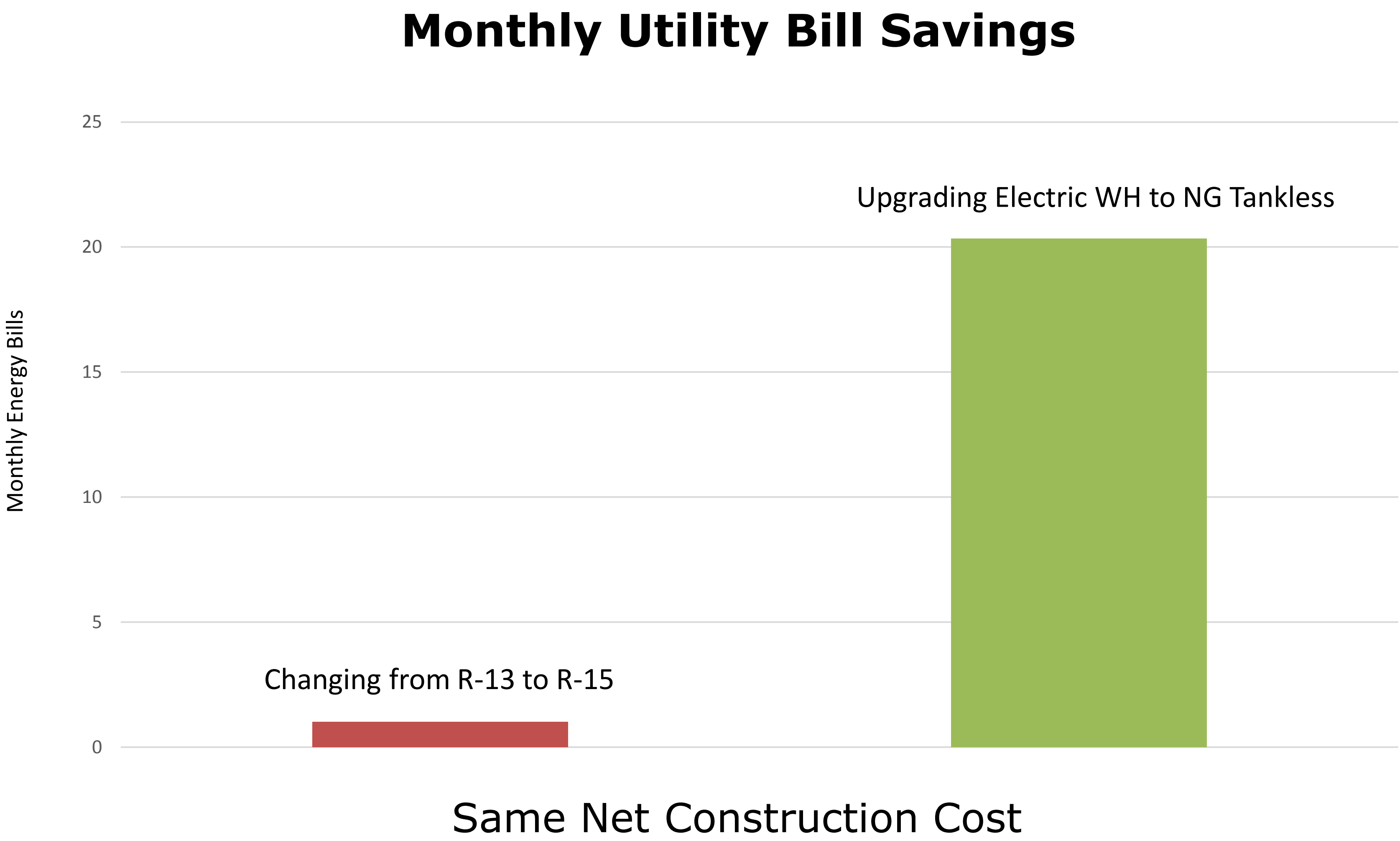
A. More than $50
B. $25 - $50
C. $10 - $25
D. $5 – 10
E. Less than $5

Wall Diminishing Returns

More is not necessarily better



Real Scenarios – Unexpected Tradeoffs



Real Scenarios – Utility Rebates

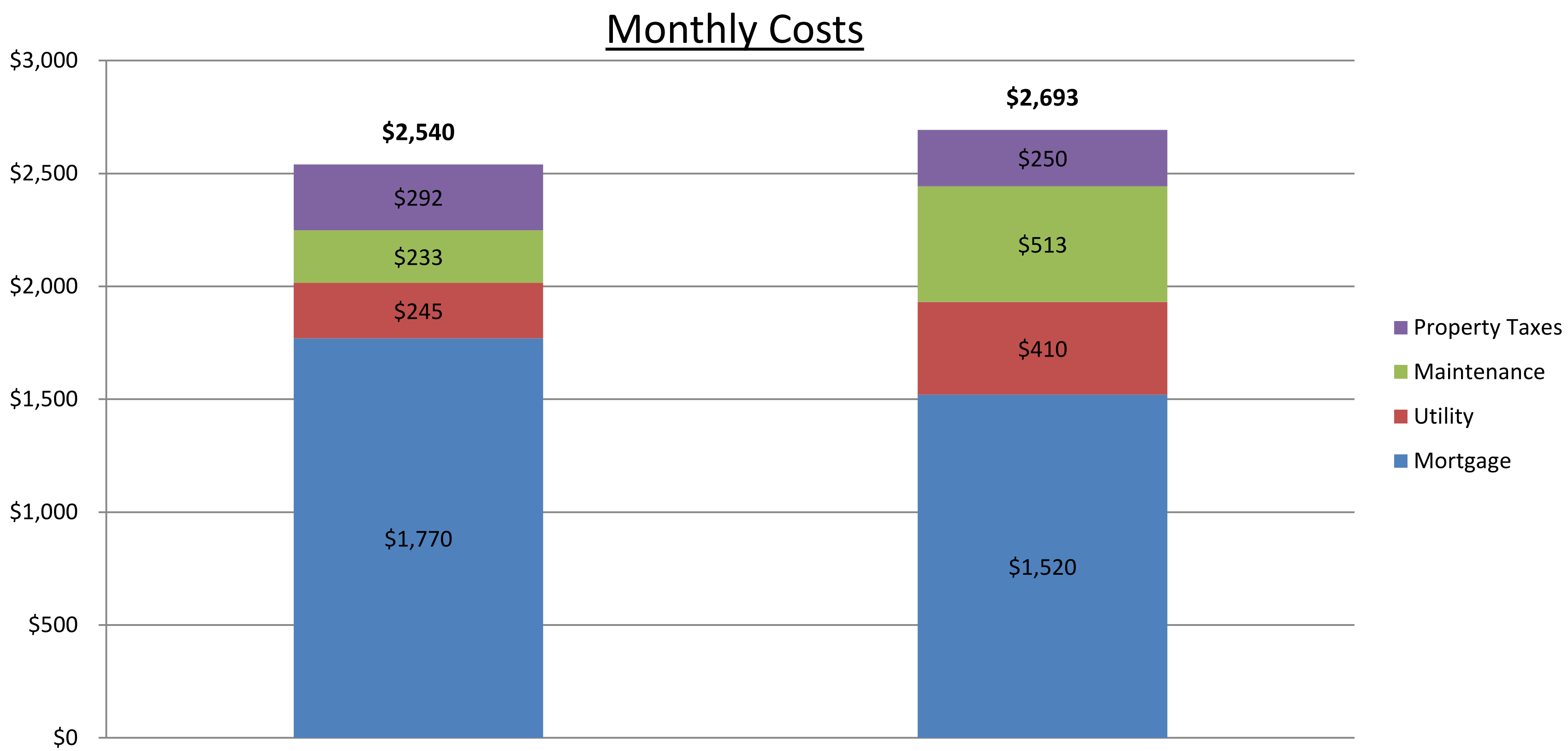
Real Example of Impact of Optimization w/ Utility Incentives

	Initial House Design (No rebate)	Optimized With Performance-based Utility Rebate
HERS	69	55 (-14)
Capital Cost w/ Incentives	Baseline	-$1,366
Payback Period	N/A	Instant
Monthly Energy Bills	$138	-$15

Results from one large production builder in North Carolina

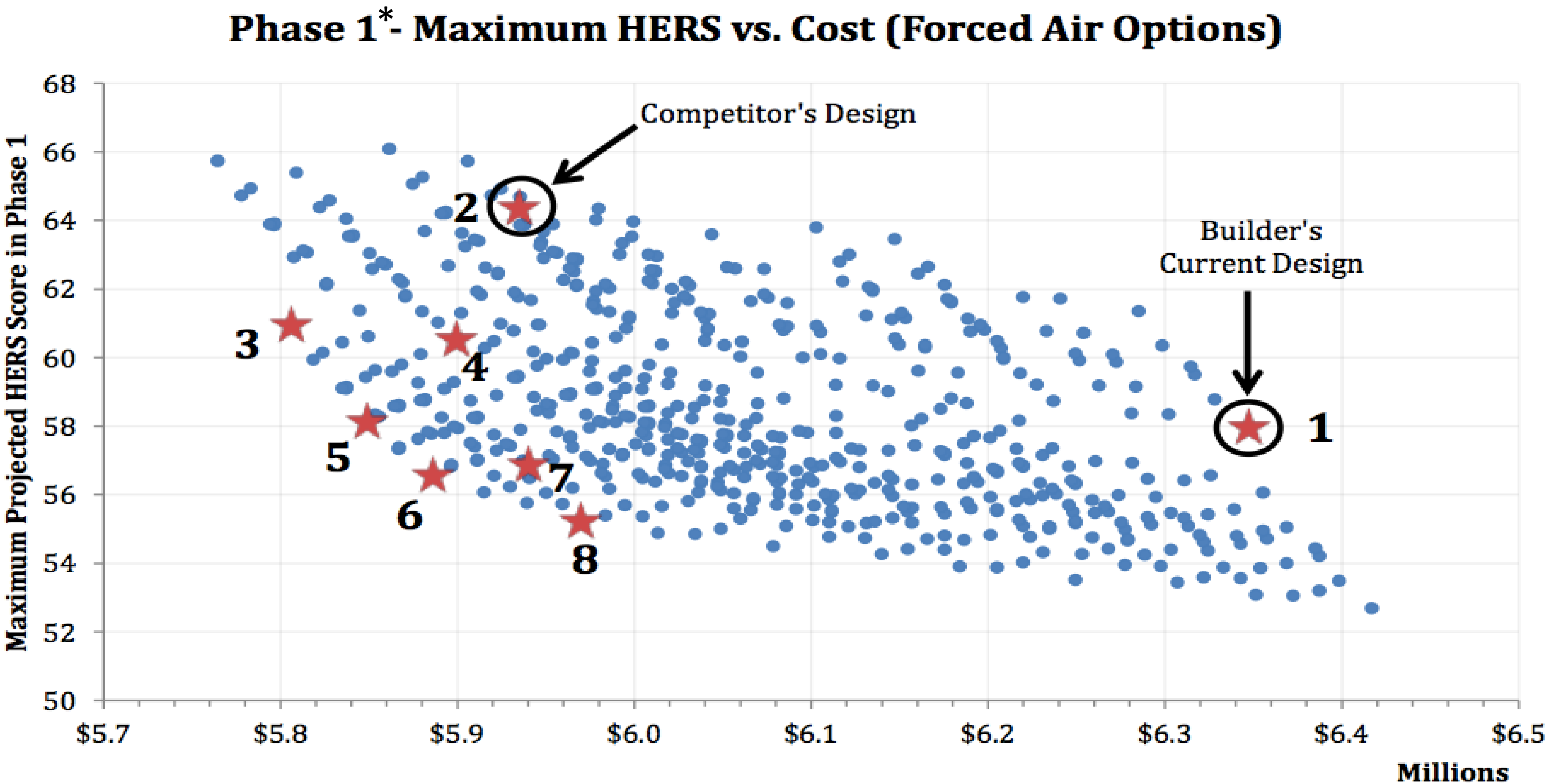
Real Scenarios – Total Ownership Costs
may be less for a more expensive new home

	New Home	Resale Home
Sale Price:	$350,000	$300,000



A Real Use Case – New Mexico

Purpose: Identify optimal energy specification that is the most cost effective; comparing performance (HERS, energy bills), code, cost and sales velocity



***7 base plans; ~80 homes**

A Real Use Case – New Mexico
Changes to Baseline Spec

= changes from Builder Spec

	1. Baseline (HERS 58)	Option 3 (HERS 61)	Option 5 (HERS 58)	Option 6 (HERS 57)	Option 8 (HERS 55)
Capital Cost w/incentives	$6.35MM	$5.81MM	$5.85MM	$5.89MM	$5.97MM
Only changes are represented below. All other materials stay the same.					
Attic Insulation	R49 Blown	R30 Blown	R38 Blown	R49 Blown	
Slab	R23 ICF + R5 Under	R5 Footer		R10 Footer	R10 Footer + R5 Under
Above Grade Wall	2x6 R20.4 + 2” EPS	2x4 R13 + R6 Insulated Sheathing			
Air Conditioner	15 SEER	13 SEER			
Heating Equip	95.5 AFUE Furnace	92 AFUE Furnace	95.5 AFUE Furnace		
Water Heater	50 Gal NG	50 Gallon GE GeoSpring Hybrid Electric			NG Tankless (0.95 EF)

How to Implement this?

Few Options:

- Manual analysis with HERS Rater
- Ekotrope
- BEopt

How do you determine energy specs today?

Let’s share techniques!

BEopt
Building Energy Optimization
with Hour-by-Hour Simulations

NREL
National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
www.nrel.gov

ekotrope

Questions?

Nick Sisler

Co-Founder, Lead Engineer

Ekotrope

nick@ekotrope.com

617-453-8041