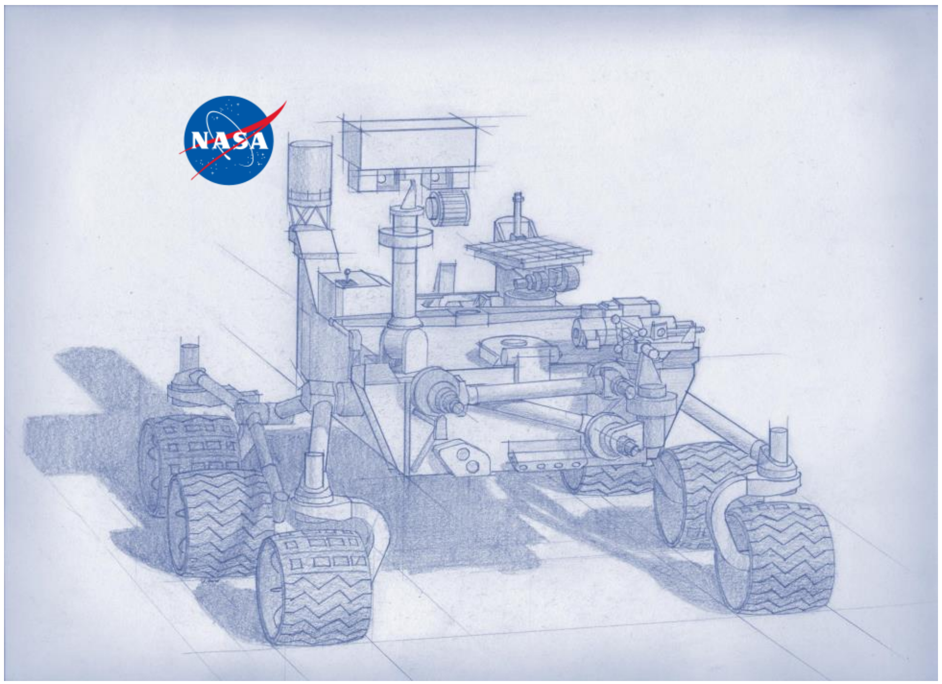
How to Build Better Homes for Less Money

Applying Lessons from NASA and Major League Baseball



Presented by: Cy Kilbourn

Audience Survey

- Raters
- Providers
- Builders
- Efficiency Program Personnel
- Utility Personnel
- Others?

What makes a "Better Home"?

What makes a “Better Home”?

Comfort

Low Cost of Ownership

Energy Efficiency

Low Environmental Impact

The Real Benefits of Features

Features

- 16+ SEER Air Conditioner
- High R Envelope
- R60 Attic Insulation
- Low blower-door results
- Heat Recovery Ventilator

The Real Benefits of Features

Features

- 16 SEER Air Conditioner
- High R Envelope
- R60 Attic Insulation
- Quality Air Sealing
- Heat Recovery Ventilator

Benefits

- Low Cost of Ownership
- Comfortable Living
- Low Environmental Impact
- Resale Value

How to Build a Better Home

Audience Poll:

“Raise your hand if you think building a better home means spending more money.”

How to Build a Better Home:
The Typical Path

14 SEER

16 SEER

Better Home = More Expensive Home

How to Build a Better Home: The Typical Path

14 SEER

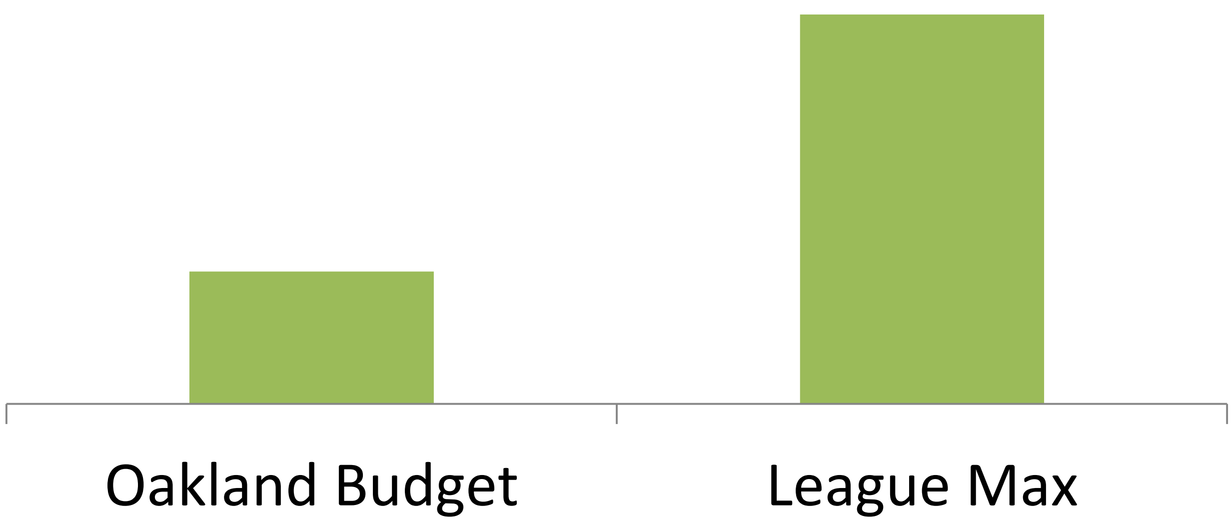
Is there a better way?

Better Home = More Expensive Home

Let’s talk baseball…

Oakland: 2002

The Problem:
Build a better team with less money than the competition (~1/3 of the max league salary total).



Oakland: 2002

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The Solution?

Oakland: 2002

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The Solution?

Oakland: 2002

The Problem:

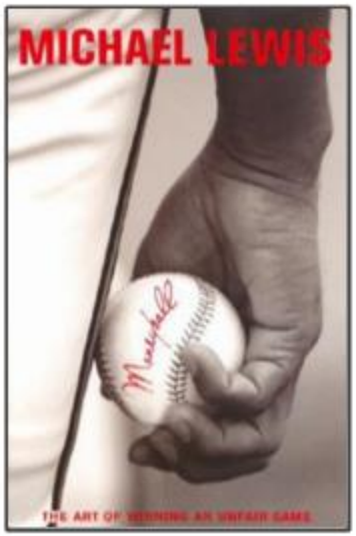
Build a better team with less money than the competition (~1/3 of the max league salary total).

The Solution?

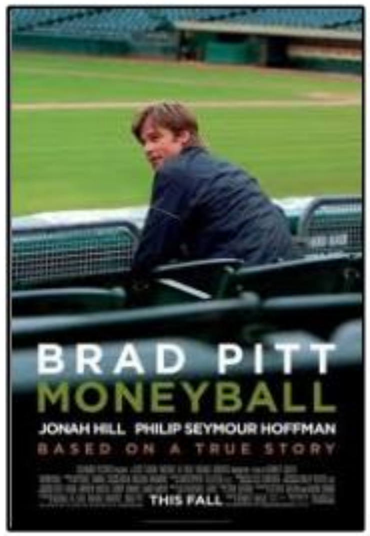
Moneyball - “Sabermetrics”. Using superior analysis to put undervalued players together to form a better performing team.

The Moneyball Solution

THE BOOK



THE MOVIE



"Your goal shouldn't be to buy players, your goal should be to buy wins."

Billy Beane, GM
Oakland Athletics

How it works

1. Determine success metrics and constraints

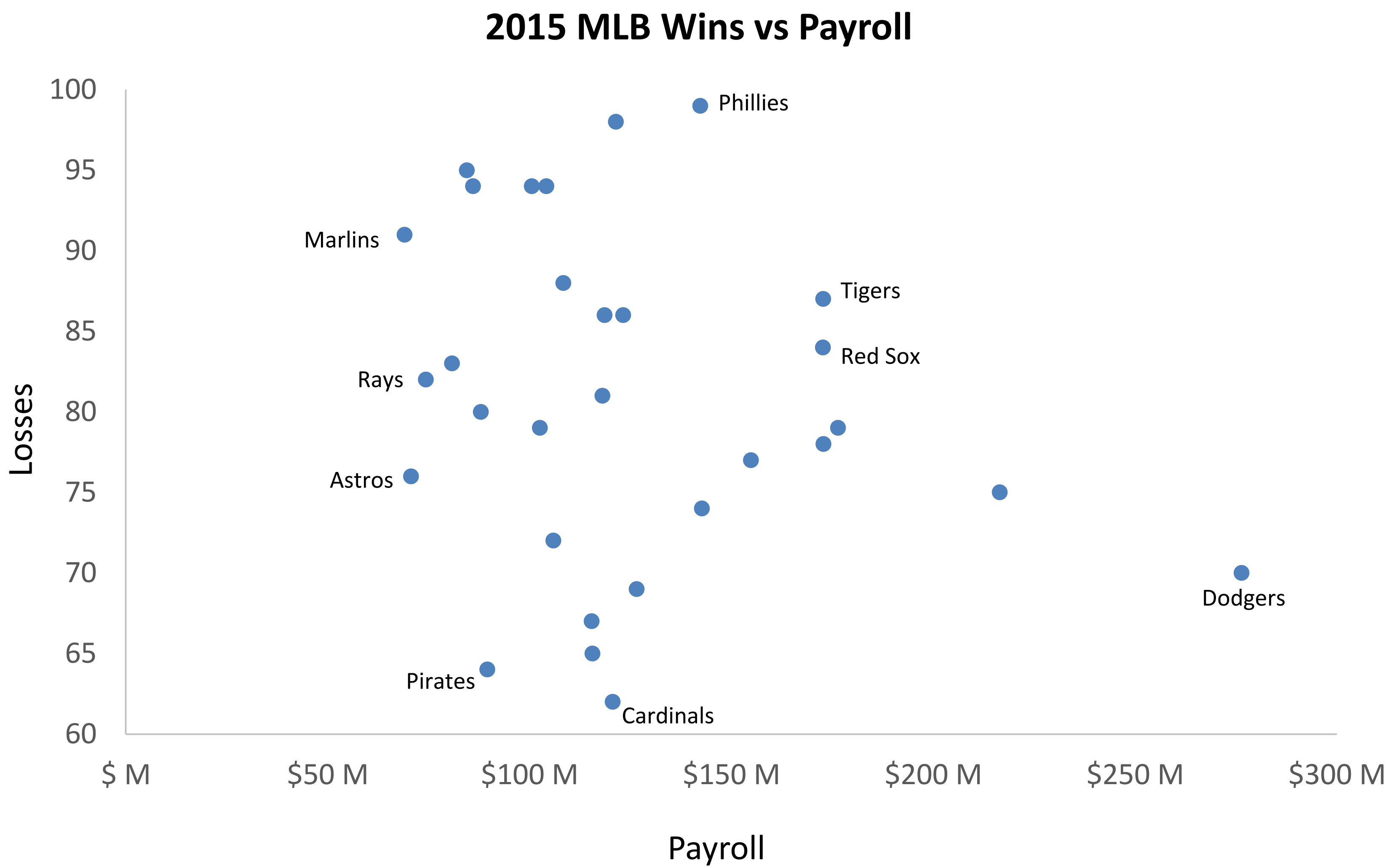
Maximize wins at lowest salary

2. Predict performance based on available information

$$Runs\ Created = TB * \frac{H + BB}{AB + BB}$$

3. Run a system optimization

Best in the MLB



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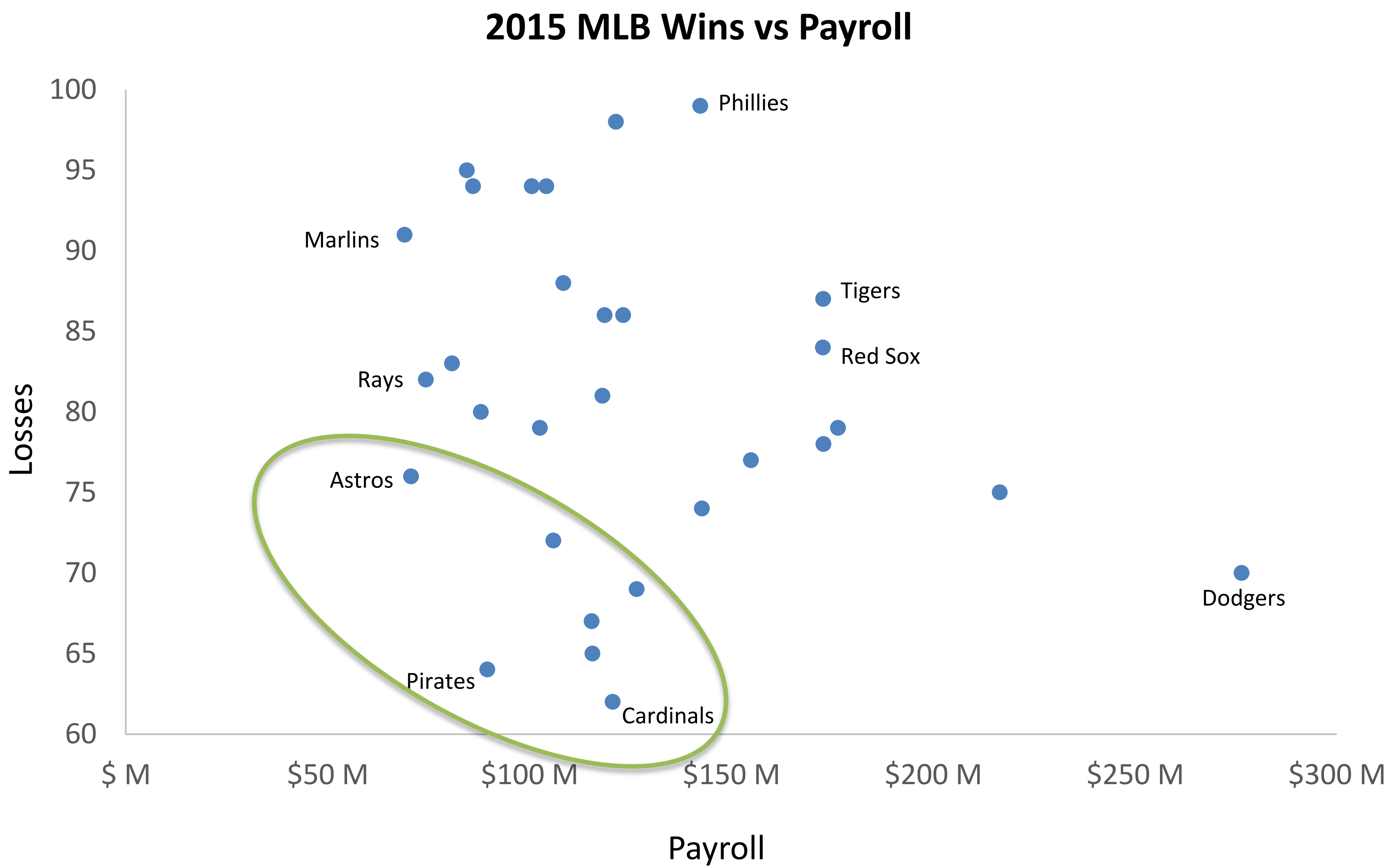

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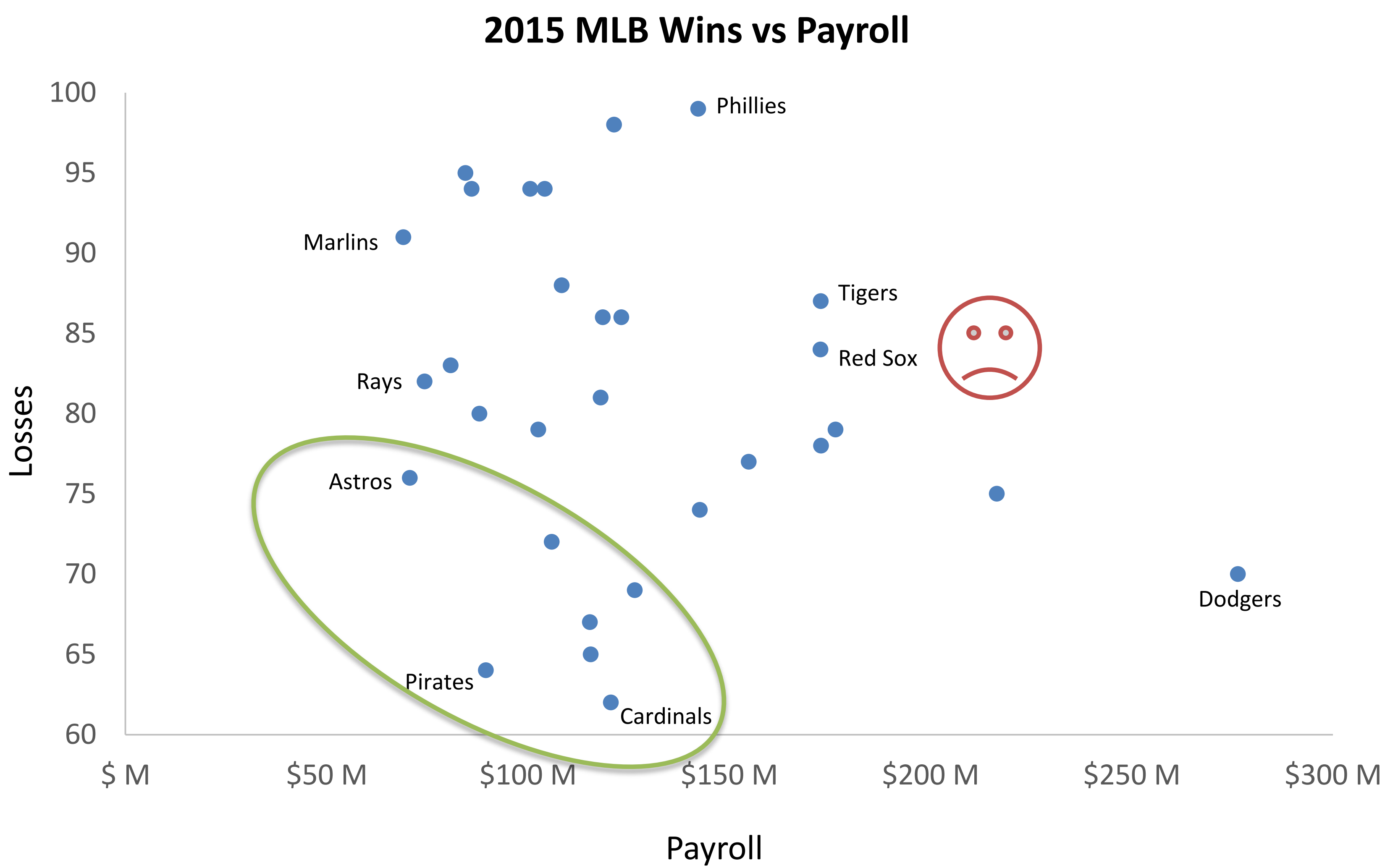
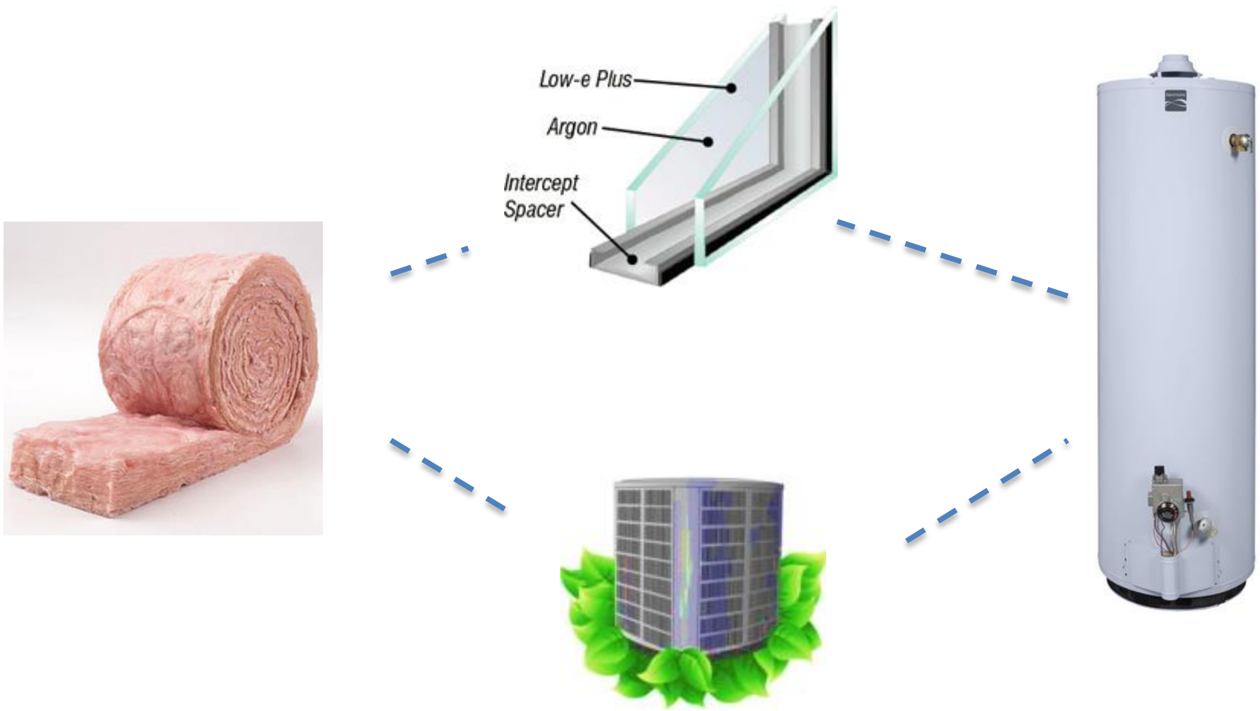


The Moneyball Solution

Applied to Homebuilding…



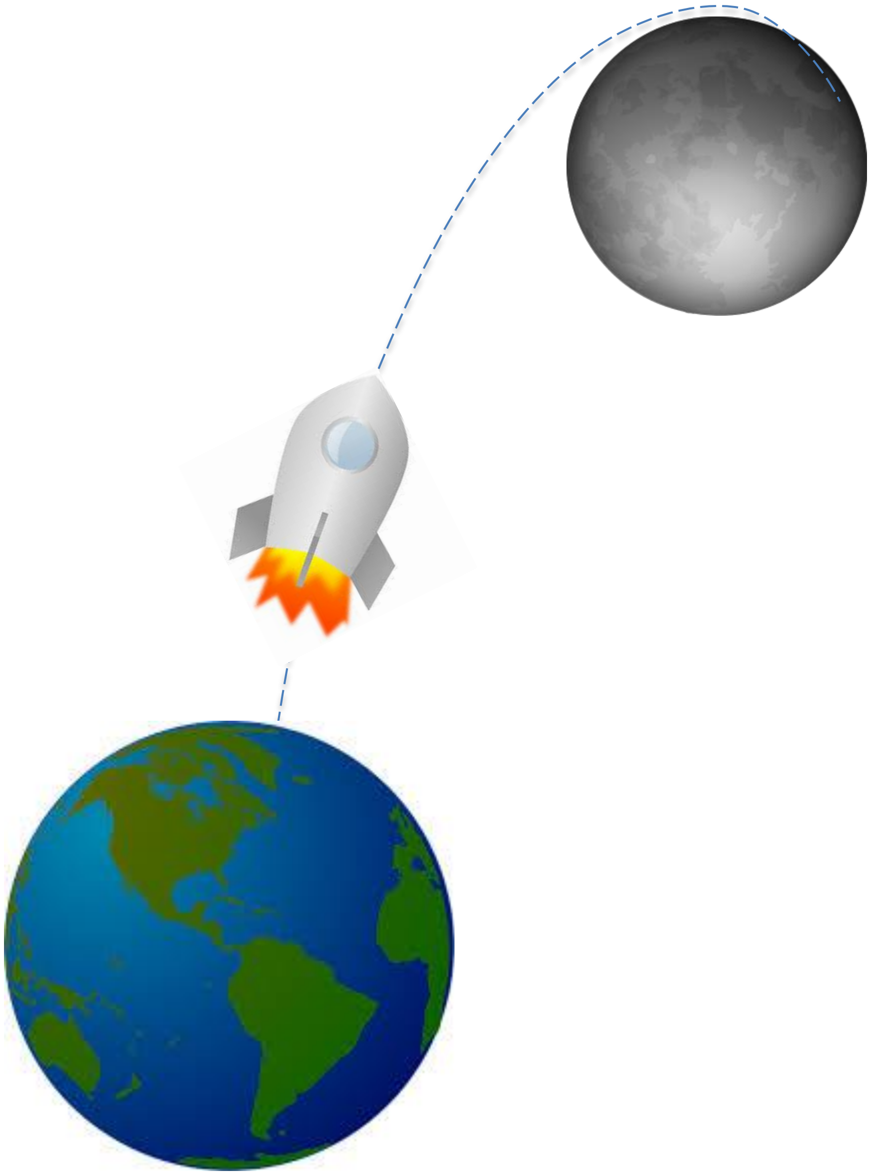
It’s all about the give and take:

System, not components

Examples of Systems Approach in other Industries…

- Computer chip design
- Robotics
- Structural engineering
- **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

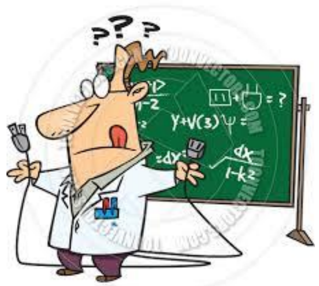
How can we choose
the design with the
highest probability of
success?

How can we make the best decision?

1. Determine success metrics and constraints

Low risk, low weight

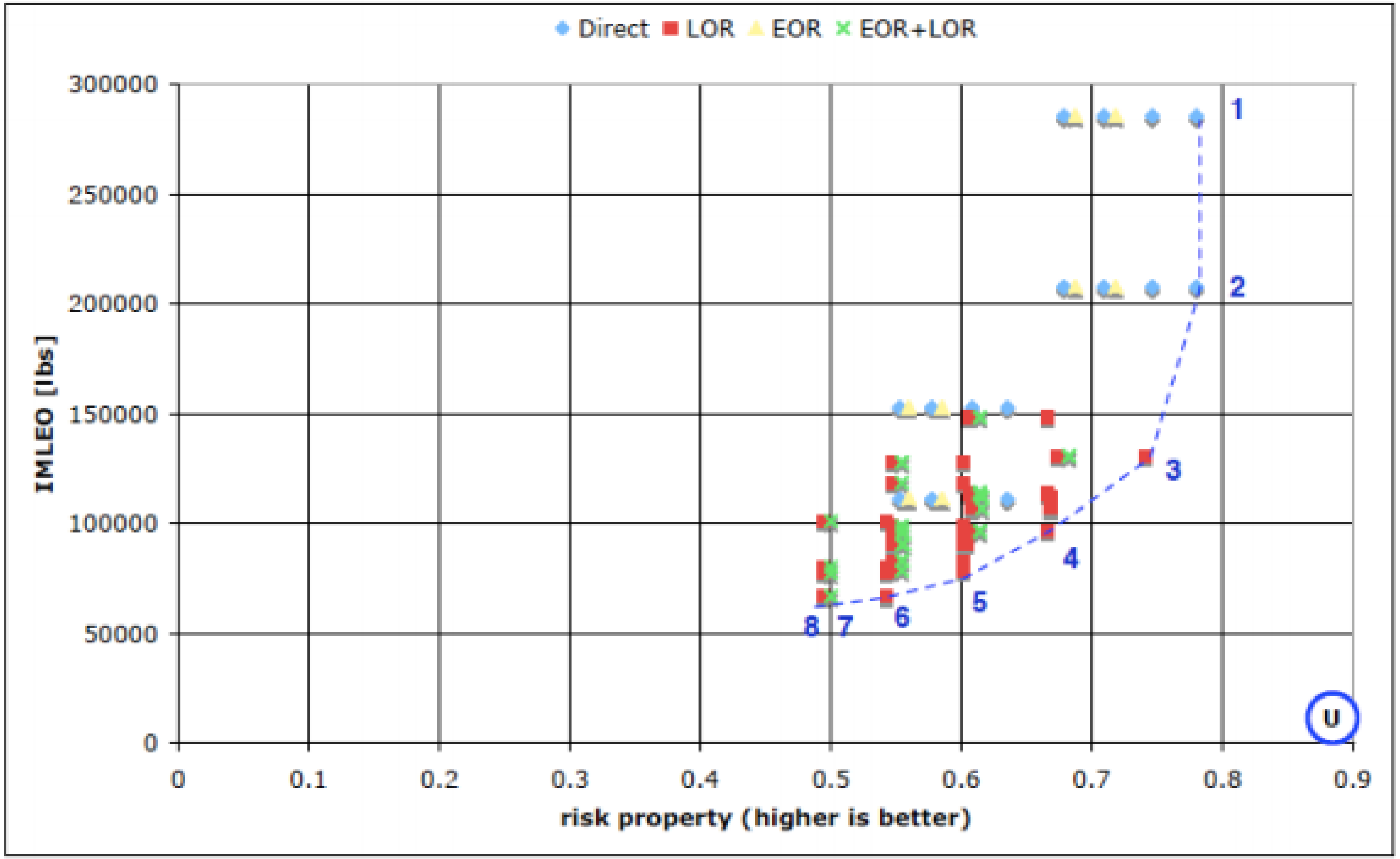
2. Predict performance based on available information



3. Run a system optimization

What is Rocket Science?

How can we make the best 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.

?

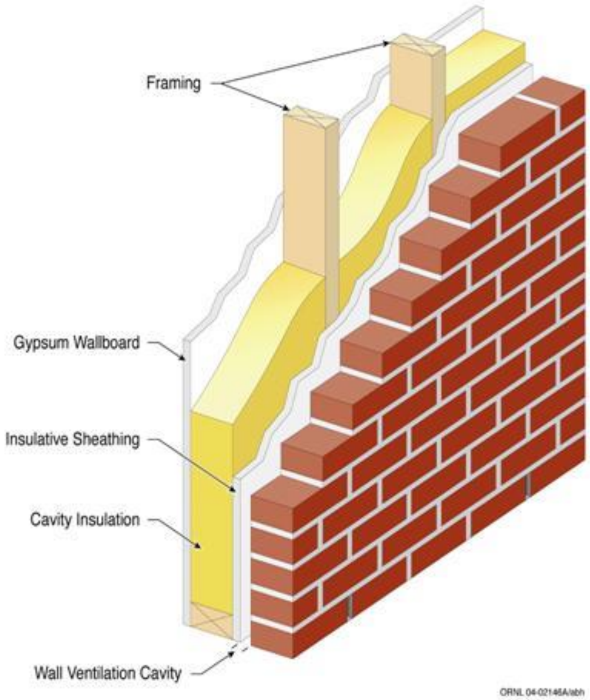
Rocket Science --> Home Building

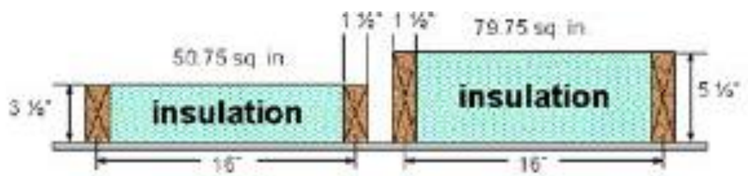
	Rocket Science		Home Building
Success Criteria	- Mission Success Probability - Cost (Tax Dollars) - Crew Safety	→	- Cost - HERS Score - Comfort Level - Energy Bills
Decisions to Make	- Spacecraft shape - Communication system - Fuel system - Ground transport system - Etc.	→	- HVAC products - Envelope insulation - Window type - Ventilation - Lighting systems

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?

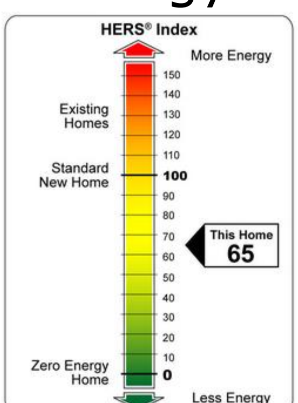
SAVE UP TO $600

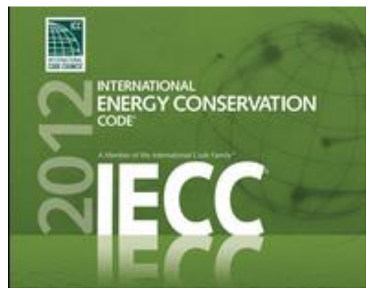
Building a Home is Complex Too!

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

Re-use the same pattern!

1. Determine success metrics and constraints

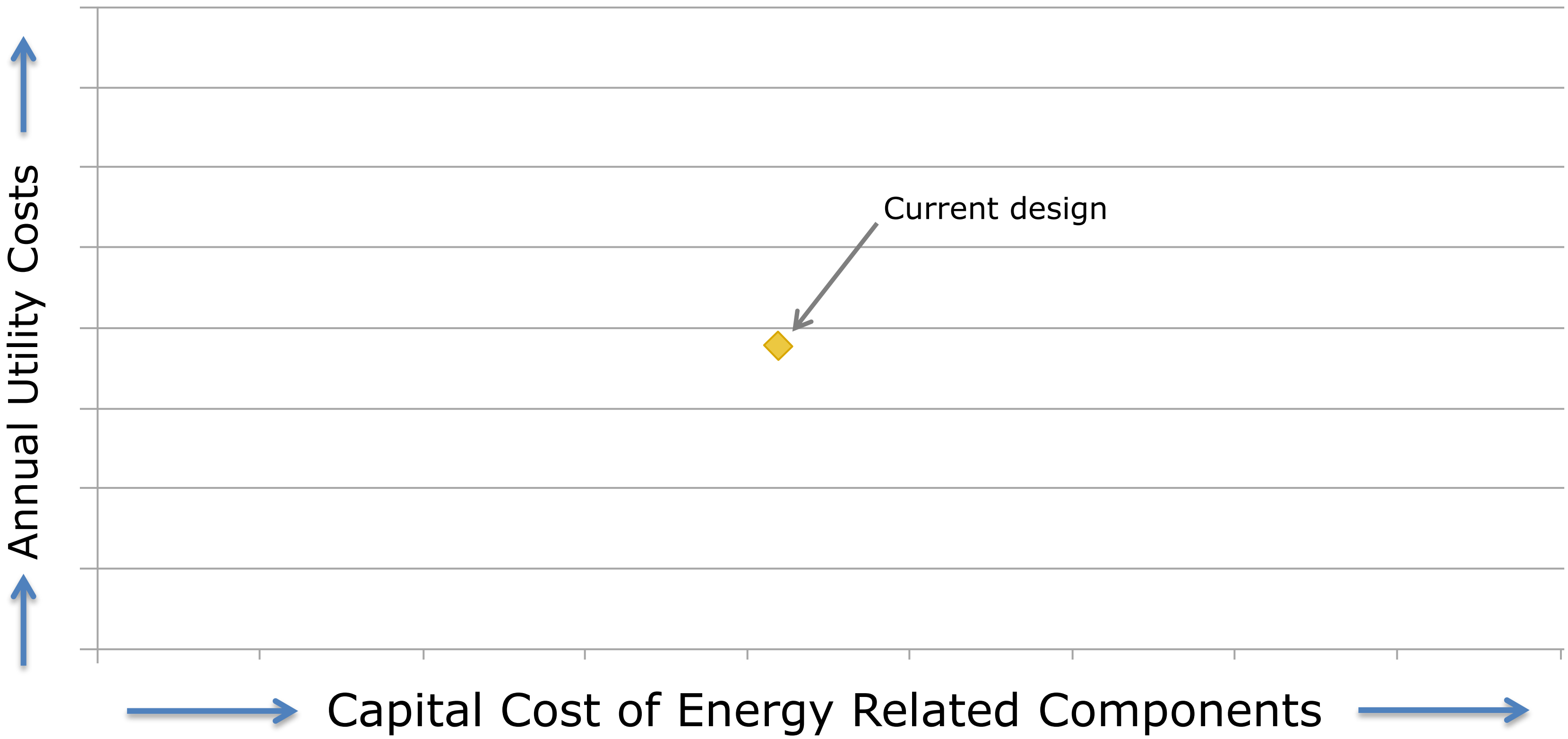
   High performance, low cost

2. Predict performance based on available information

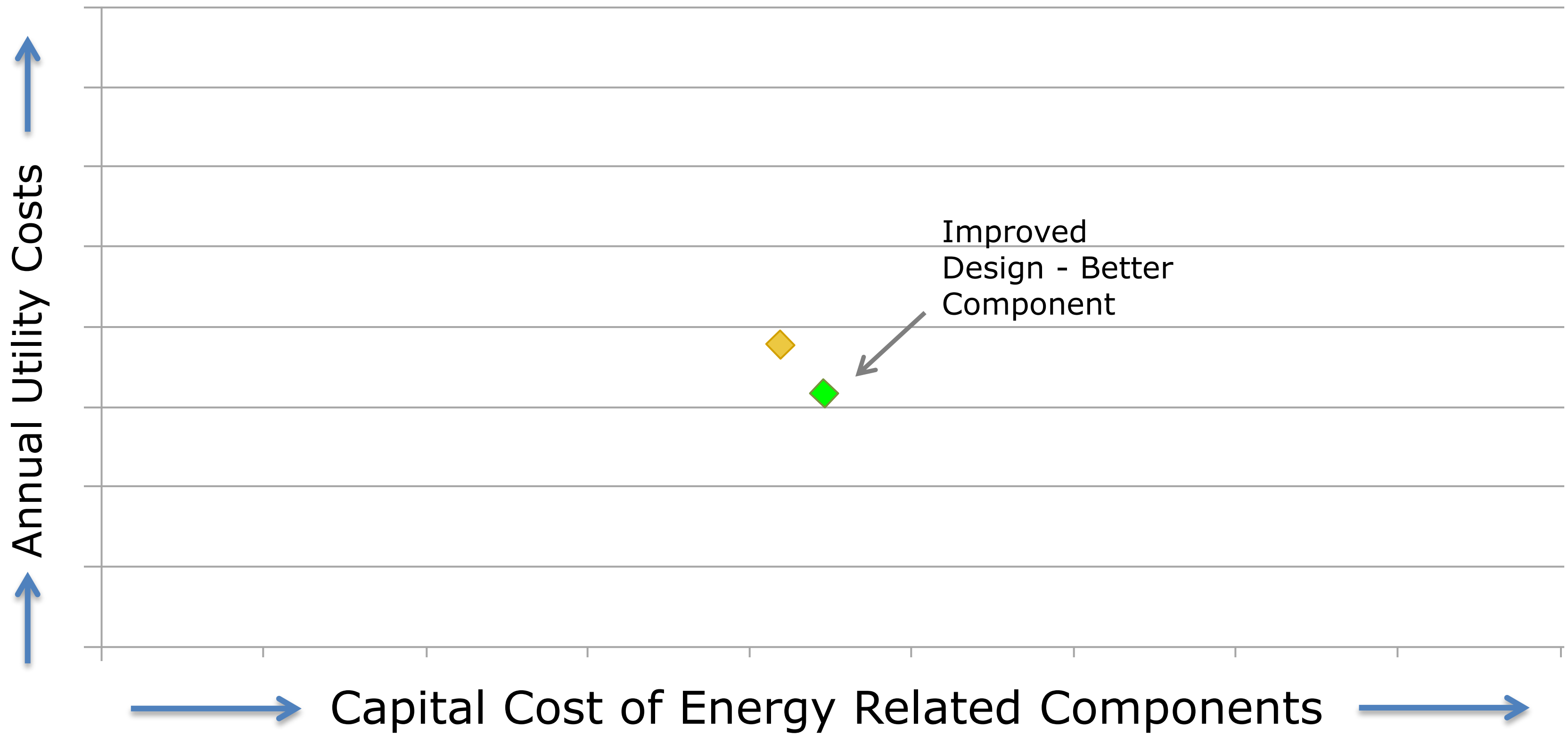
   HERS Rating Tools,
   builder cost estimates

3. Run a system optimization

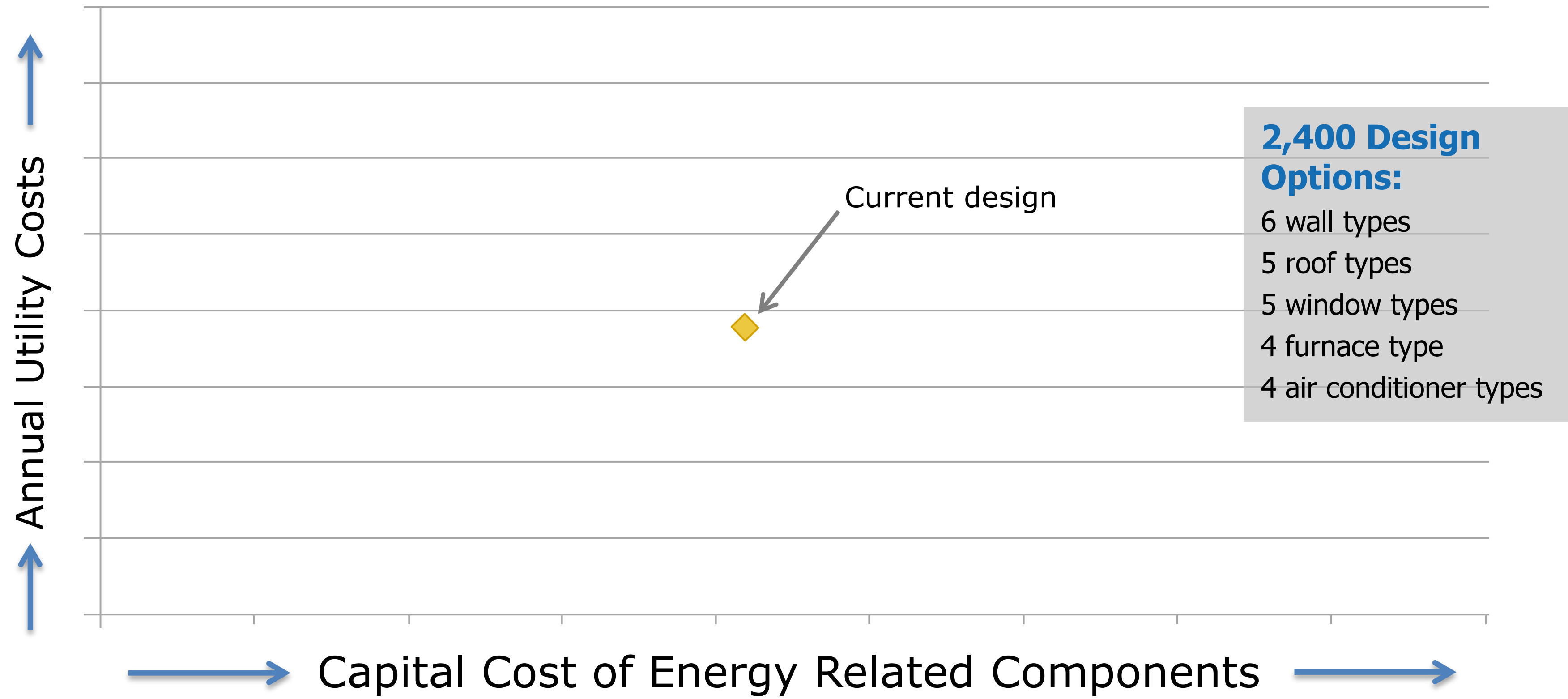
How Building Design Process Works Today



How Building Design Process Works Today



Systems Optimization Approach



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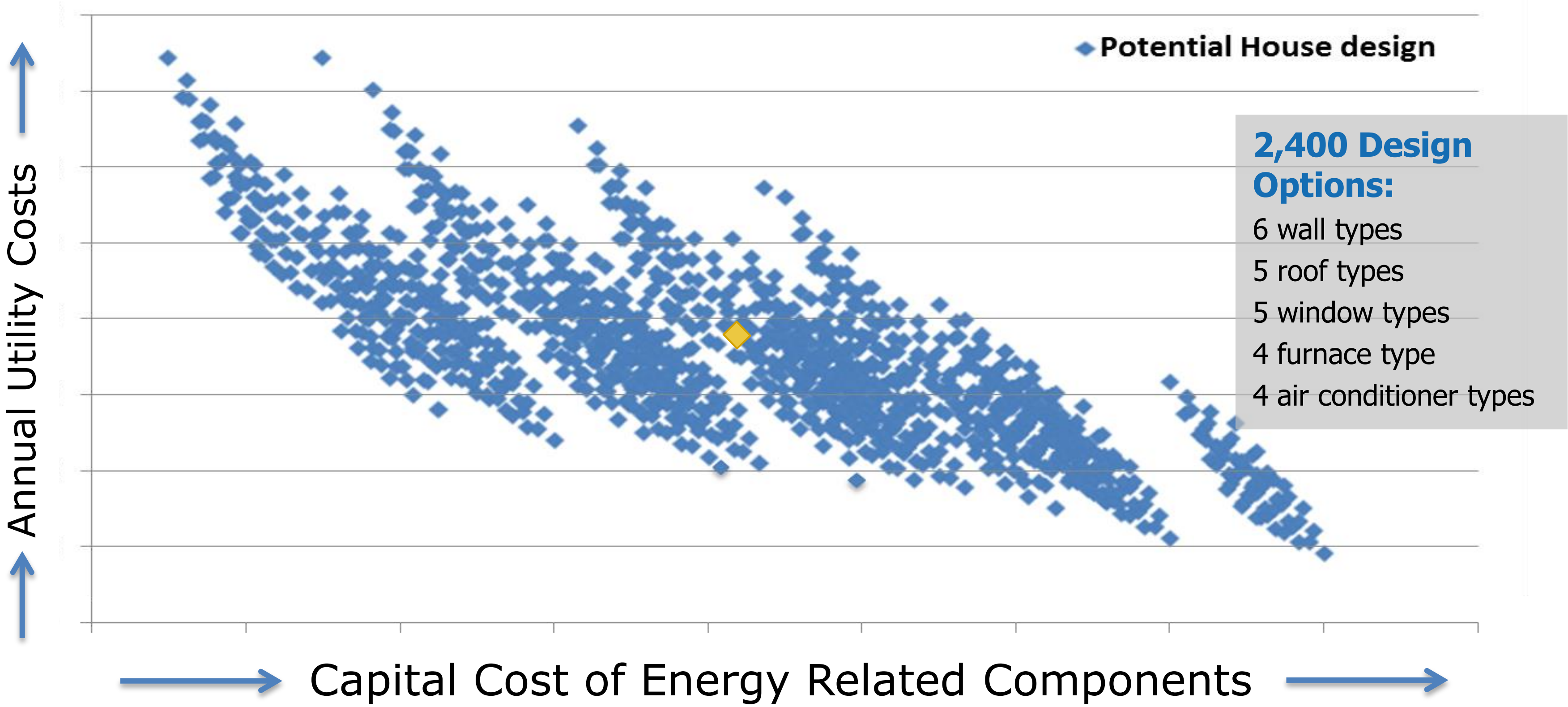

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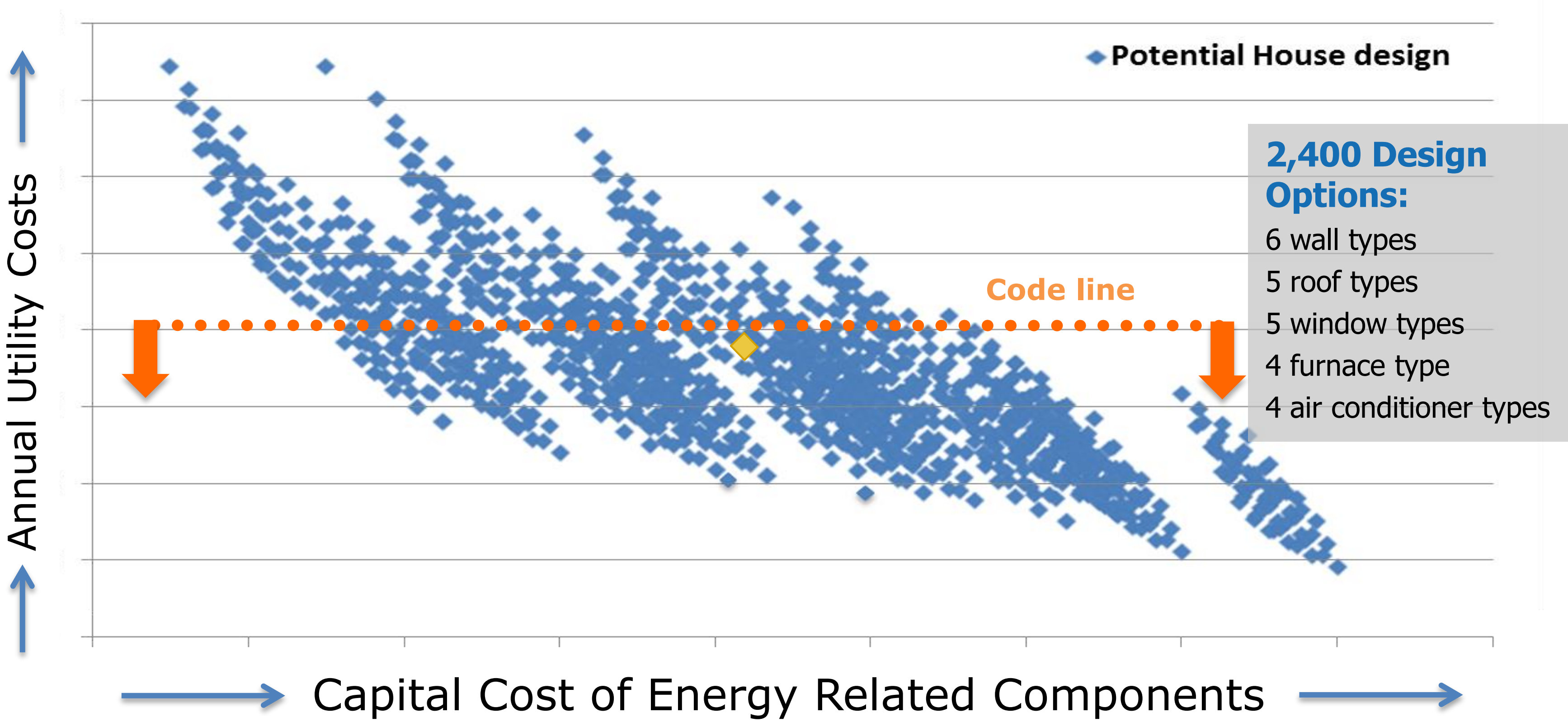

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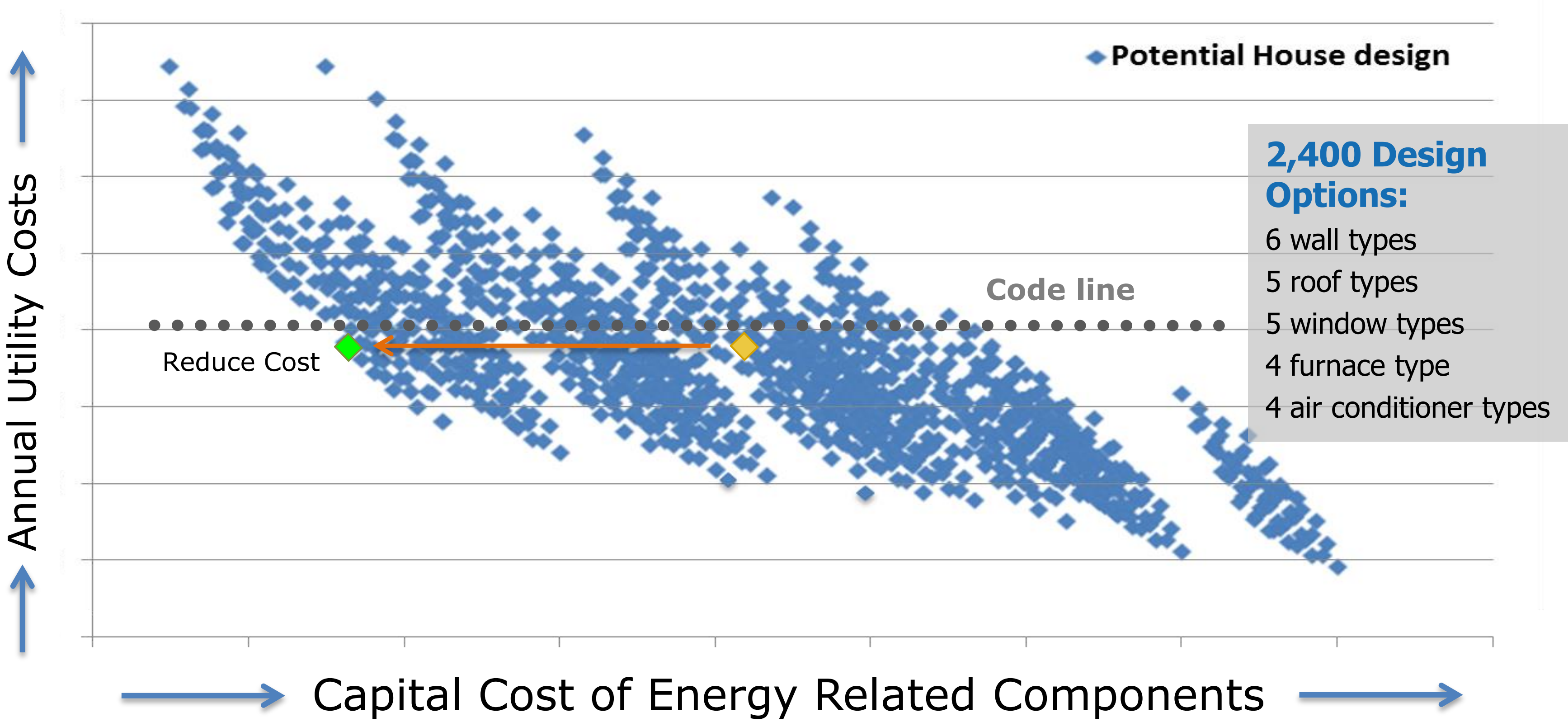

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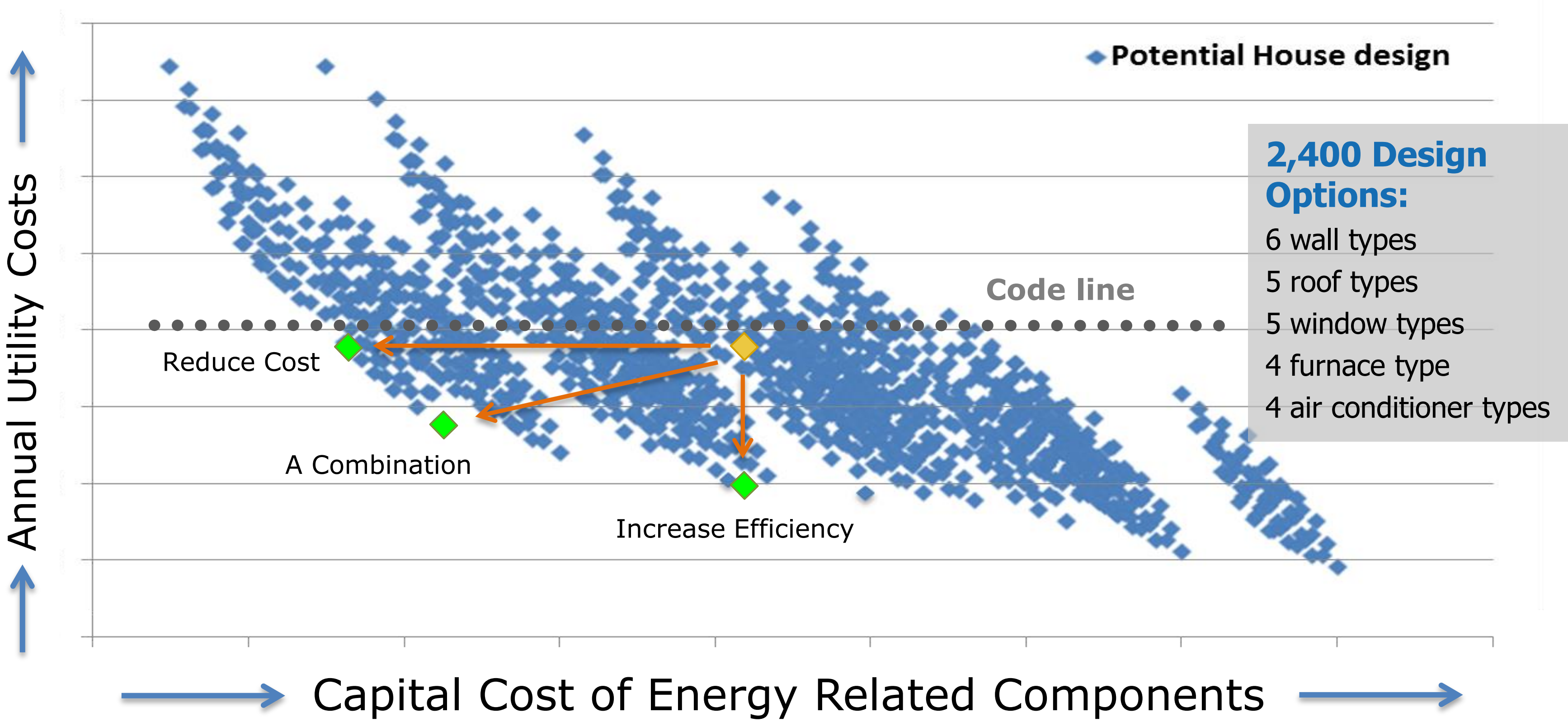

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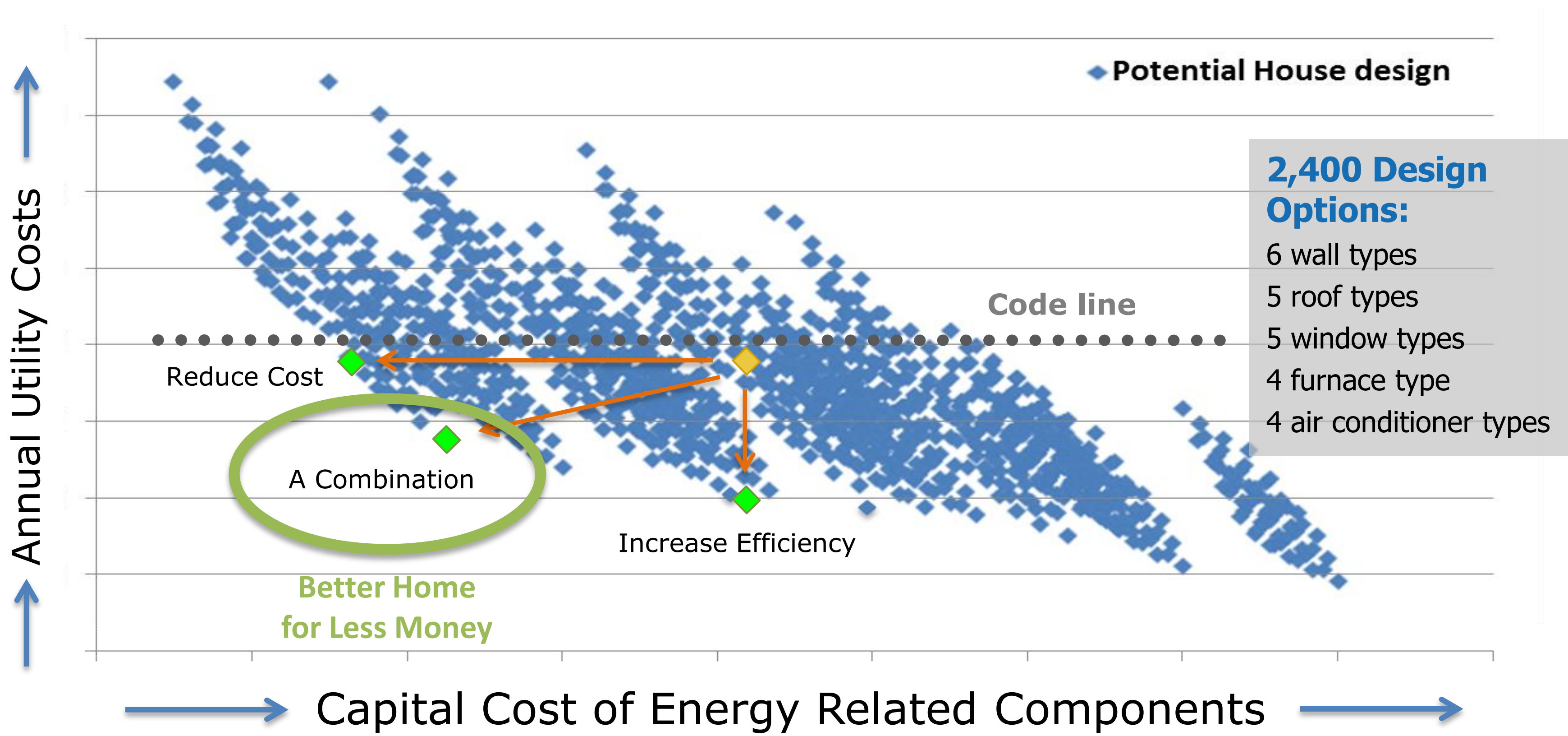
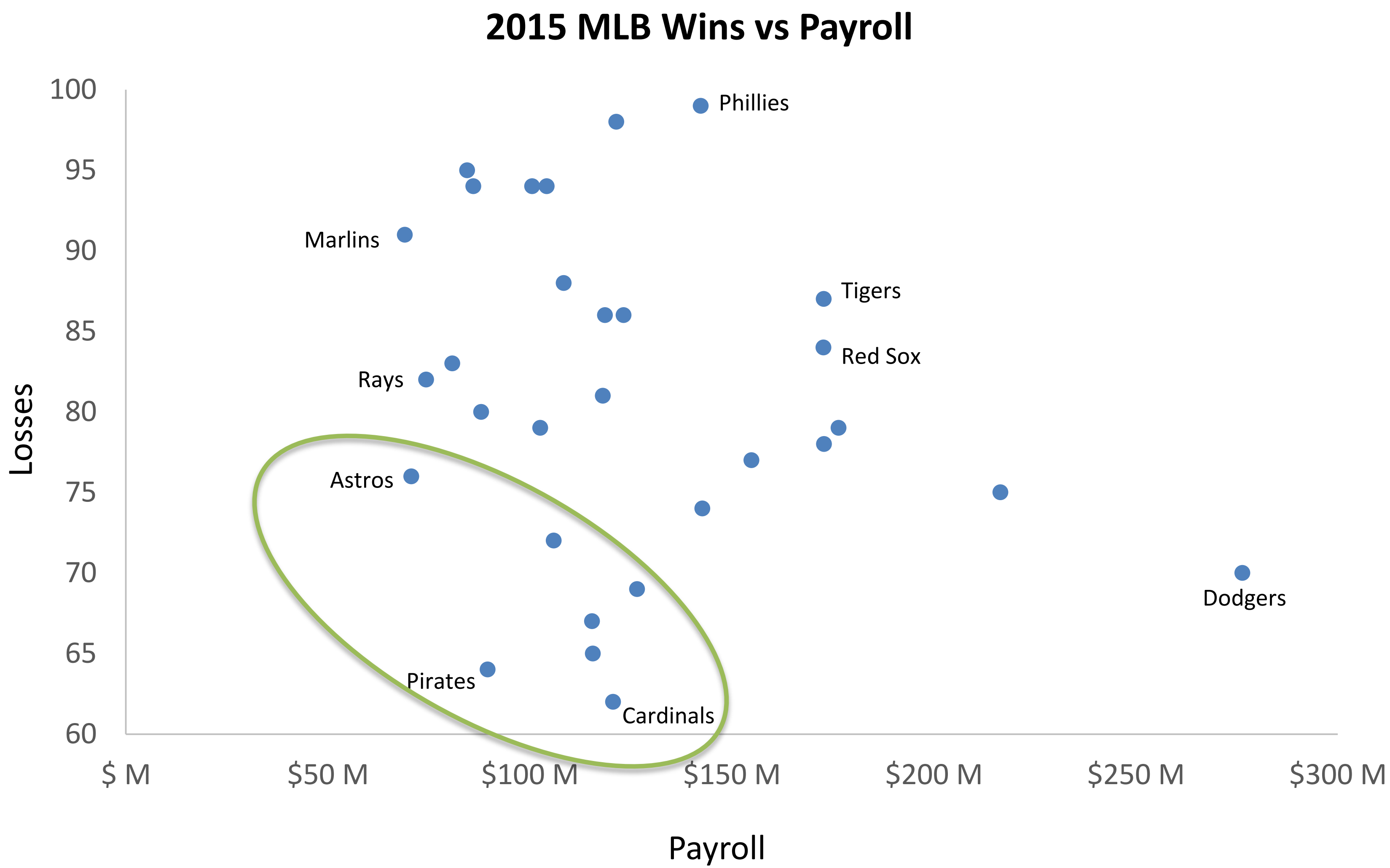


Best in the MLB



Does this really make a difference?

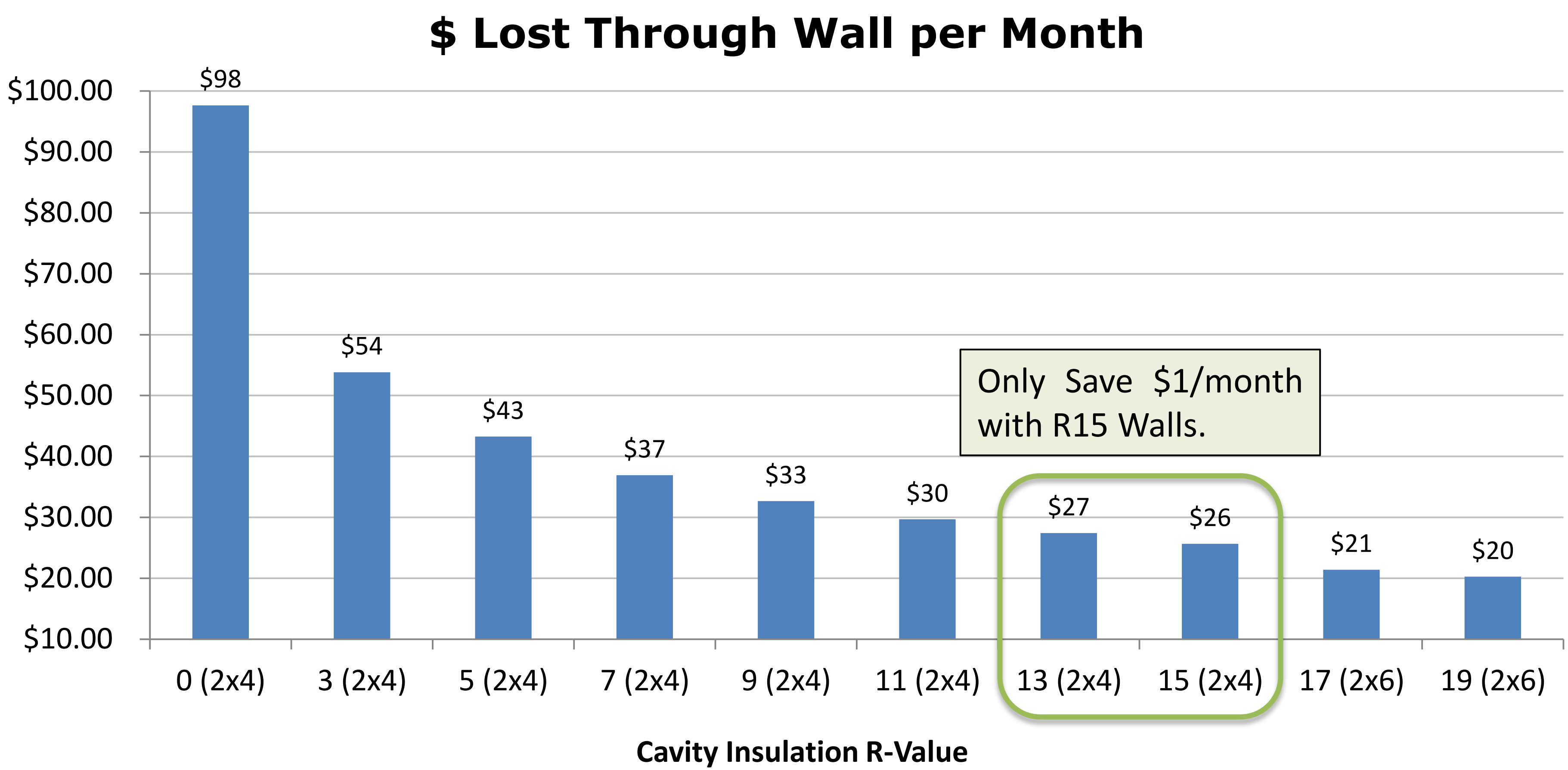
Real Scenarios

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?

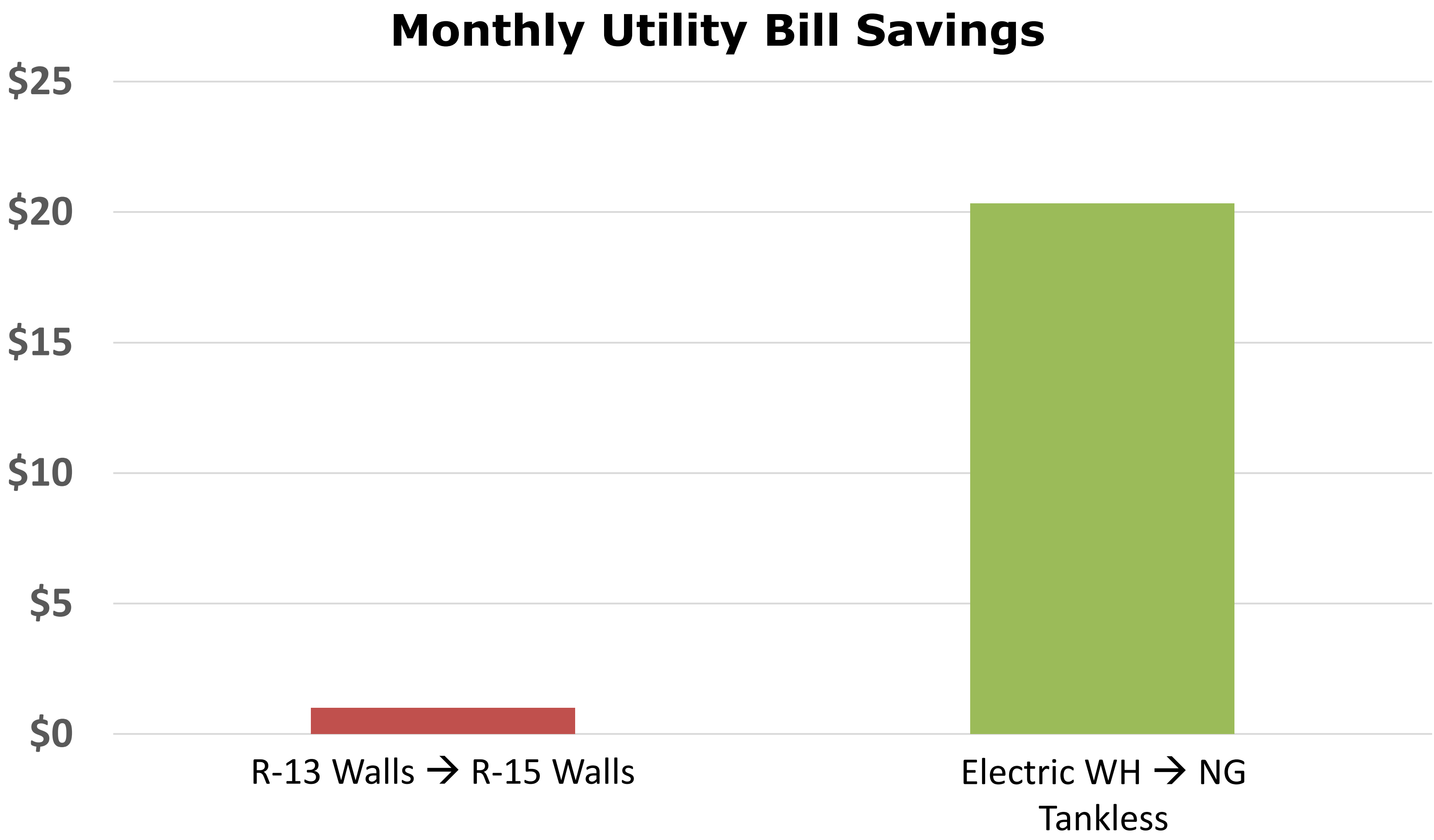
A. More than $50
B. $25 - $50
C. $10 - $25
D. $5 – 10
E. Less than $5

Wall Insulation Diminishing Returns



Component Tradeoffs

Real Scenario #1



Component Tradeoffs

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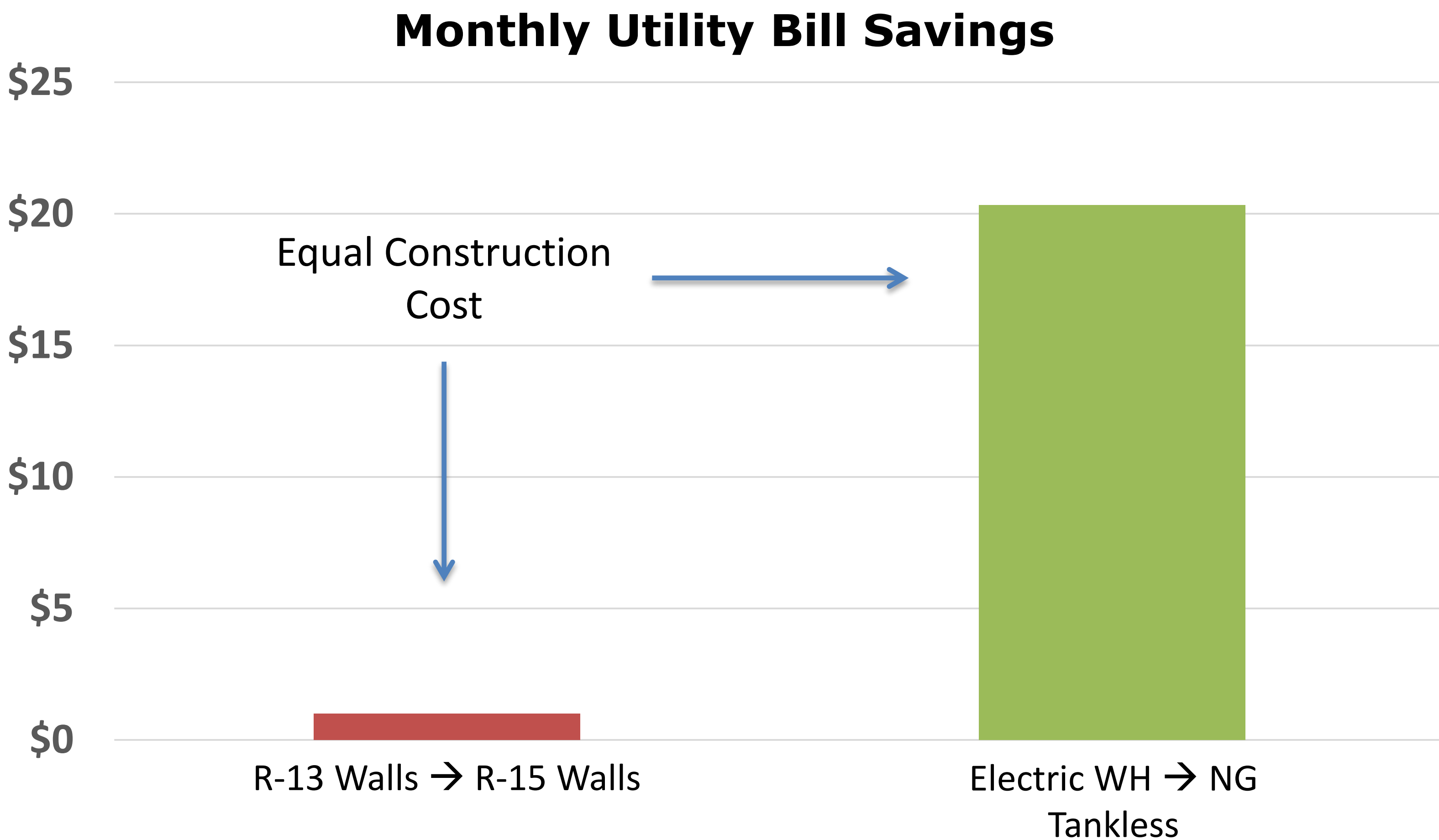
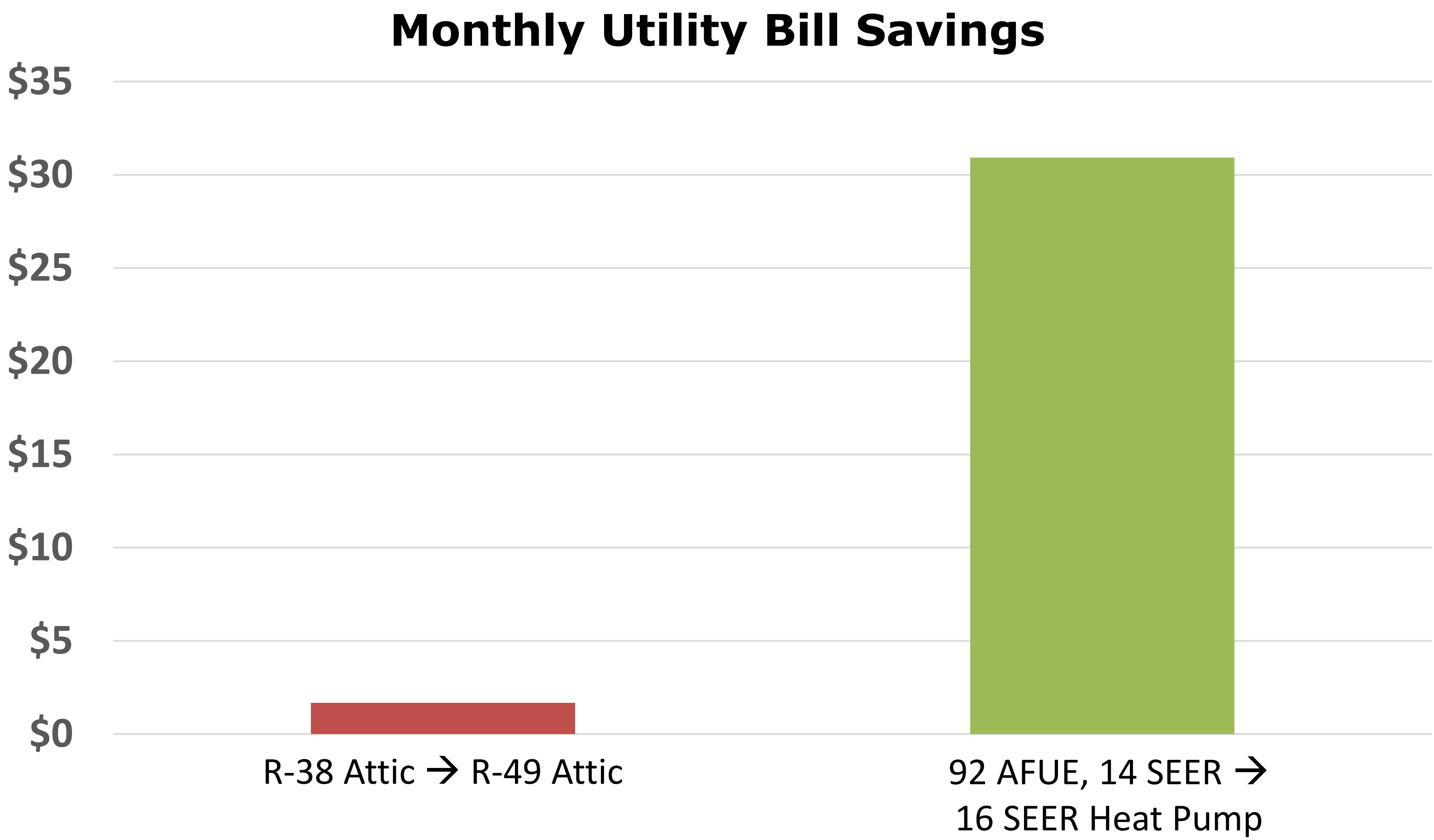


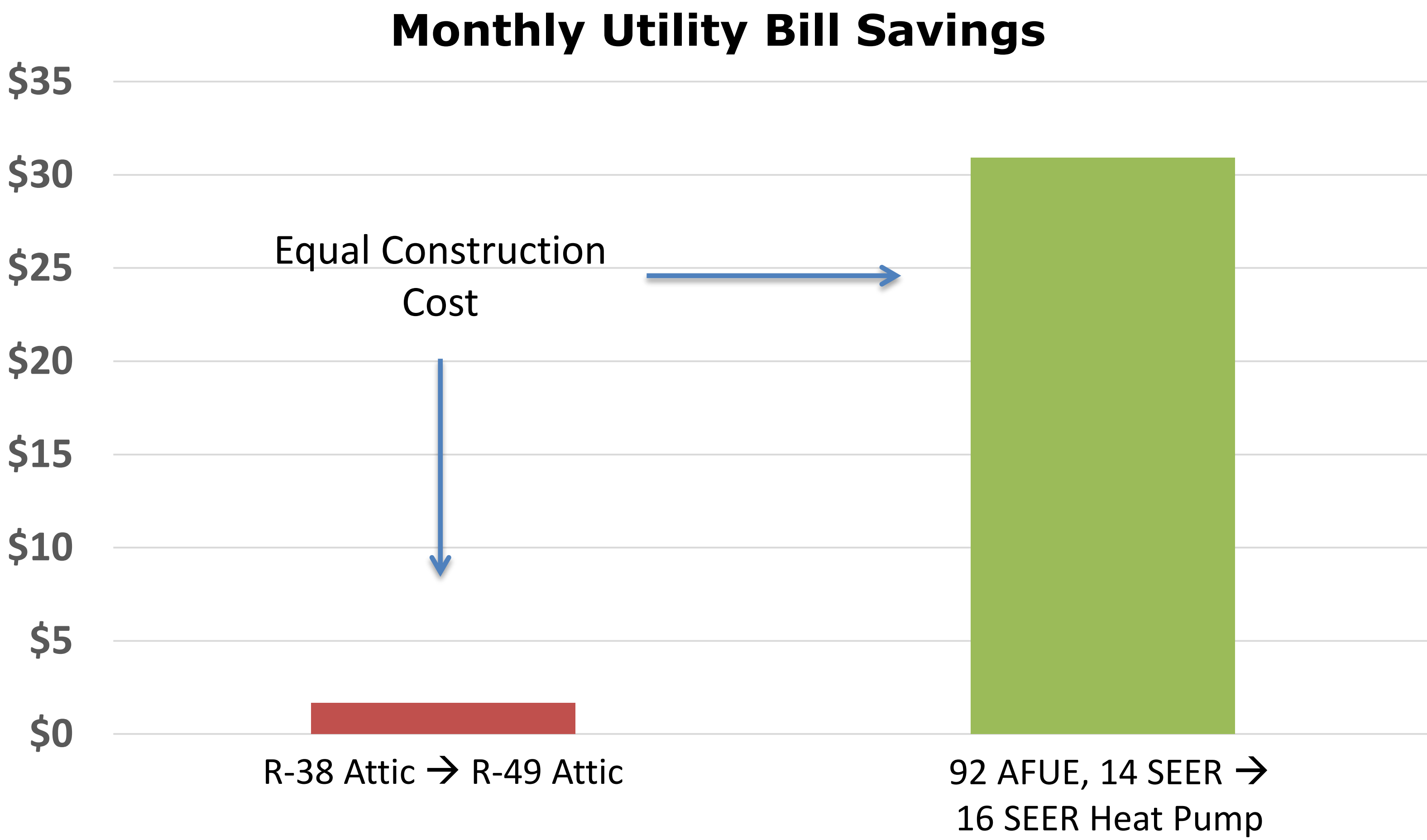
Component Tradeoffs

Real Scenario #2



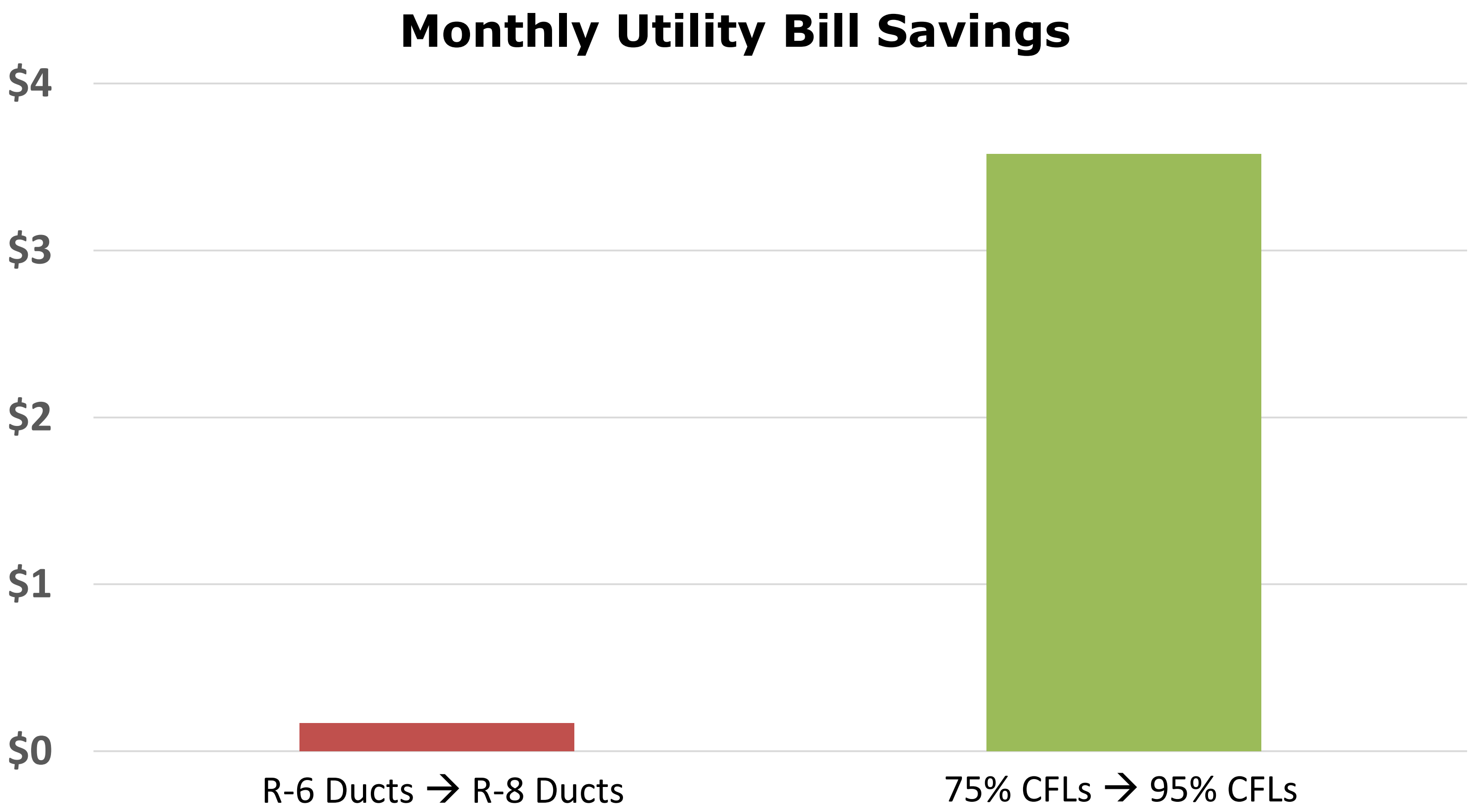
Component Tradeoffs

Real Scenario #2



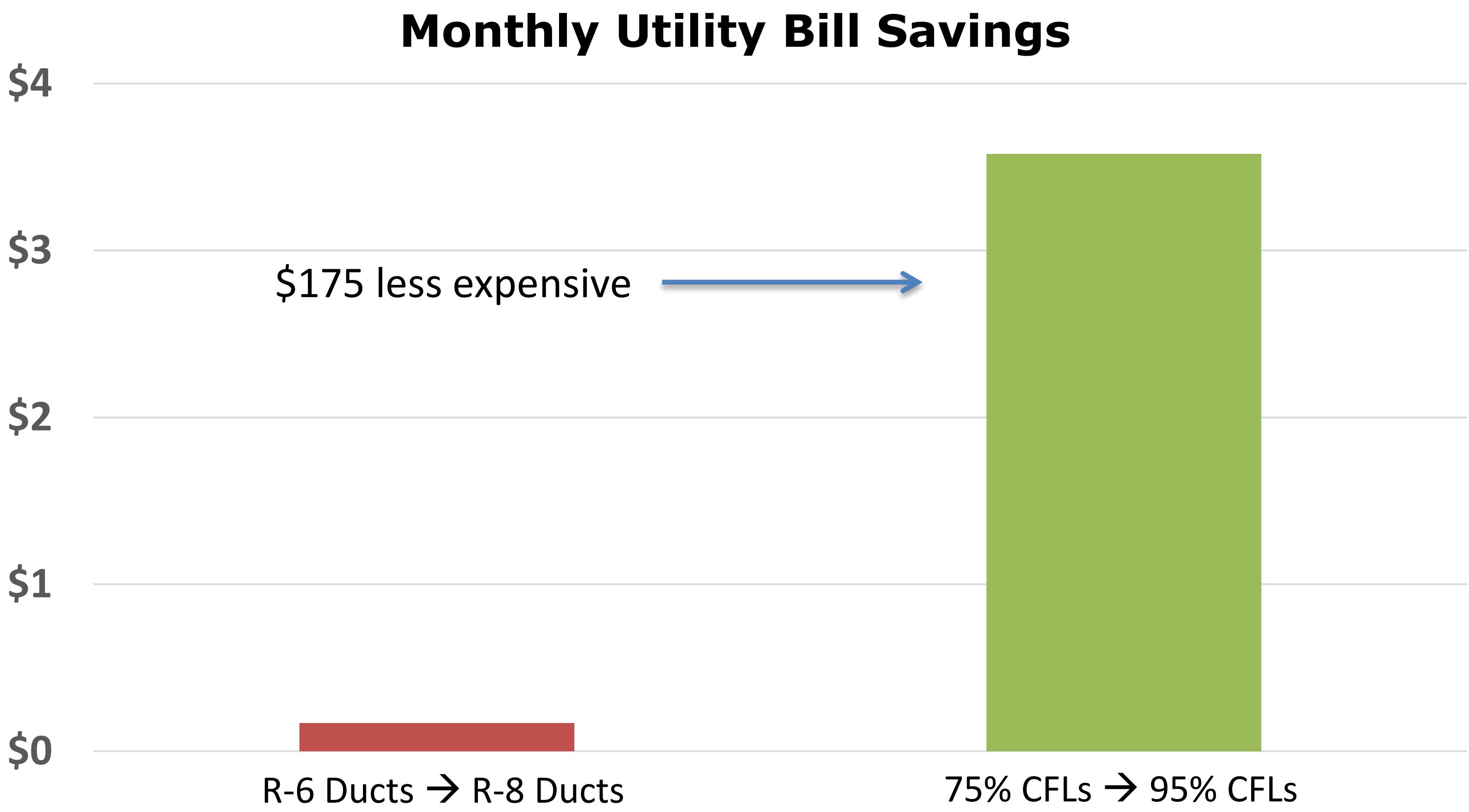
Component Tradeoffs

Real Scenario #3

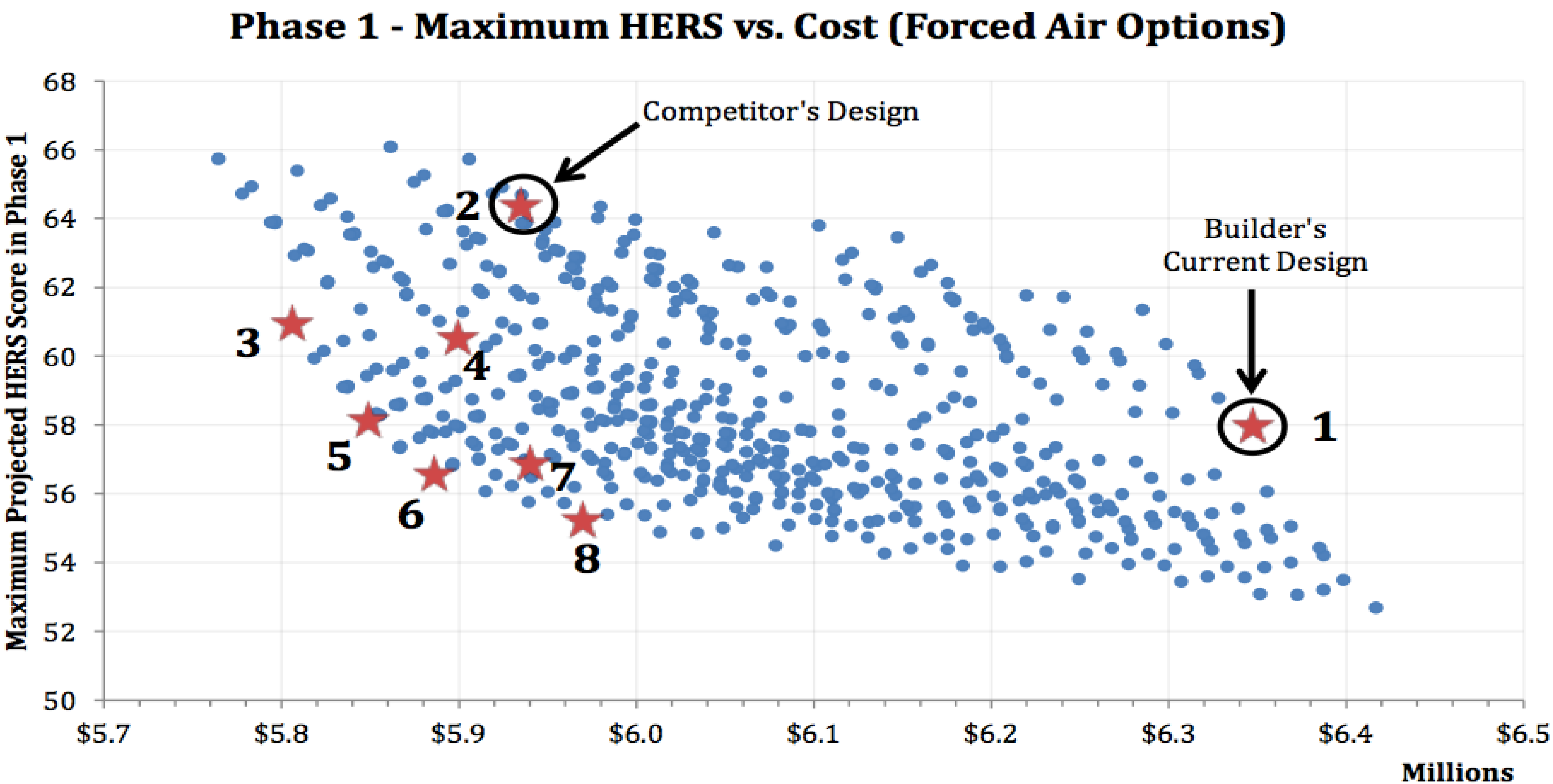


Component Tradeoffs

Real Scenario #3

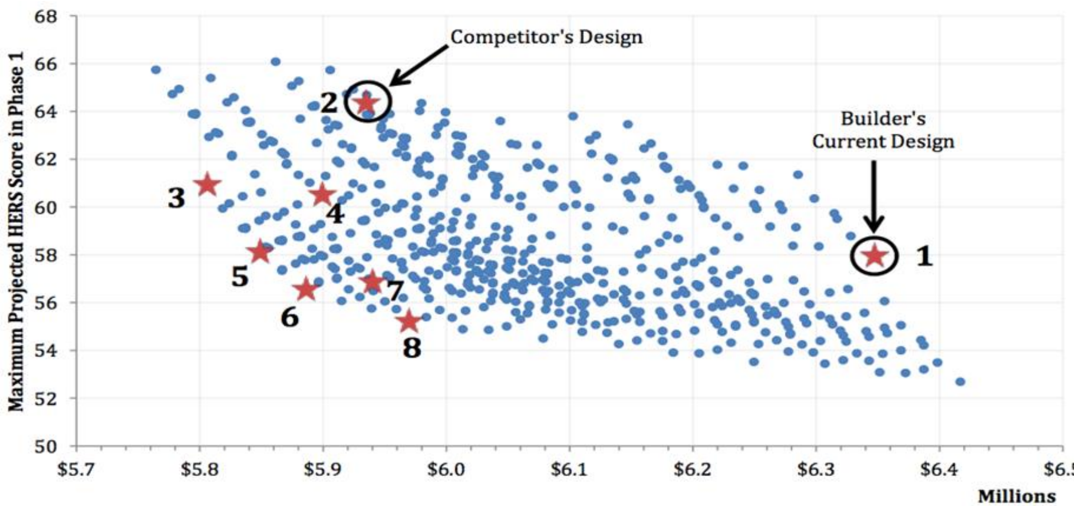


A Real Example – Project in New Mexico



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

A Real Example – Project in New Mexico



<table>
<tr><th></th><th>1. Baseline
(HERS 58)</th><th>Option 3
(HERS 61)</th><th>Option 5
(HERS 58)</th><th>Option 6
(HERS 57)</th><th>Option 8
(HERS 55)</th></tr>
<tr><td>Total Cost Change</td><td>$6.35MM</td><td>$5.81MM</td><td>$5.85MM</td><td>$5.89MM</td><td>$5.97MM</td></tr>
<tr><td colspan="6">= changes from Baseline spec (components not shown do NOT change)</td></tr>
<tr><td>Attic Insulation</td><td>R49 Blown</td><td>R30 Blown</td><td>R38 Blown</td><td colspan="2">R49 Blown</td></tr>
<tr><td>Slab</td><td>R23 ICF + R5 Under</td><td colspan="2">R5 Footer</td><td>R10 Footer</td><td>R10 Footer + R5 Under</td></tr>
<tr><td>Above Grade Wall</td><td>2x6 R20.4 + 2” EPS</td><td colspan="4">2x4 R13 + R6 Insulated Sheathing</td></tr>
<tr><td>Cooling</td><td>15 SEER A/C</td><td colspan="4">13 SEER A/C</td></tr>
<tr><td>Heating</td><td>95.5 AFUE Furnace</td><td>92 AFUE Furnace</td><td colspan="3">95.5 AFUE Furnace</td></tr>
<tr><td>Water Heater</td><td>50 Gal NG</td><td colspan="3">50 Gallon GE GeoSpring Hybrid Electric</td><td>NG Tankless (0.95 EF)</td></tr>
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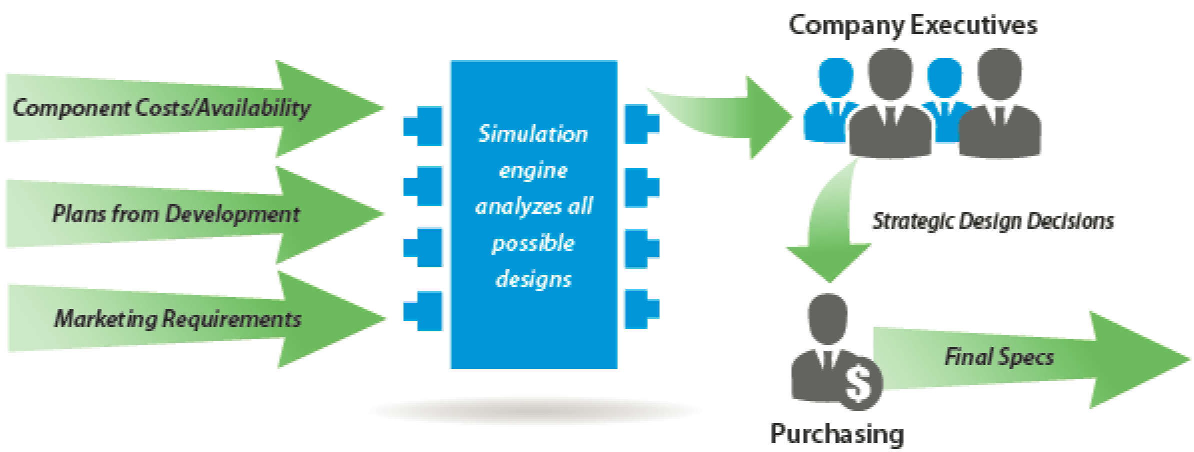
10 Builder Case Study

- Data collected from projects with 10 production builders.
- Purpose: to evaluate average per home savings potential for residential production-build companies when using Ekotrope's energy spec optimization method.



10 Builder Case Study – Results

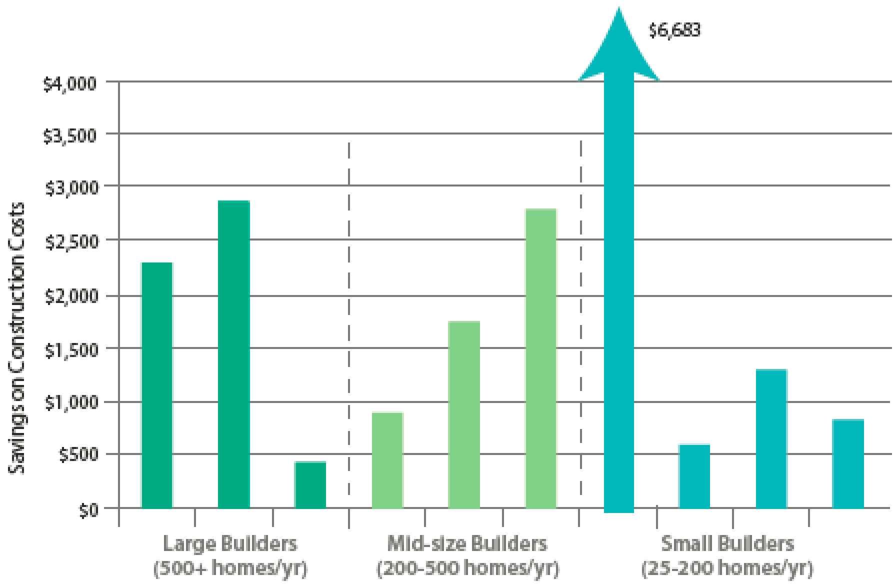


Figure 1 – Per-home construction cost savings and profit margin increase for the 10 builders in the study.

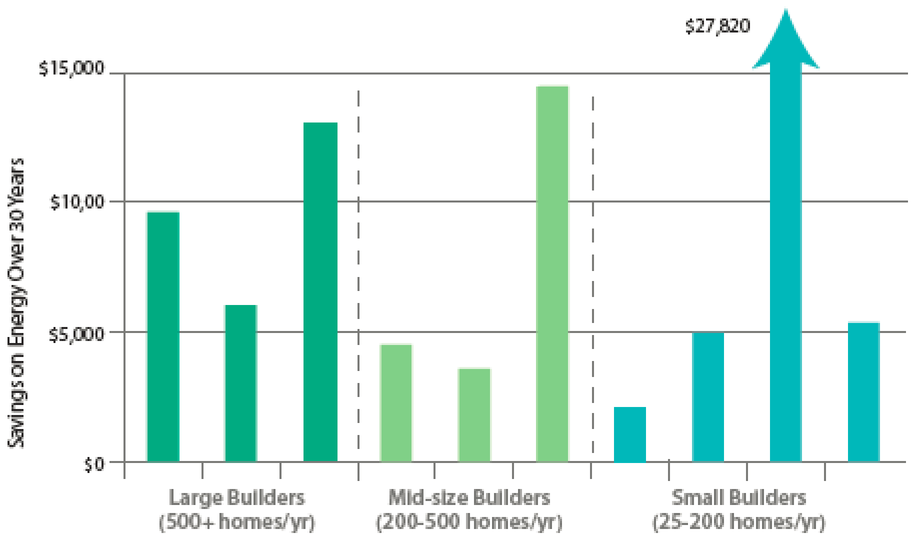


Figure 2 – Savings on every per-home for 10 builders in the study. Energy price escalation is included in the 30 year savings calculations as estimated by the U.S. Energy Information Administration.

10 Builder Case Study – Results

- Construction cost savings range: **$400 - $6,680 per home**
    - Results in an average **profit margin increase of 13%**
- Energy savings range: **5% - 25%**
    - Average 30 year energy bill savings: **$9,100 per home**

Key assumptions:

- *2% annual electric price escalation*
- *2.5% annual natural gas price escalation*

Parting Question

Are we making optimal design decisions?

Thank you!

Cy Kilbourn

Co-Founder,

Director of Engineering

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