

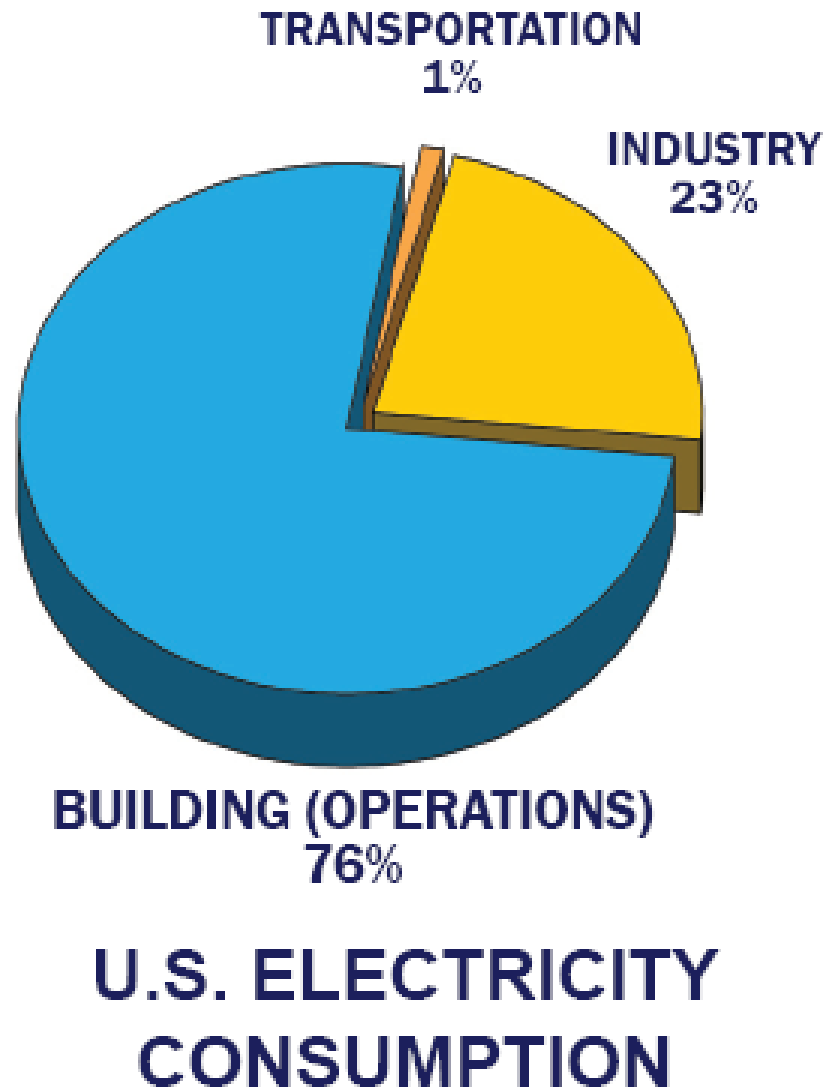
*Mixed Humid Climate Region*

# **Example Performance Targets and Efficiency Packages Greensburg, Kansas**

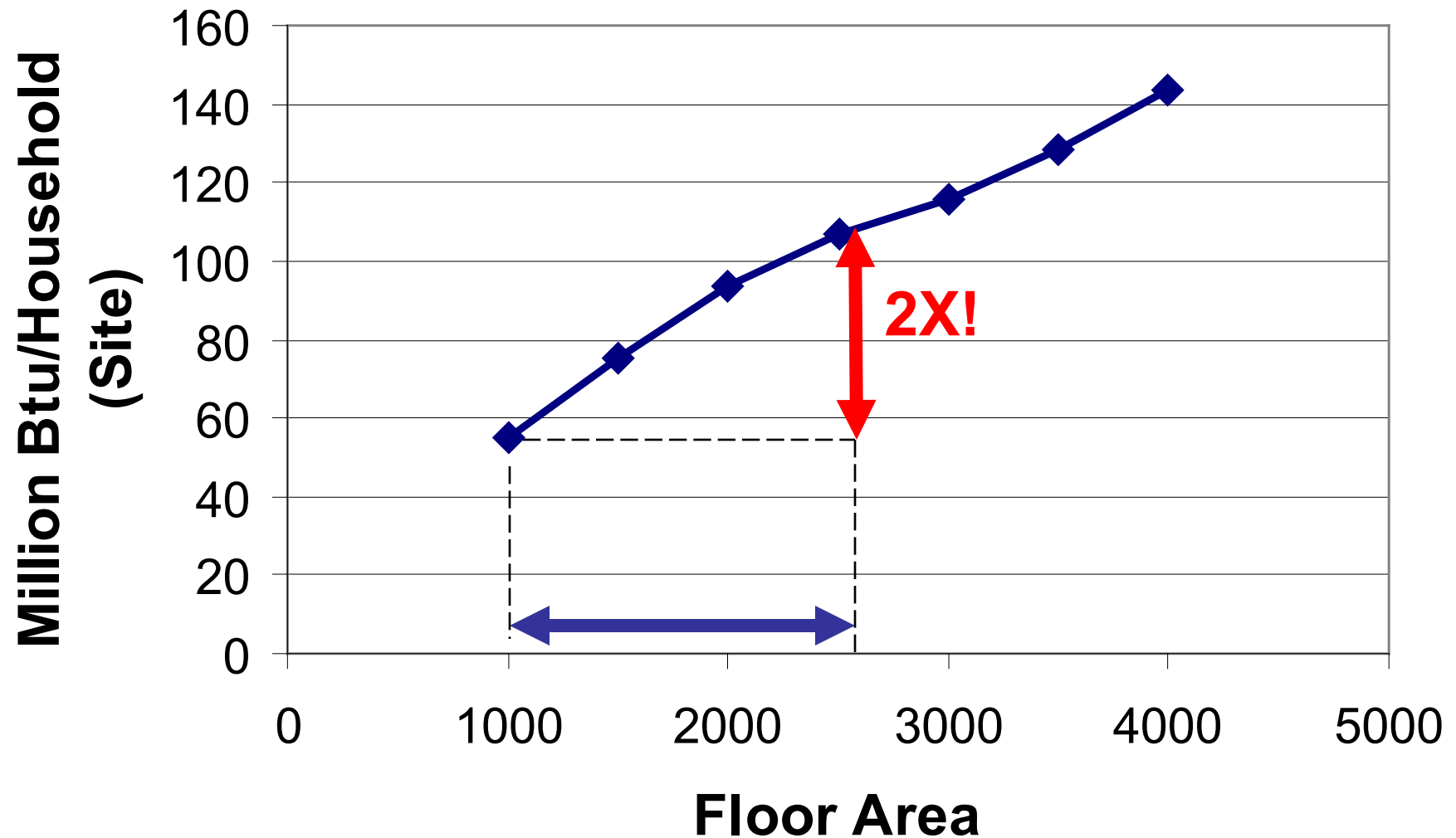
Dr. Ren Anderson, NREL



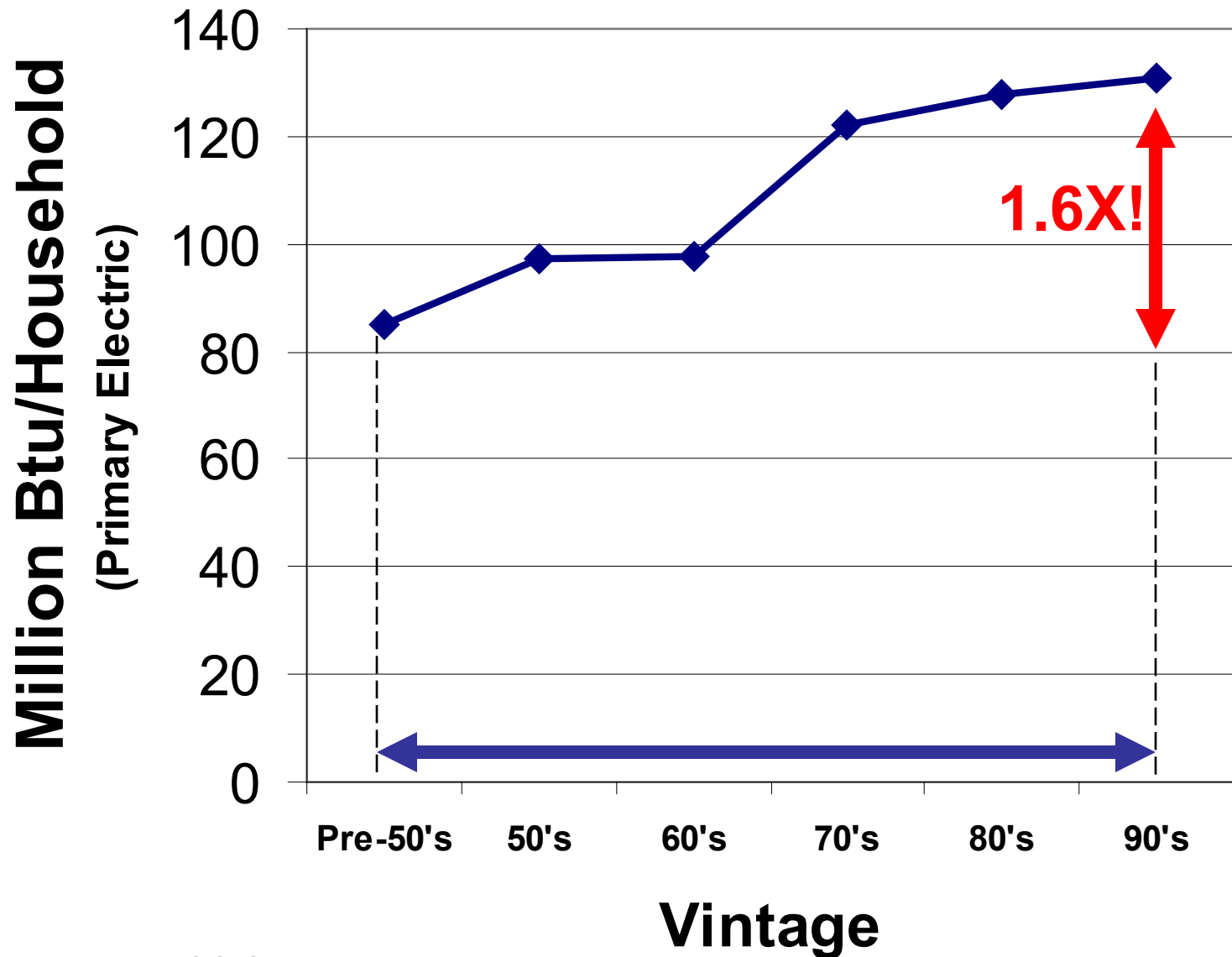
**Coal produces about half of the energy supplied by the Electric Power Sector, it is responsible for 81% of this sector's CO2 emissions.**



# Size Matters: 2001 RECS Site Energy Consumption Data

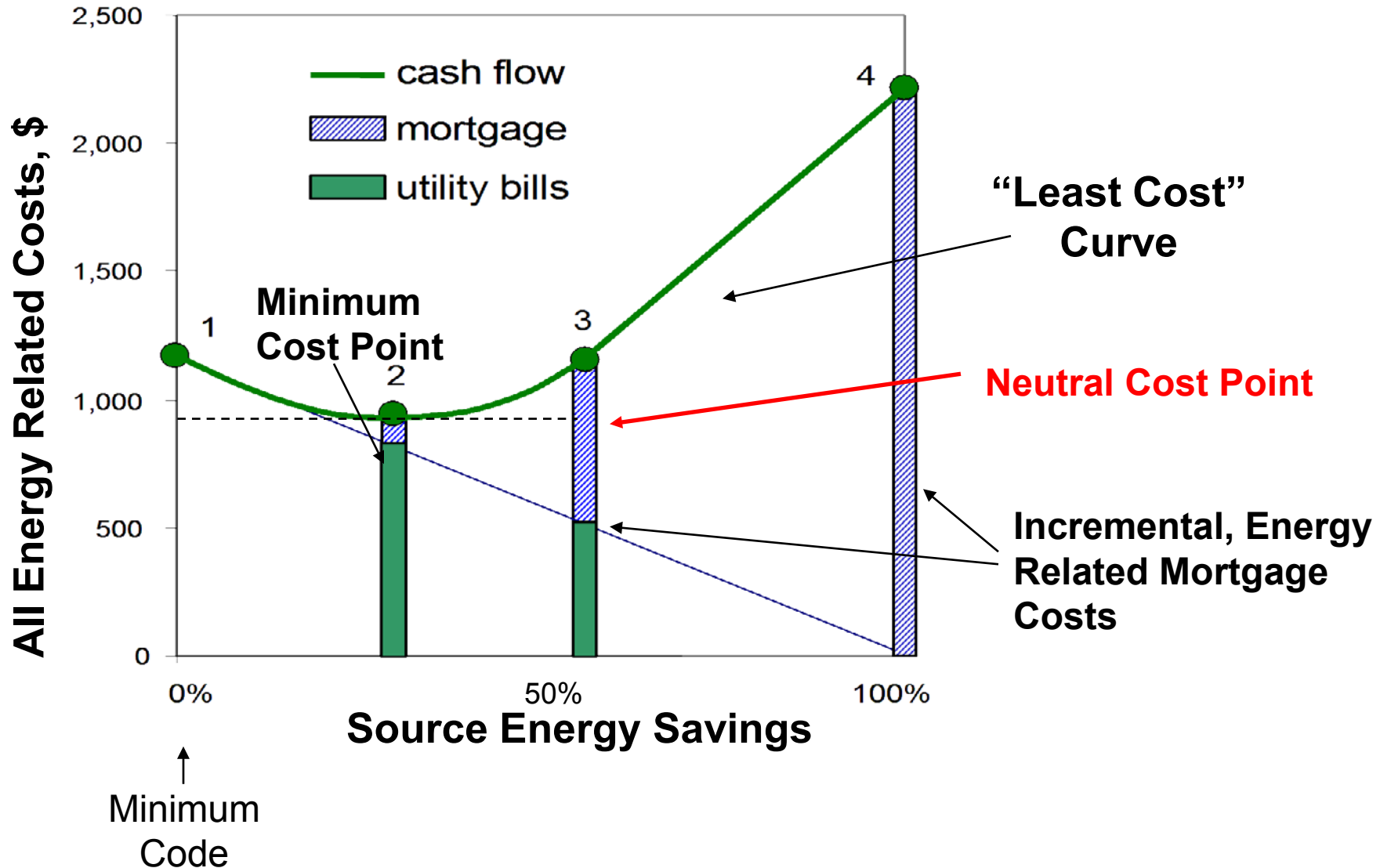


# Vintage Matters: 2001 RECS Primary Electric Data



2001 EIA RECS Survey Data

# Home Energy Related Costs



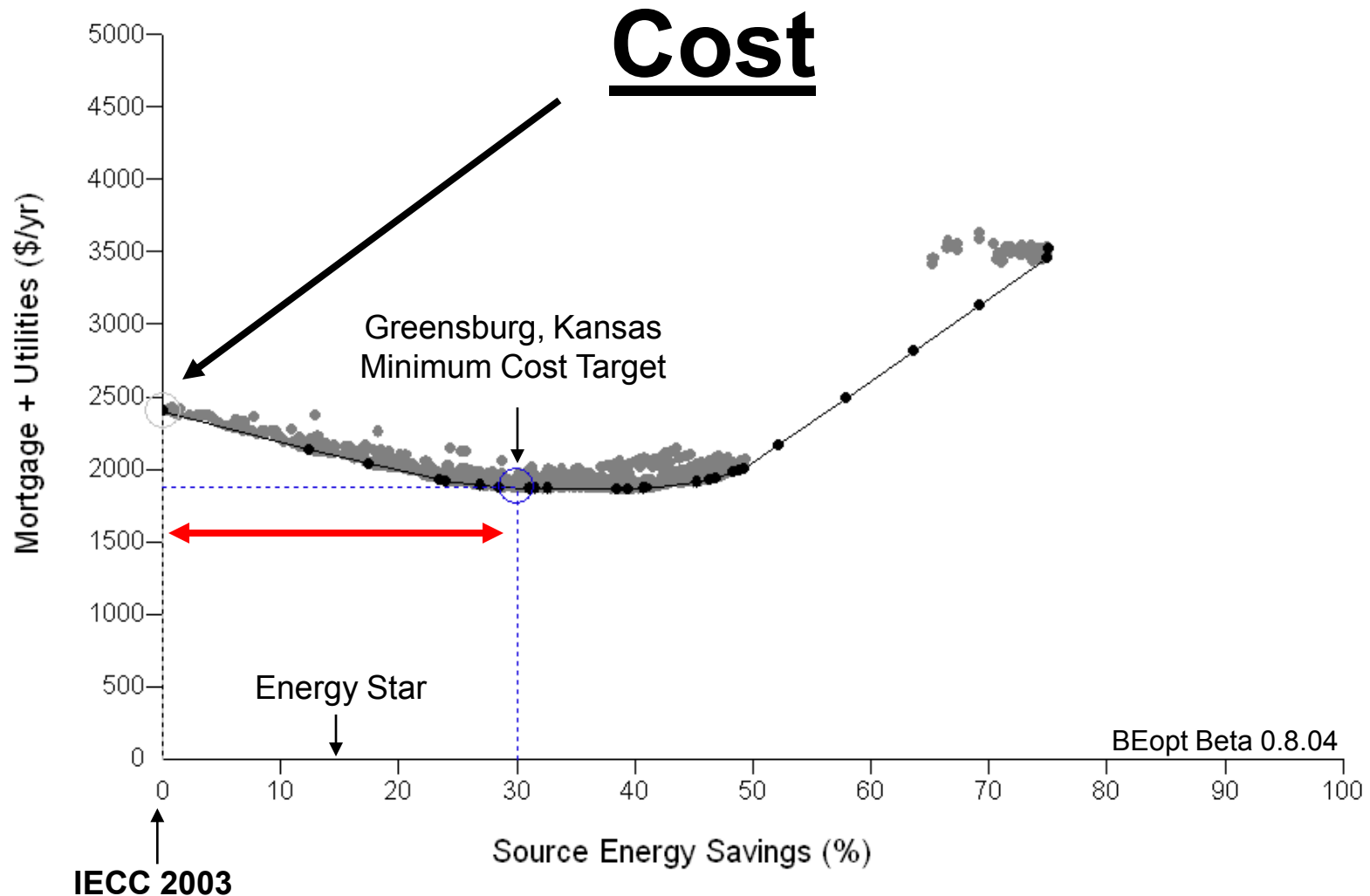
# Specific Example: 2000ft<sup>2</sup> New Home



2000 ft<sup>2</sup>, 16% window to floor area ratio

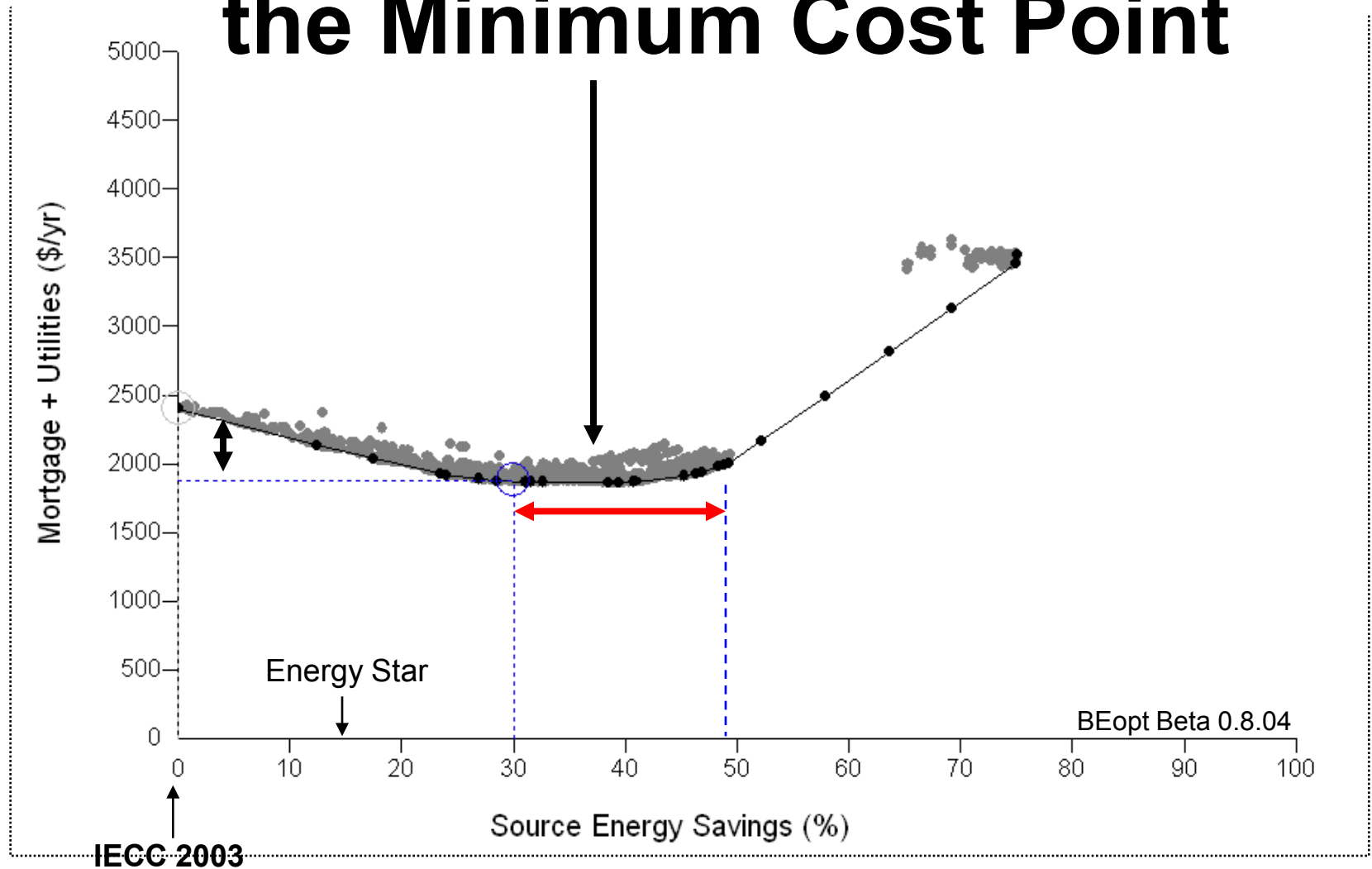
*Design: Building Science Corporation*

# Key Finding: Current Energy Codes Do Not Achieve Minimum



(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

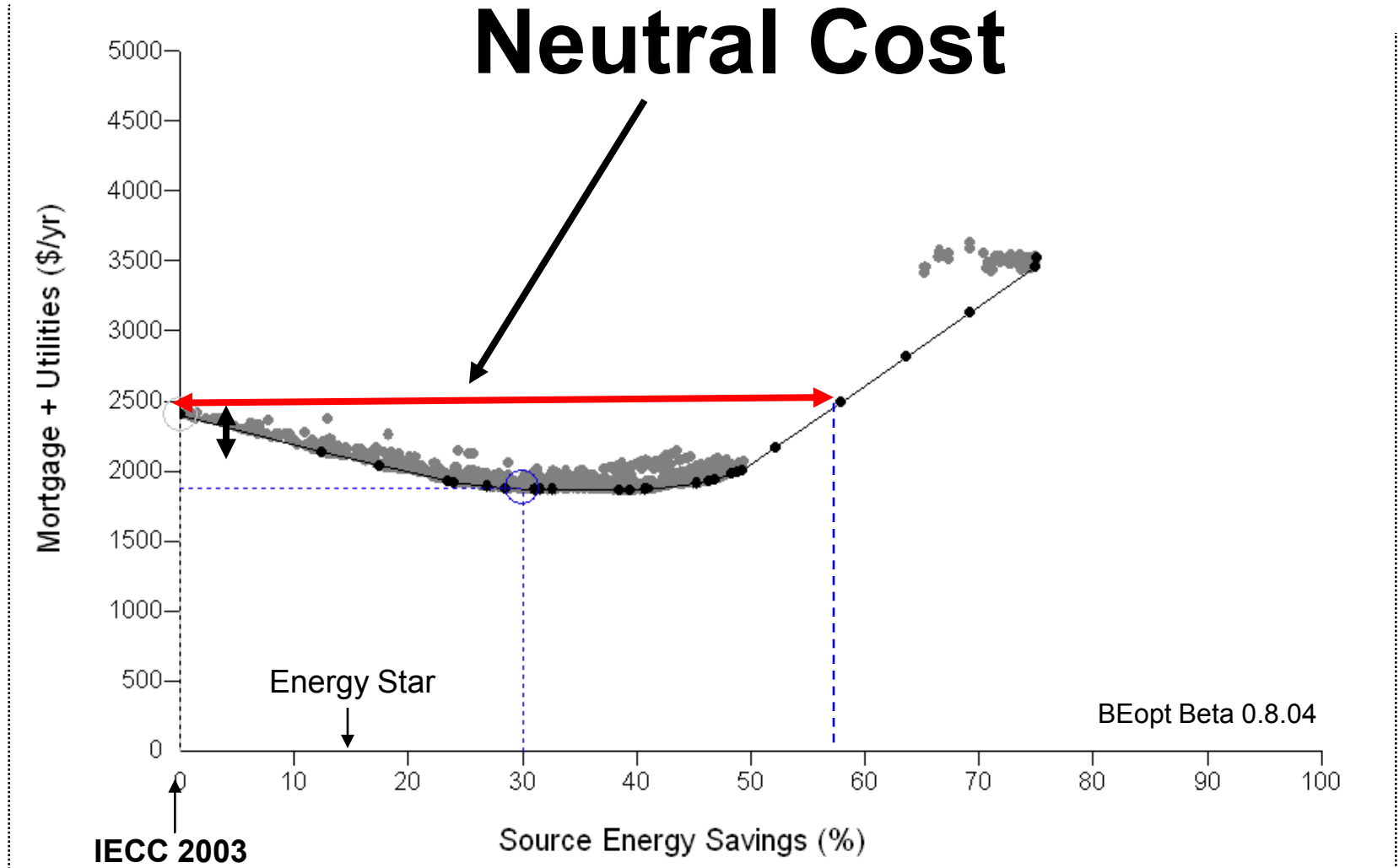
# Key Finding: There are Large Potential Energy Savings Near the Minimum Cost Point



(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

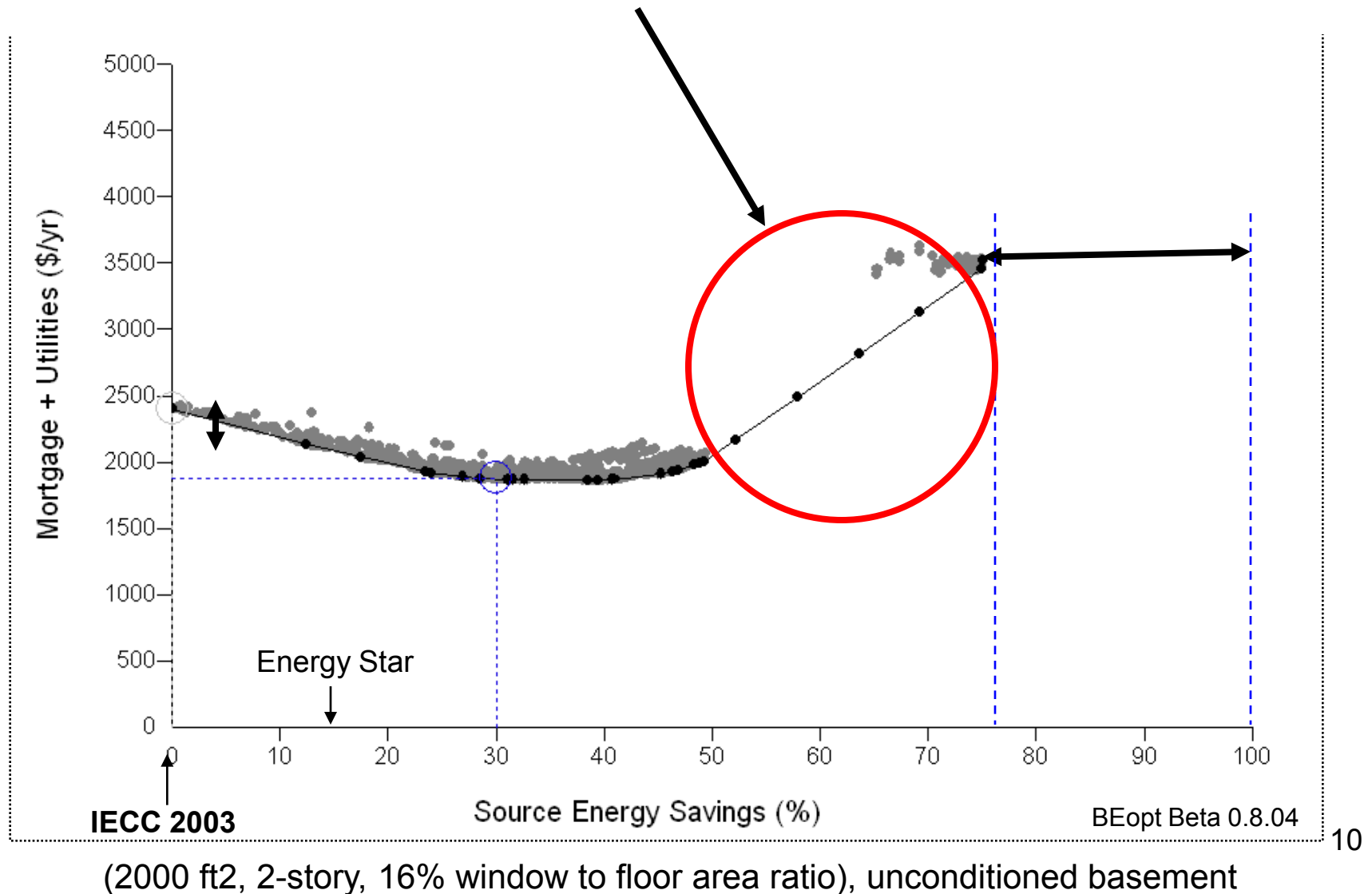


# Key Finding: There are Huge Potential Energy Savings at Neutral Cost

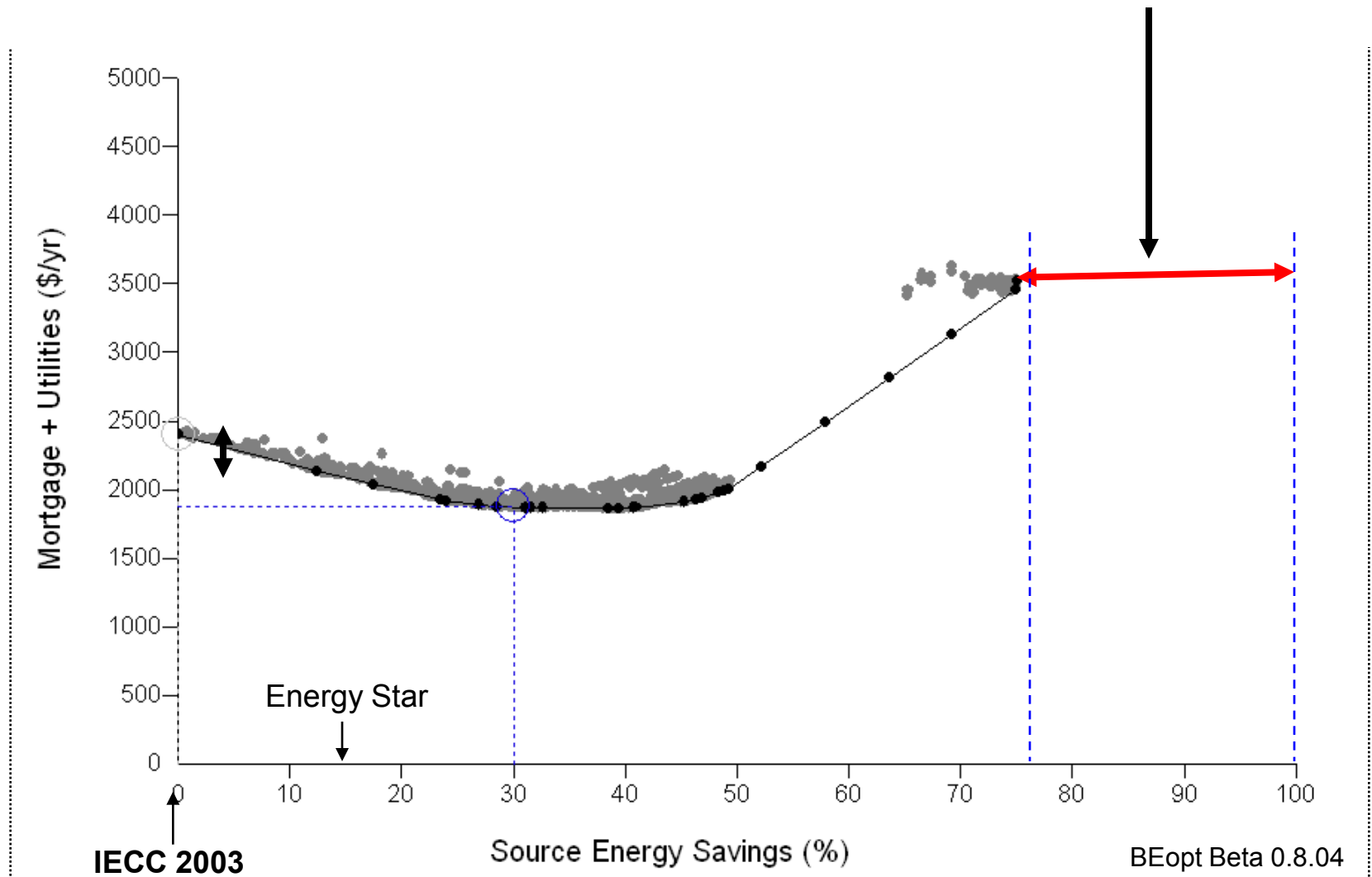


(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

# Key Finding: Onsite Renewables Play a Key Supporting Role!



# Key Finding: There is a 20%-30% Technology Gap to Achieve Net ZEH



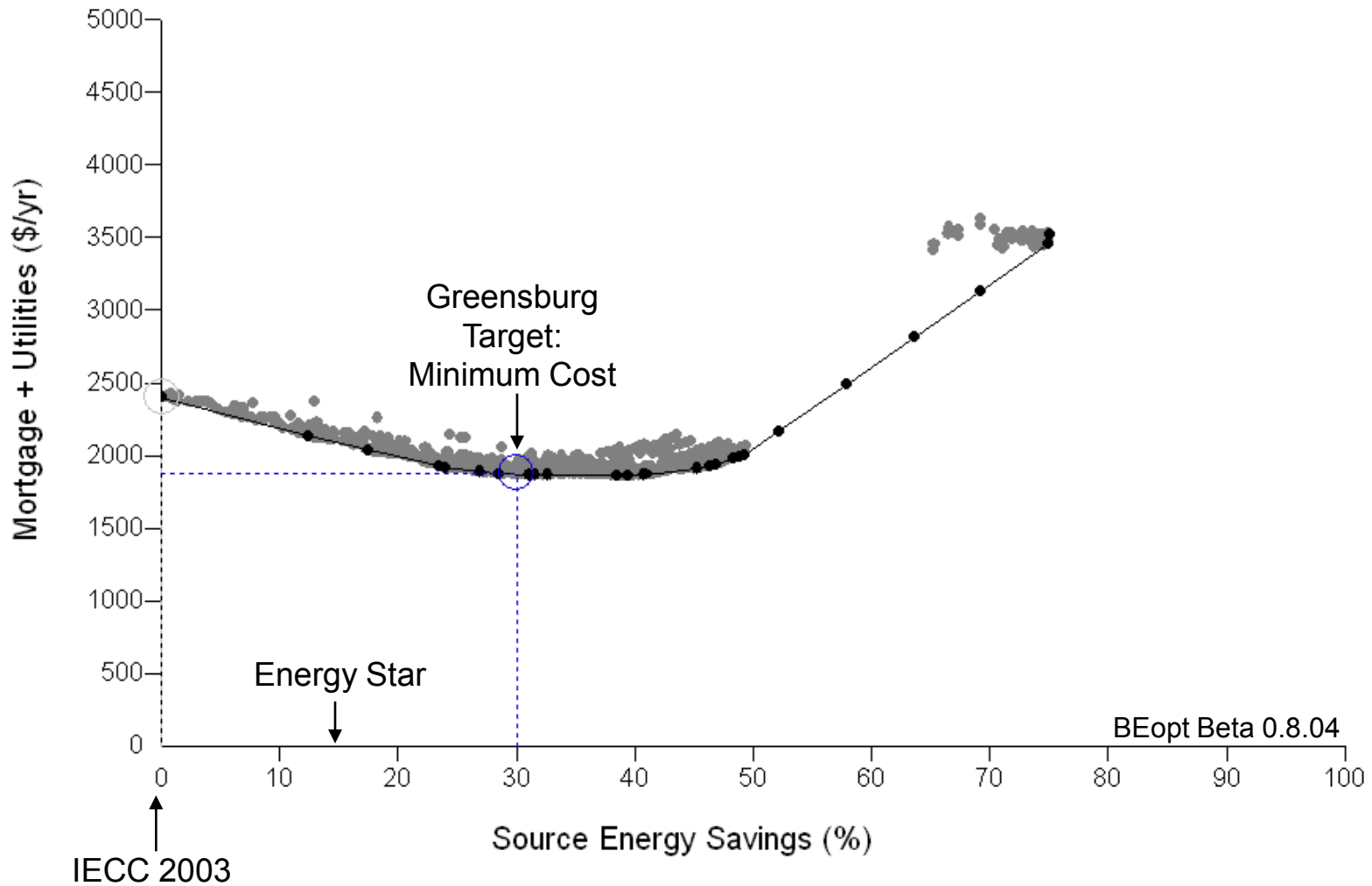
(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

# Critical ZEH Technology Gaps

- High R Wall Systems: Durable high R wall systems for cold, northern marine, and mixed climates, leading to development of an R-30 wall assembly with an *incremental cost of \$2/ft<sup>2</sup>-floor area* relative to an R-19 2x6 wall.
- Cold Climate DHW: DHW system with *\$2000 incremental system cost* and 30% reduction in annual energy relative to a gas tankless hot water system with EF=0.8.
- Cold Climate R10 Window Assembly: R10 window assembly with a minimum SHGC of 0.3 and cost of \$20/ft<sup>2</sup> (*incremental cost of \$4/ft<sup>2</sup> of window area relative to current low e*)
- Very High Performance AC<sup>[1]</sup>: AC system with 30% reduction in annual energy use and *an incremental cost increase of \$1000* relative to a current SEER 18/EER 13.4 system with tight ducts in conditioned space.
- MELs Reduction: 30% reduction in miscellaneous electric energy use with an *incremental cost of \$1000*.

<sup>[1]</sup> The AC performance goal is an overall system performance goal and includes savings from efficiency (improvements in COP), zoning, night cooling, evaporative cooling, heat recovery, and capacity modulation.

# 30% Savings Target: Greensburg



(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

# Example: Greensburg 30% Efficiency Package<sup>1</sup>

- 2x6 + R-19 batts (R14 wall assembly)
- R40 ceiling assembly
- R10 basement
- .0002 SLA (4 ACH<sub>50</sub>)
- Low e/low SHGC glazing (0.3 U-value, 0.37 SHGC)
- 50% CFL Lighting
- SEER 14 AC
- AFUE 90+ furnace
- Premium gas hot water, EF 0.61
- Tight ducts (Mastic, 5% Leakage), R-8
- BA QA (moisture control, ...)

Estimated cost increase relative to standard home<sup>2,3</sup>: +\$1.25-\$2.00/ft<sup>2</sup>

## Notes:

1. Equivalent packages may be substituted, based on specific builder preferences
2. Does not include costs associated with builder/contractor training and changes in business practices.
3. Incremental costs evaluated relative to minimum IECC 2003

# Estimated Annual Cost Savings: 30% Energy Savings Target

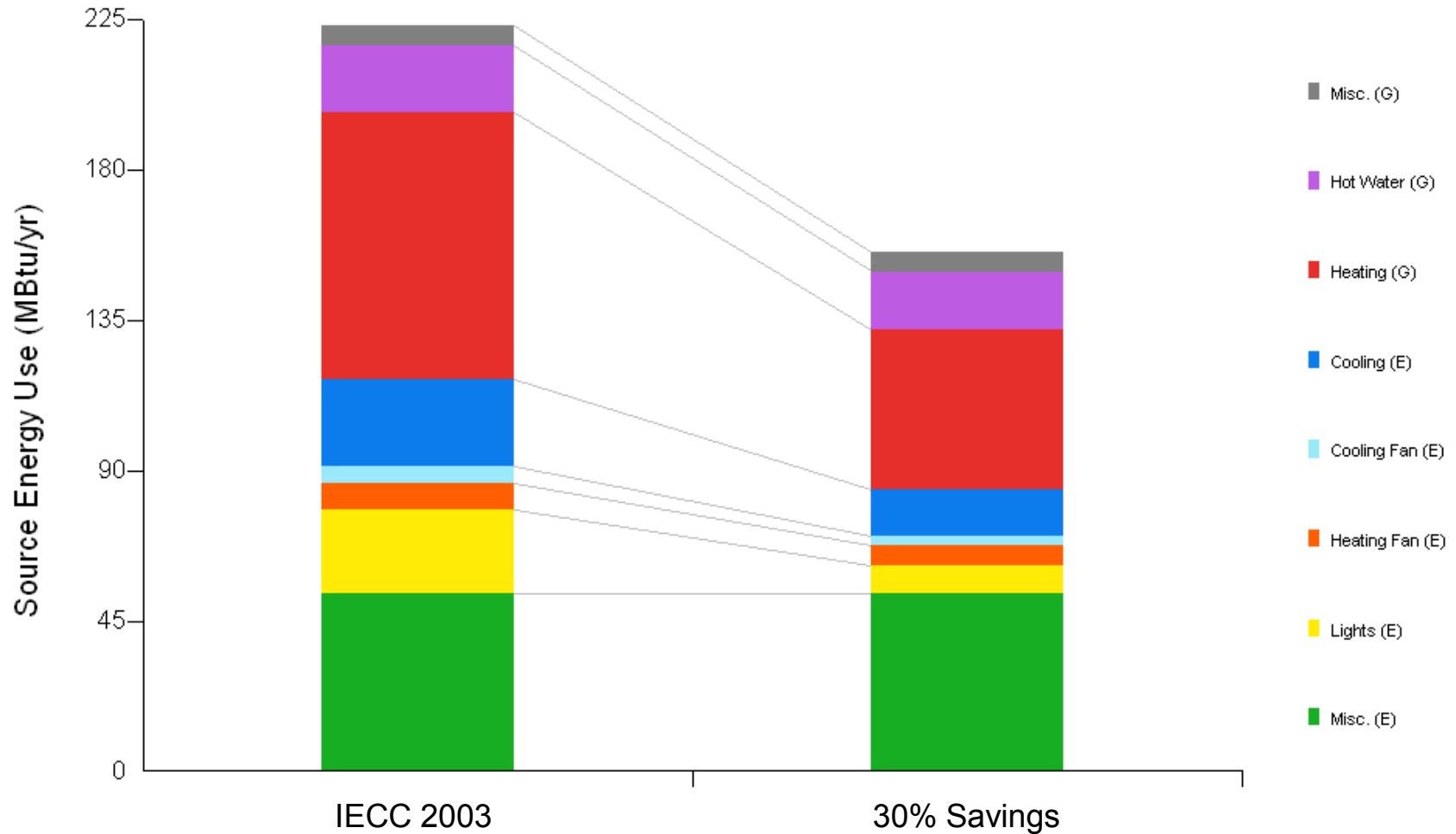
	Greensburg
Estimated Incremental First Cost Relative to Standard Practice <sup>1</sup>	\$4,000
Annual Amortized Cost 7%, 30Year mortgage <sup>2</sup>	\$211
Estimated Annual Utility Bill Savings	\$723
<b>Net Annual Savings</b>	<b>\$512</b>

(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio, unconditioned basement)

<sup>1</sup>Evaluated relative to minimum IECC 2003

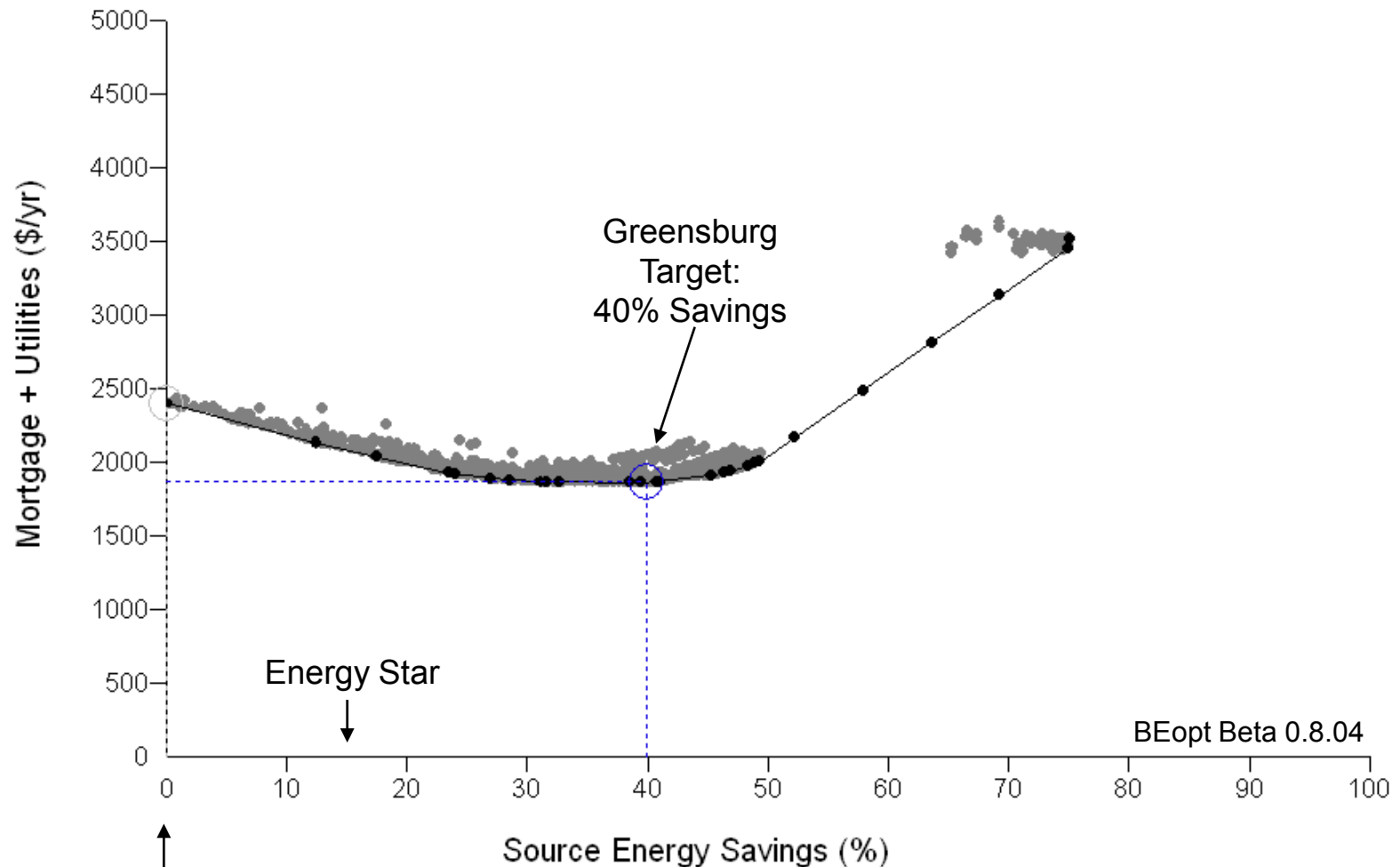
<sup>2</sup>Assumes 28% marginal tax bracket and includes present value of future replacements of equipment over 30 year life of mortgage.

# Estimated Annual Energy Savings by End Use: 30% Target





# 40% Savings Target: Greensburg



IECC 2003  
(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio, unconditioned basement)

# Example: Greensburg 40% Efficiency Package<sup>1</sup>

- 2x6 + R-21 batts (R15 wall assembly)
- R50 ceiling assembly
- R10 basement
- .0002 SLA (4 ACH<sub>50</sub>)
- Low e/low SHGC glazing, Argon Fill (0.28 U-value, 0.37 SHGC)
- 80% CFL Lighting
- SEER 18 AC
- AFUE 90+ furnace
- Premium gas hot water, EF 0.61
- Tight ducts (Mastic, 5% Leakage), R-8
- BA QA (moisture control, ...)

Estimated cost increase relative to standard home<sup>2,3</sup>: +\$3.00-\$4.00/ft<sup>2</sup>

## Notes:

1. Equivalent packages may be substituted, based on specific builder preferences
2. Does not include costs associated with builder/contractor training and changes in business practices.
3. Incremental costs evaluated relative to minimum IECC 2003

# Estimated Annual Costs: 40% Efficiency Target

	Greensburg
Estimated Incremental First Cost Relative to Standard Practice <sup>1,2</sup>	\$7,000
Annual Amortized Cost 7%, 30 Year mortgage <sup>3</sup>	\$411
Annual Utility Bill Savings	\$919
<b>Net Annual Savings</b>	<b>\$508</b>

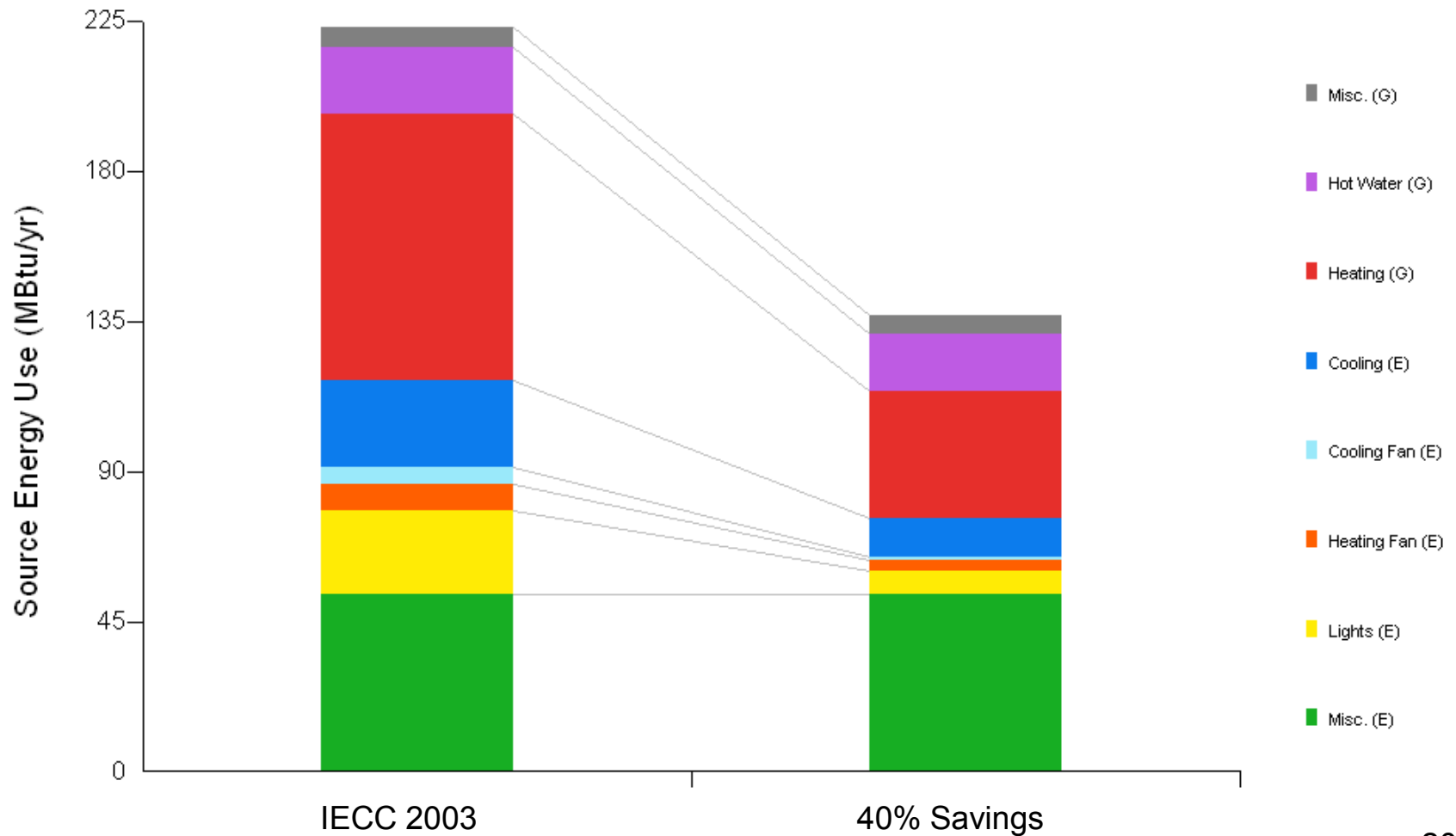
(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

<sup>1</sup>Evaluated relative to minimum IECC 2003. Cost does not include impact of \$2000 tax credit.

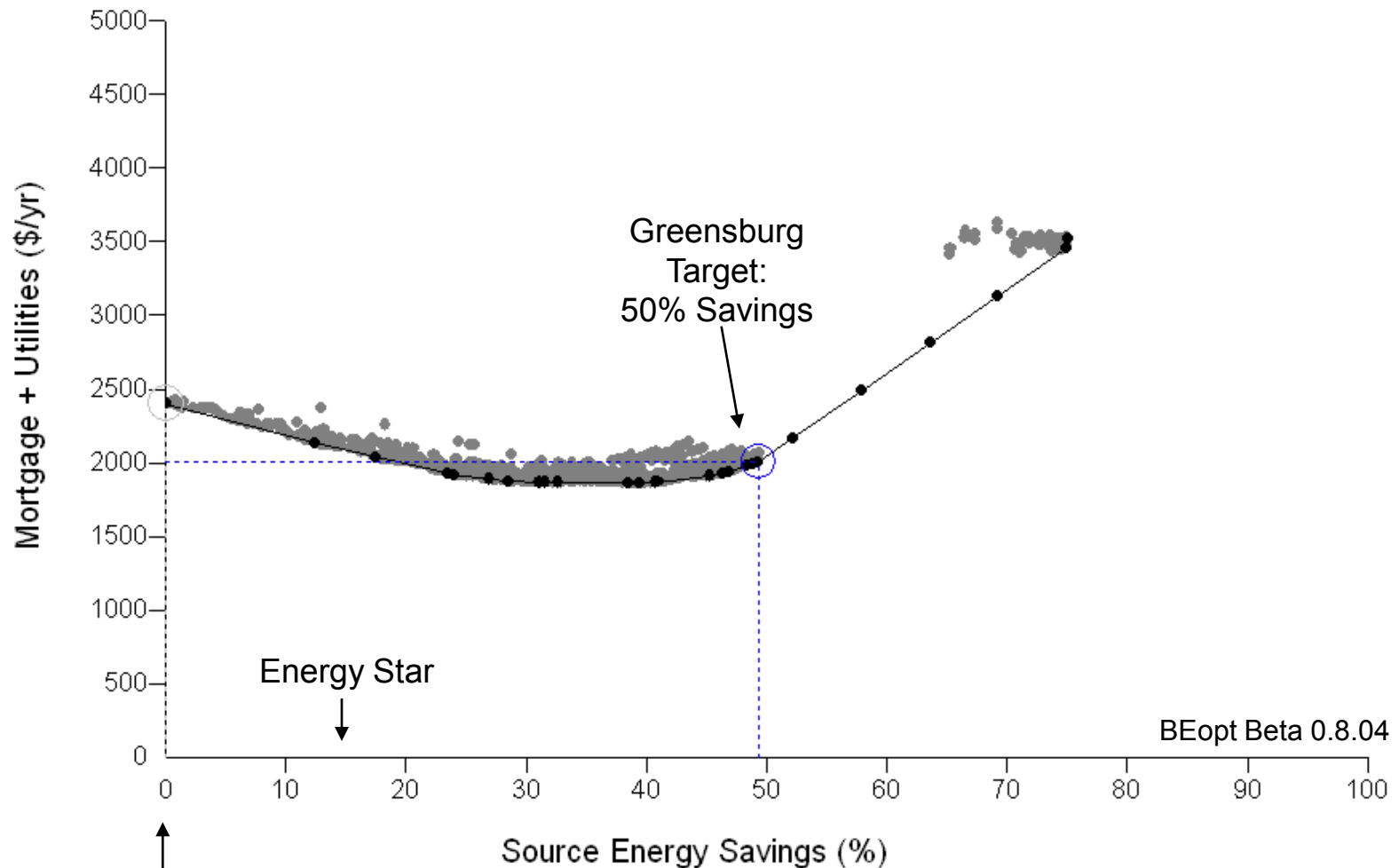
<sup>2</sup>Qualifies for federal new home tax credit

<sup>3</sup>Assumes 28% marginal tax bracket and includes present value of future replacements of equipment over 30 year life of mortgage.

# Estimated Annual Energy Savings by End Use: 40% Target



# 50% Savings Target: Greensburg



IECC 2003  
(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio, unconditioned basement)

# Example: Greensburg 50% Efficiency Package<sup>1</sup>

- 2x6 + R-19 batts+ foam sheathing (R22 wall assembly)
- R50 ceiling assembly
- R10 basement
- .0001 SLA (2 ACH<sub>50</sub>)
- Low e/low SHGC glazing, Argon Fill (0.28 U-value, 0.37 SHGC)
- 80% CFL Lighting
- SEER 18 AC
- AFUE 90+ furnace
- Gas tankless hot water, EF 0.8+
- Tight ducts (Mastic, 5% Leakage), in conditioned space
- Energy Star Appliances
- BA QA (moisture control, ...)

Estimated cost increase relative to standard home<sup>2,3</sup>: +\$6.00-\$8.00/ft<sup>2</sup>

## Notes:

1. Equivalent packages may be substituted, based on specific builder preferences
2. Does not include costs associated with builder/contractor training and changes in business practices.
3. Incremental costs evaluated relative to minimum IECC 2003

# Estimated Annual Costs: 50% Efficiency Target

	Greensburg
Estimated Incremental First Cost Relative to Standard Practice <sup>1,2</sup>	\$13,000
Annual Amortized Cost 7%, 30Year mortgage <sup>3</sup>	\$706
Annual Utility Bill Savings	\$1162
<b>Net Annual Savings</b>	<b>\$456</b>

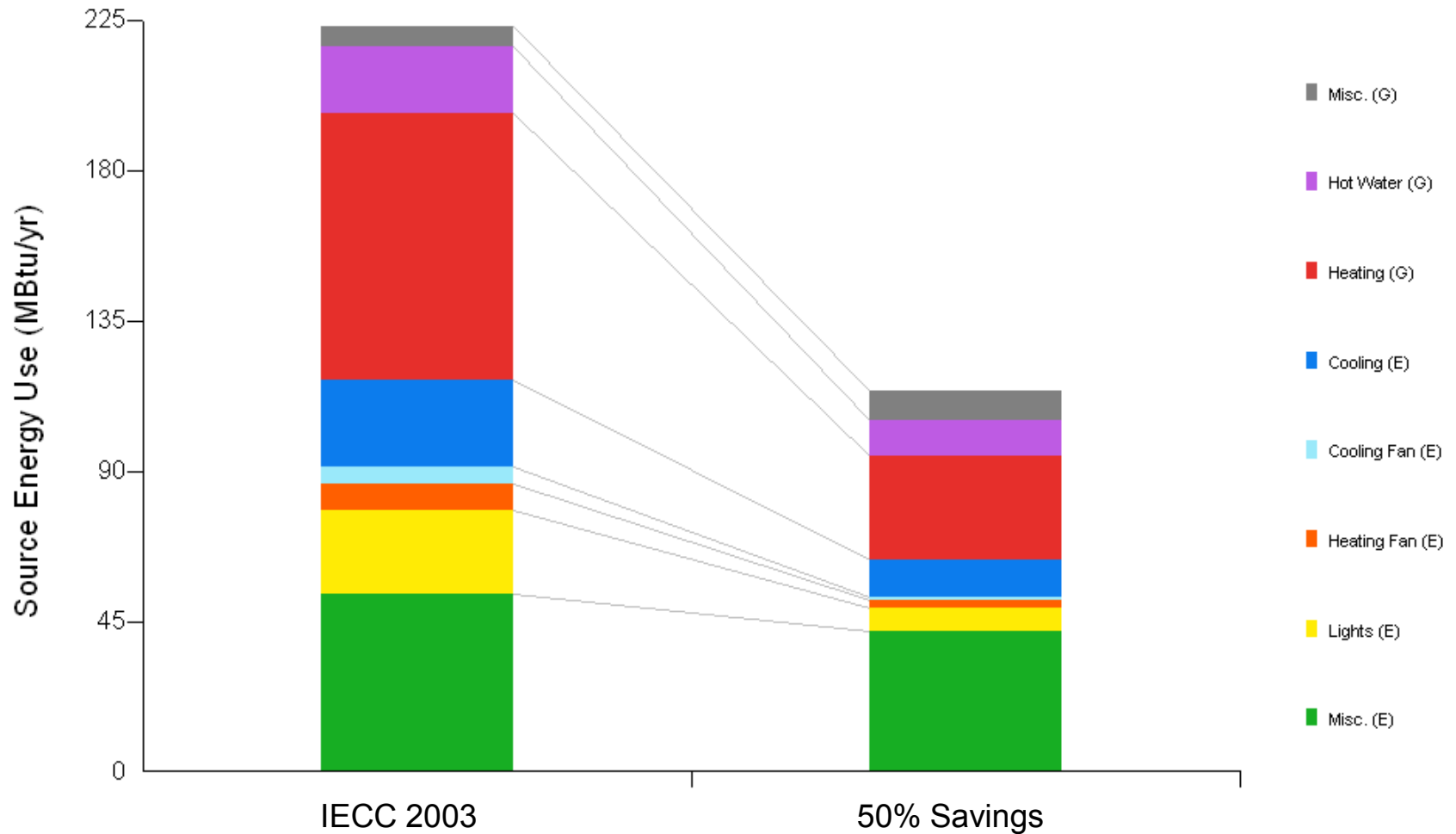
(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

<sup>1</sup>Evaluated relative to minimum IECC 2003

<sup>2</sup>Qualifies for federal new home tax credit

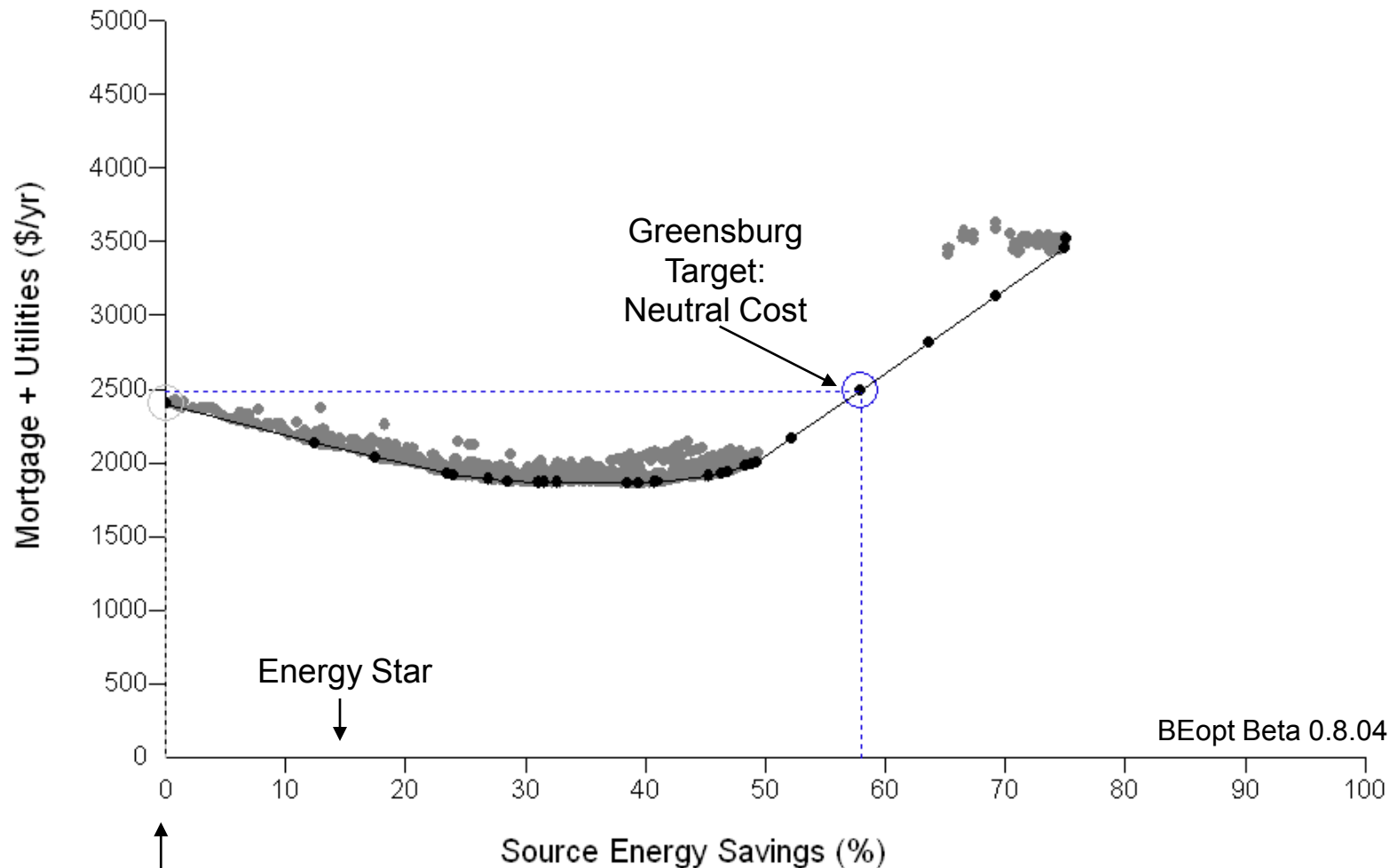
<sup>3</sup>Assumes 28% marginal tax bracket and includes present value of future replacements of equipment over 30 year life of mortgage.

# Estimated Annual Energy Savings by End Use: 50% Target





# Neutral Cost Point: Greensburg



IECC 2003  
(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio, unconditioned basement)

# Example: Greensburg Neutral Cost Package<sup>1</sup>

- R22 wall assembly (2x6 + R-19 batts+ foam sheathing)
- R50 ceiling assembly
- R10 basement
- .0001 SLA (2 ACH<sub>50</sub>)
- Low e/low SHGC glazing, Argon Fill (0.28 U-value, 0.37 SHGC)
- 80% CFL Lighting
- SEER 18 AC
- AFUE 90+ furnace
- Gas tankless hot water, EF 0.8+
- Tight ducts (Mastic, 5% Leakage), in conditioned space
- Energy Star Appliances
- 1.5 kW<sub>DC</sub> PV System
- BA QA (moisture control, ...)

Estimated cost increase relative to standard home<sup>2,3</sup>: +\$10.00-\$13.00/ft<sup>2</sup>

Notes:

1. Equivalent packages may be substituted, based on specific builder preferences
2. Does not include costs associated with builder/contractor training and changes in business practices.
3. Incremental costs evaluated relative to minimum IECC 2003

# Estimated Annual Costs: Neutral Cost Target

	Greensburg
Estimated Incremental First Cost Relative to Standard Practice <sup>1,2</sup>	\$25,000
Annual Amortized Cost 7%, 30Year mortgage <sup>3</sup>	\$1386
Annual Utility Bill Savings	\$1386
<b>Net Annual Savings</b>	<b>\$0</b>

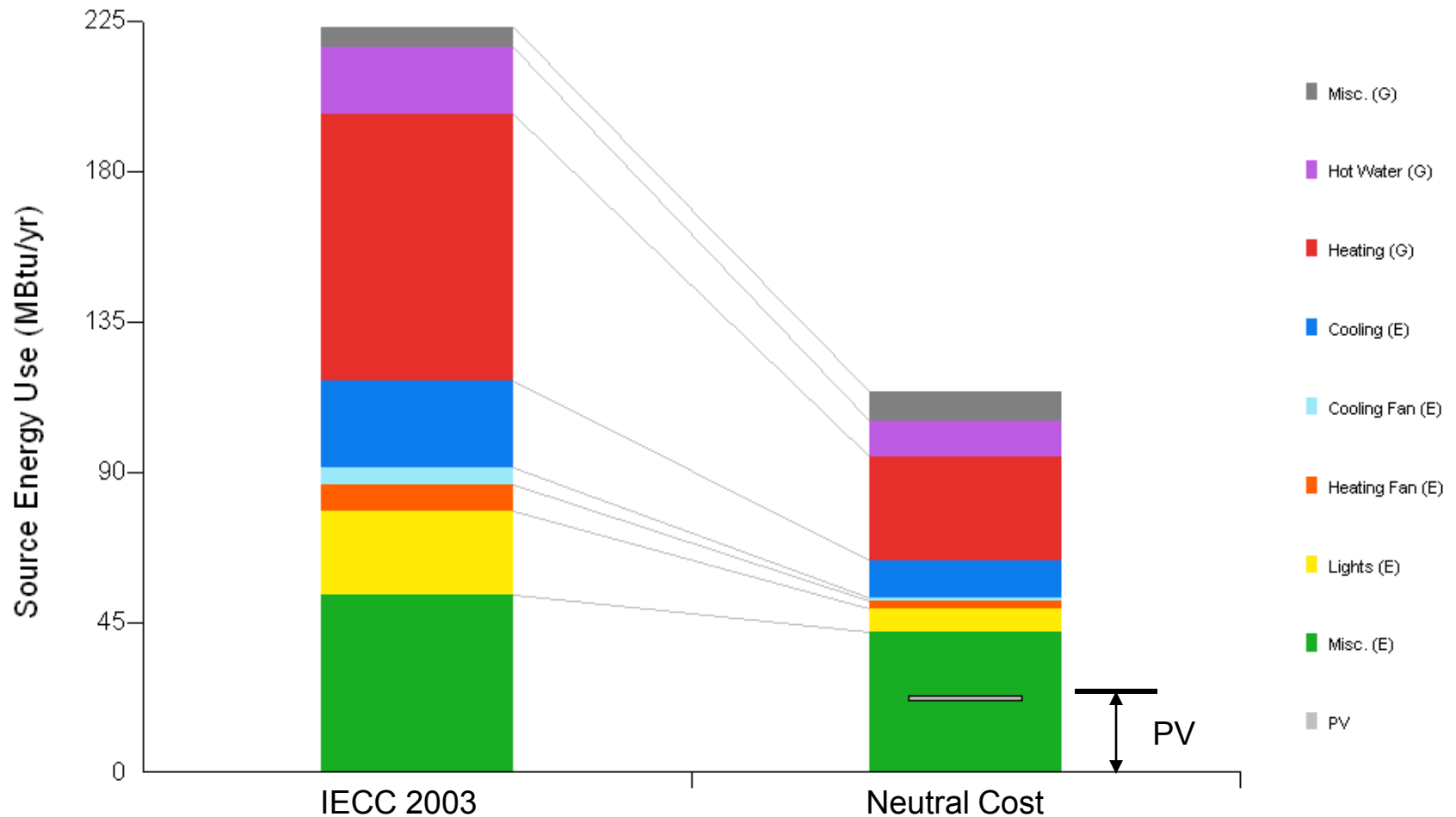
(2000 ft2, 2-story, 16% window to floor area ratio), unconditioned basement

<sup>1</sup>Evaluated relative to minimum IECC 2003

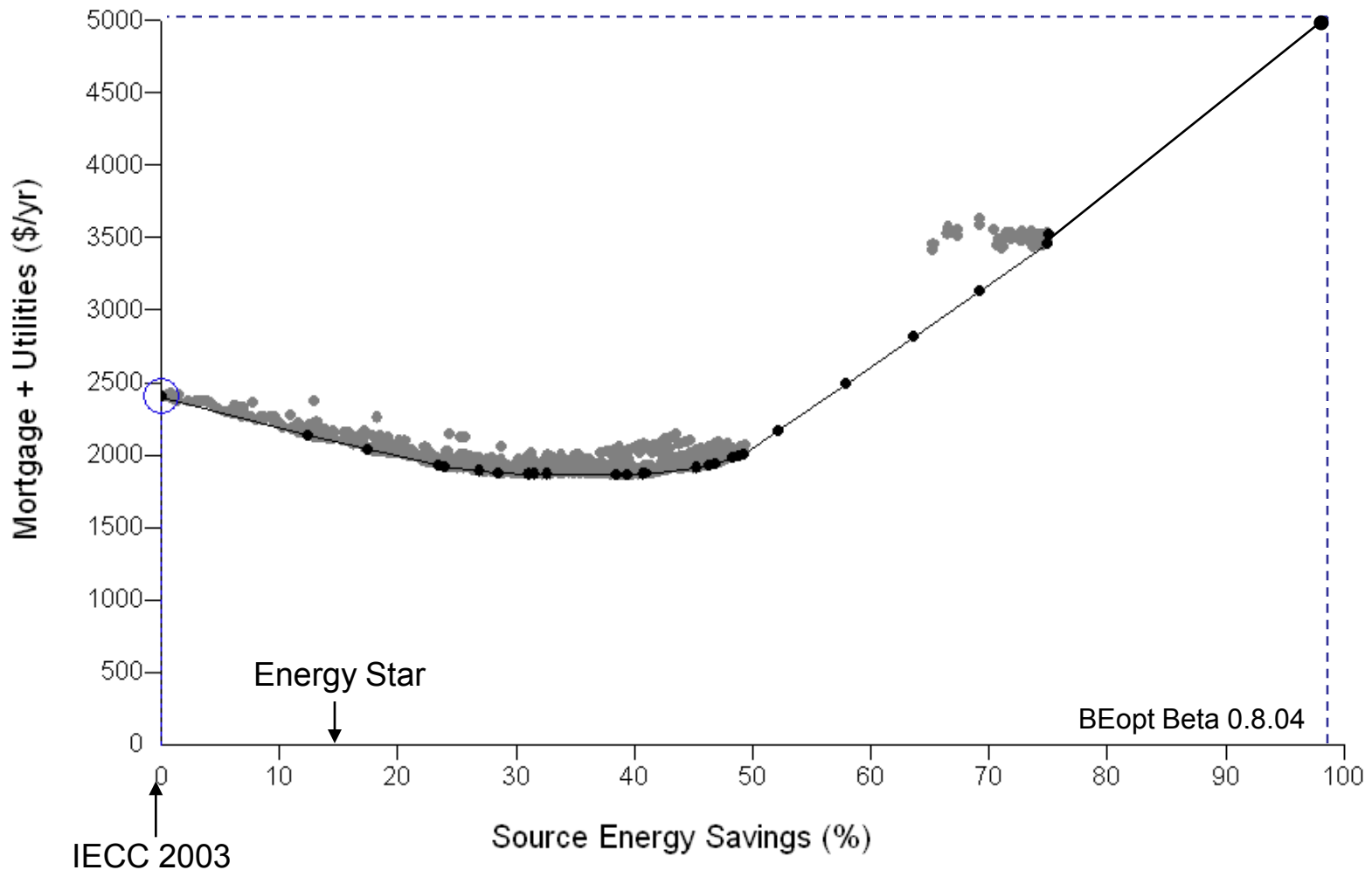
<sup>2</sup>Qualifies for federal new home tax credit

<sup>3</sup>Assumes 28% marginal tax bracket and includes present value of future replacements of equipment over 30 year life of mortgage.

# Estimated Annual Energy Savings by End Use: Neutral Cost Target



# Net Zero Energy Target: Greensburg



(2000 ft², 2-story, 16% window to floor area ratio, unconditioned basement)

# Example: Greensburg NZEH Package<sup>1</sup>

- R22 wall assembly (2x6 + R-19 batts+ foam sheathing)
- R50 ceiling assembly
- R10 basement
- .0001 SLA (2 ACH<sub>50</sub>)
- Low e/low SHGC glazing, Argon Fill (0.28 U-value, 0.37 SHGC)
- 80% CFL Lighting
- SEER 18 AC
- AFUE 90+ furnace
- Gas tankless hot water, EF 0.8+
- Tight ducts (Mastic, 5% Leakage), in conditioned space
- Energy Star Appliances
- 7 kW<sub>DC</sub> PV System and solar hot water system
- BA QA (moisture control, ...)

Estimated cost increase relative to standard home<sup>2,3</sup>: +\$35.00-\$40.00/ft<sup>2</sup>

Notes:

1. Equivalent packages may be substituted, based on specific builder preferences
2. Does not include costs associated with builder/contractor training and changes in business practices.
3. Incremental costs evaluated relative to minimum IECC 2003

# Estimated Annual Costs: Net Zero Energy Target

	Greensburg
Estimated Incremental First Cost Relative to Standard Practice <sup>1,2</sup>	\$69,000
Annual Amortized Cost 7%, 30Year mortgage <sup>2</sup>	\$4102
Annual Utility Bill Savings	\$2306
<b>Net Annual Savings</b>	<b>-\$1796</b>

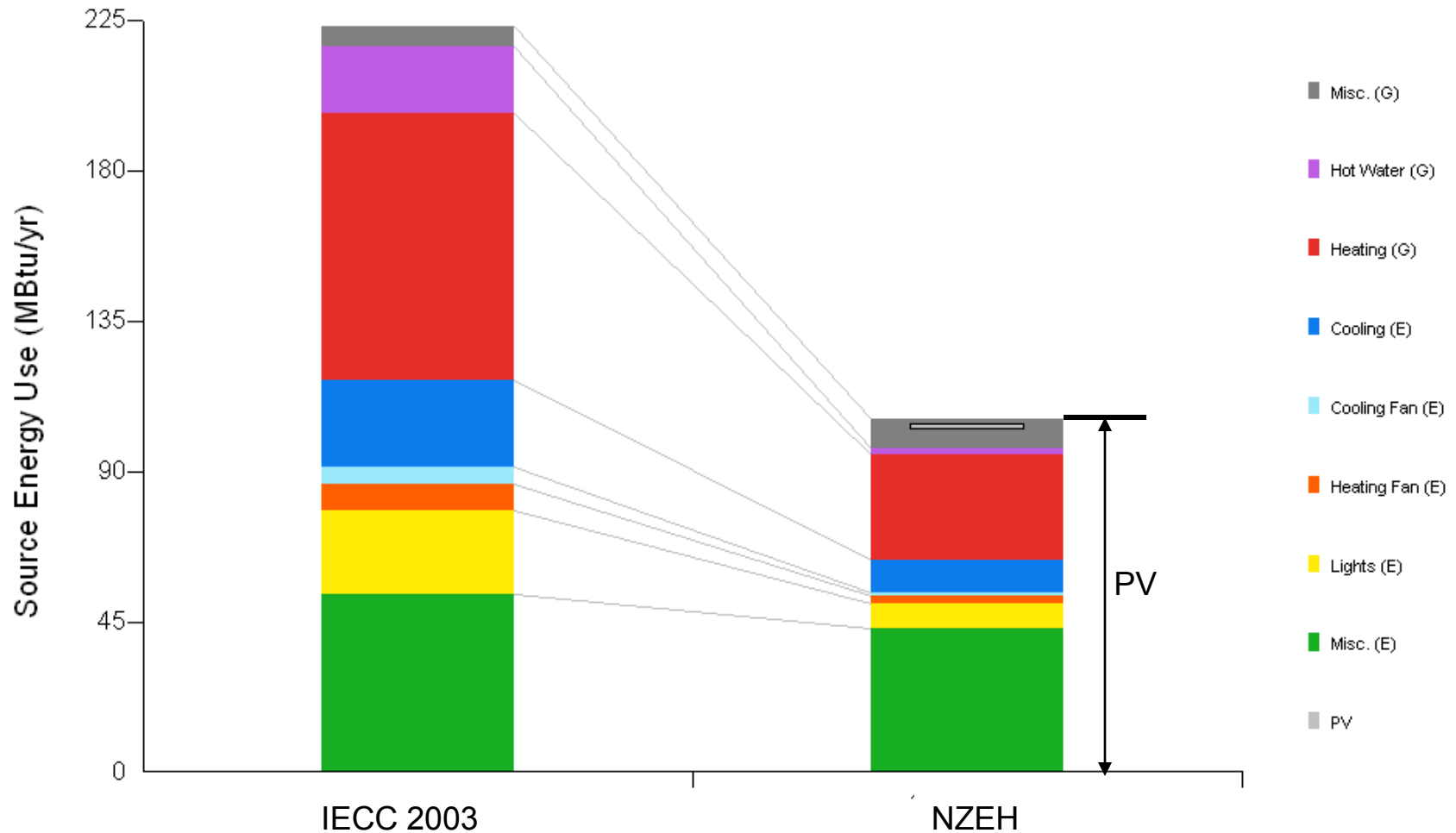
(2000 ft<sup>2</sup>, 2-story, 16% window to floor area ratio), unconditioned basement

<sup>1</sup>Evaluated relative to minimum IECC 2003

<sup>2</sup>Qualifies for federal new home tax credit

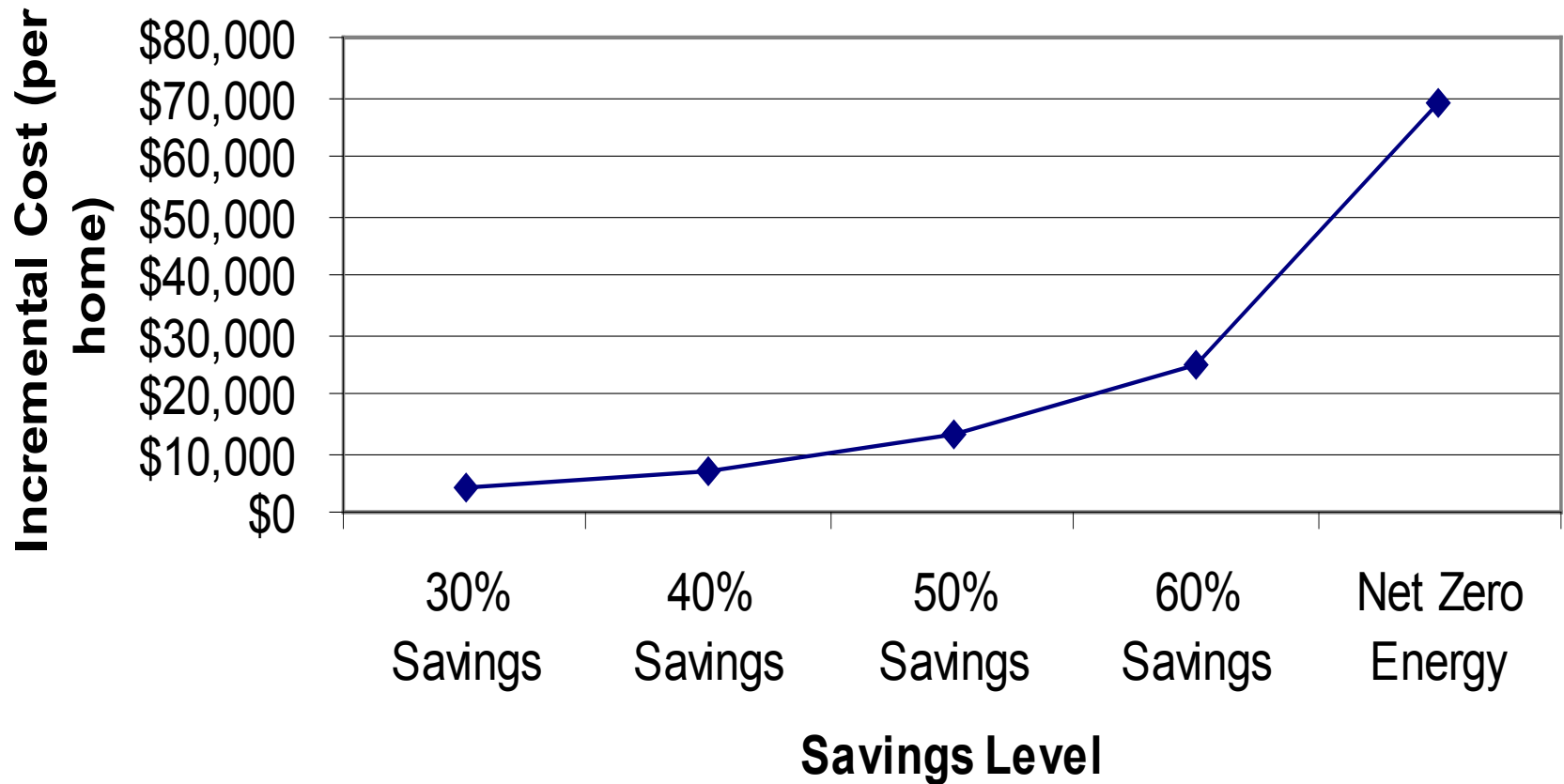
<sup>3</sup>Assumes 28% marginal tax bracket and includes present value of future replacements of equipment over 30 year life of mortgage.

# Estimated Annual Energy Savings by End Use: Net Zero Energy Target





## Cost of Energy Saving Upgrades



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