Higher-Performing Building Envelopes:

Where Do We Go From Here?

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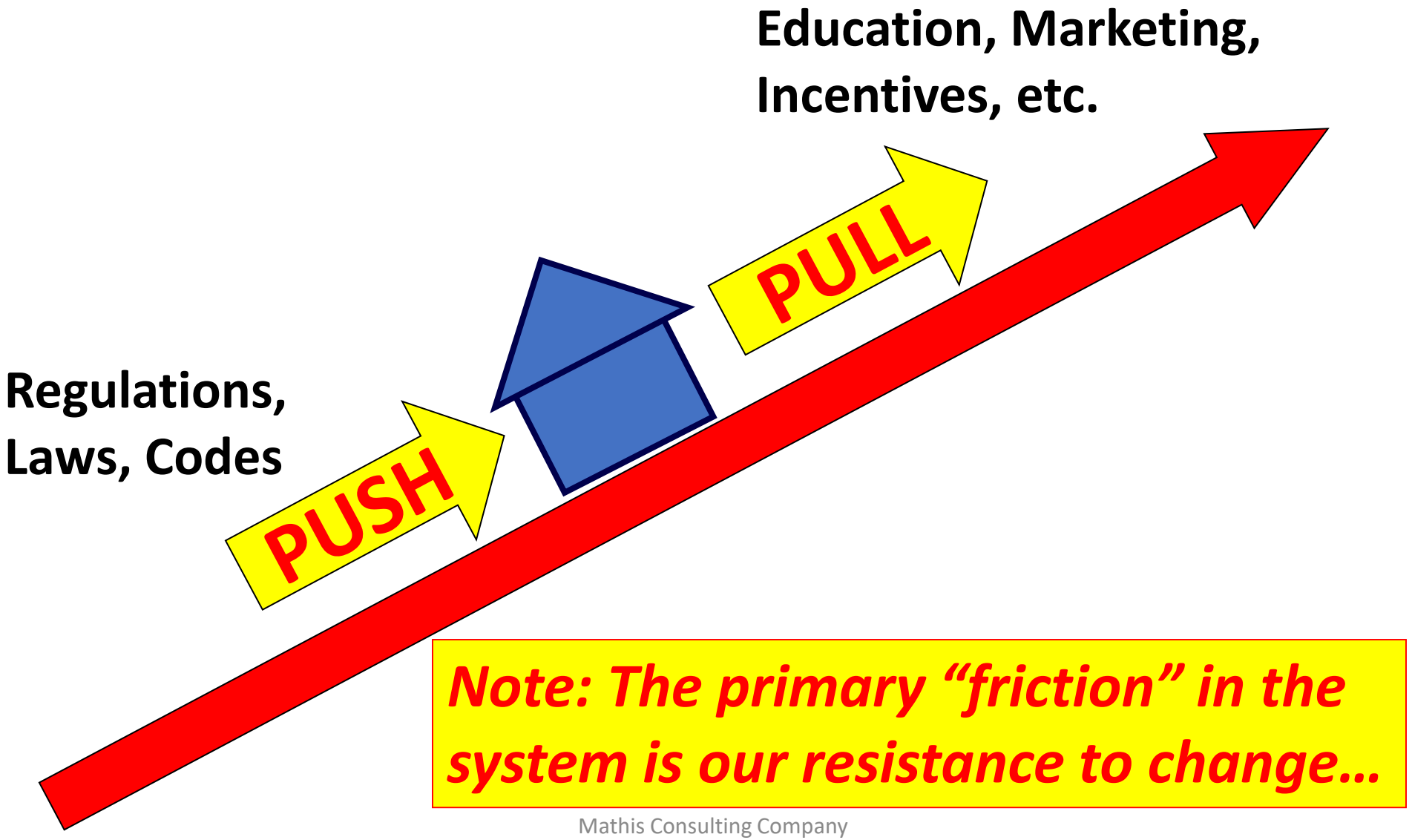
Market Transformation…



Note: The primary "friction" in the system is our resistance to change…

On the Risks of Leading Change

"There is nothing more difficult to attempt,
more perilous to conduct,
or more uncertain in its success,
than to take the lead in
the introduction of a new order of things...
Because the innovator has for enemies all those
who have done well under the old conditions,
and only lukewarm defenders in those
who might do well under the new."

Machiavelli, 16th Century

Translations:

- Change is hard
- Change is risky
- Change usually brings opposition

- Change MAY create allies
- Change MAY bring benefits

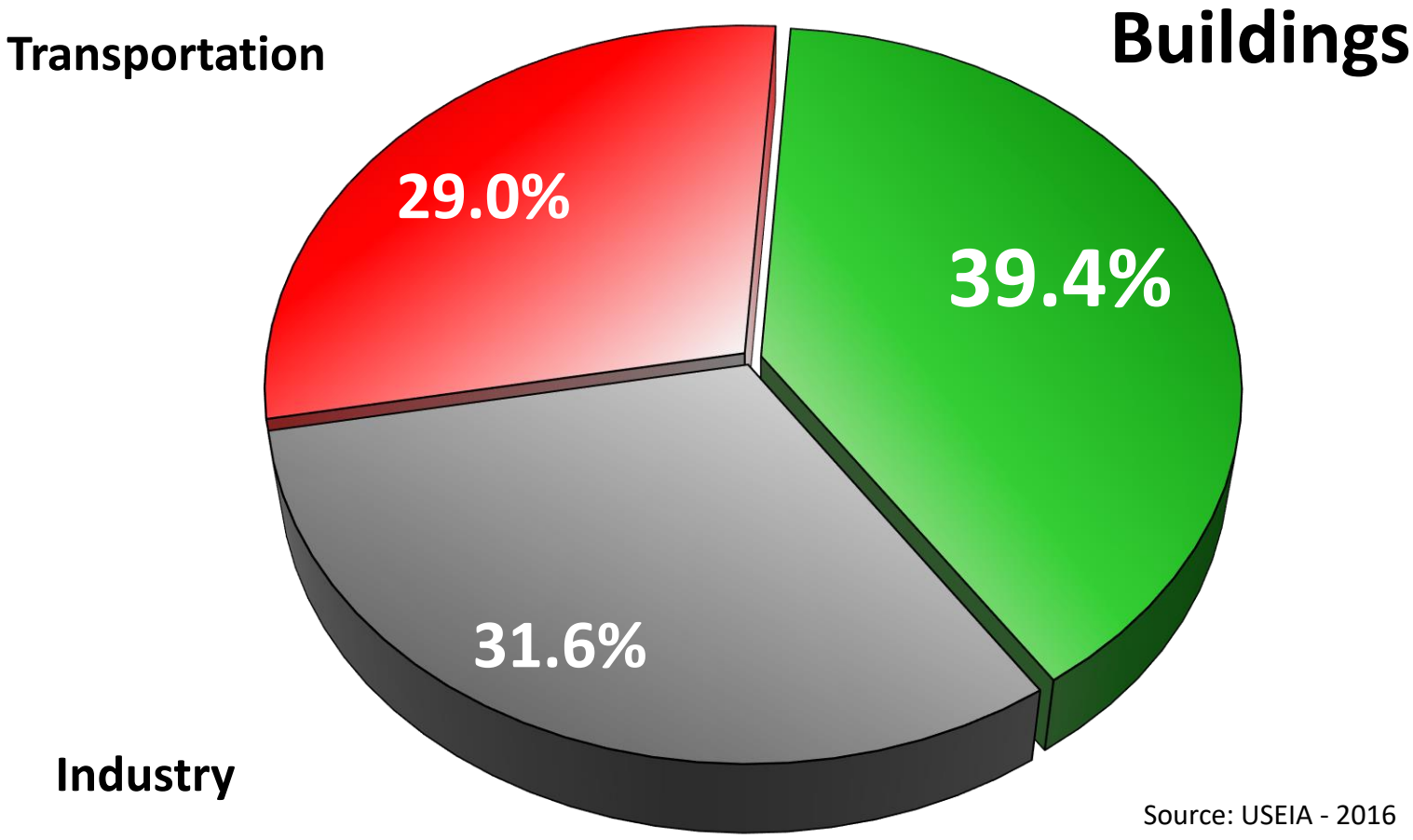
What is a “Higher Performing Building Envelope”?

- Better Energy Efficiency?
- More Durable?
- More Comfortable?
- Better Resilience?
- More Predictable?
- More Reliable?

Why Do We Even NEED "Higher Performing Building Envelopes"?

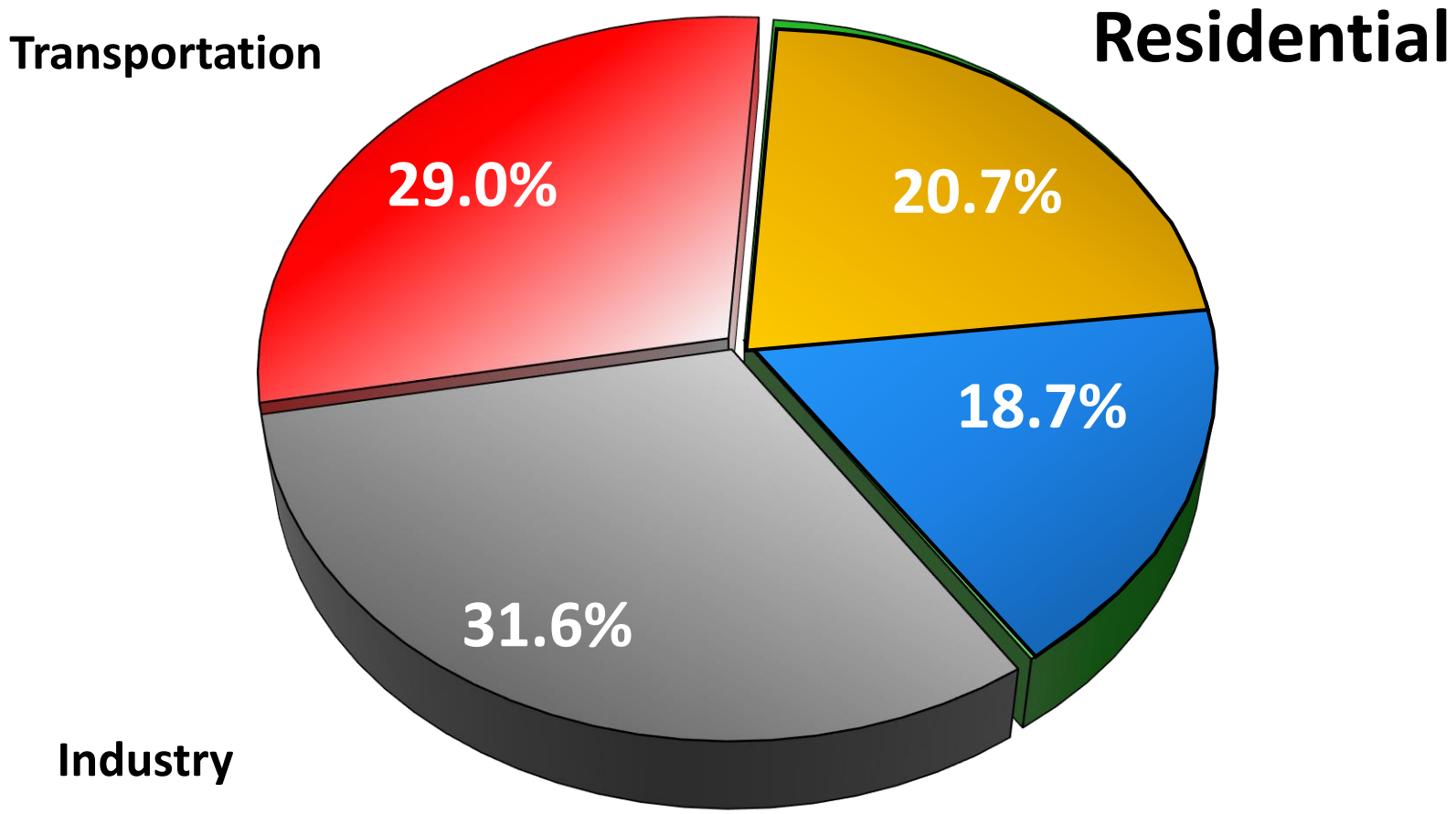
(glad you asked...)

Buildings Matter: US Energy Use



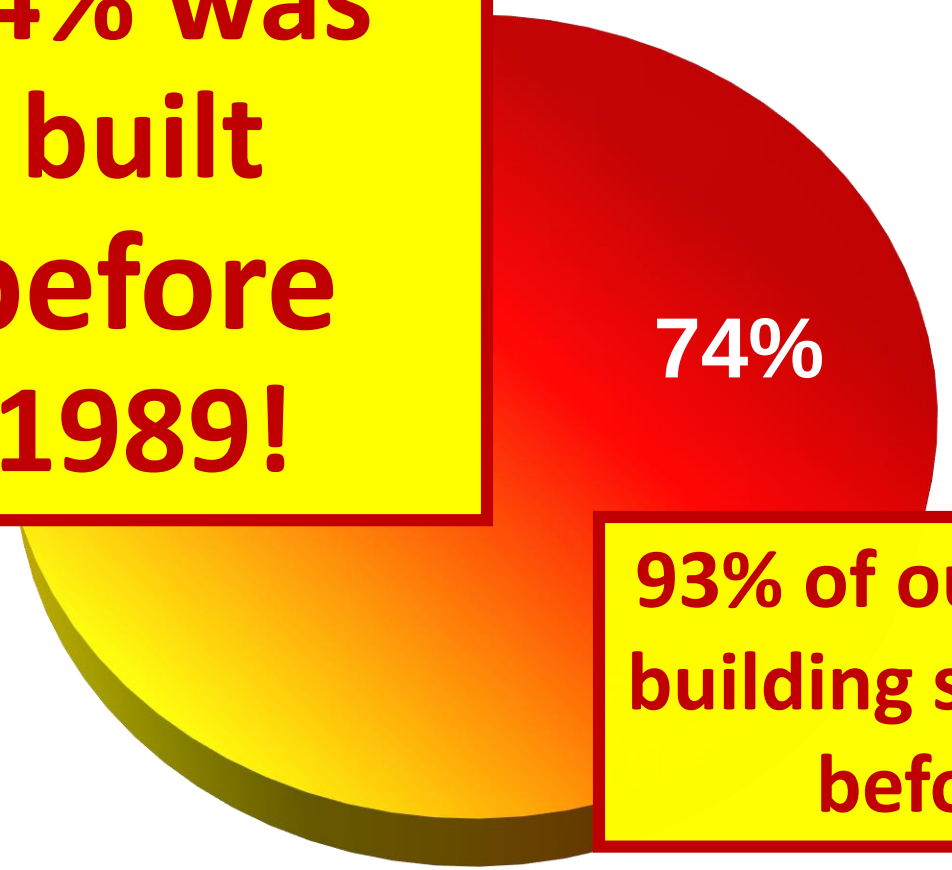
Source: USEIA - 2016

Buildings Matter: US Energy Use



US Commercial Buildings

74% was built before 1989!



Before 1989

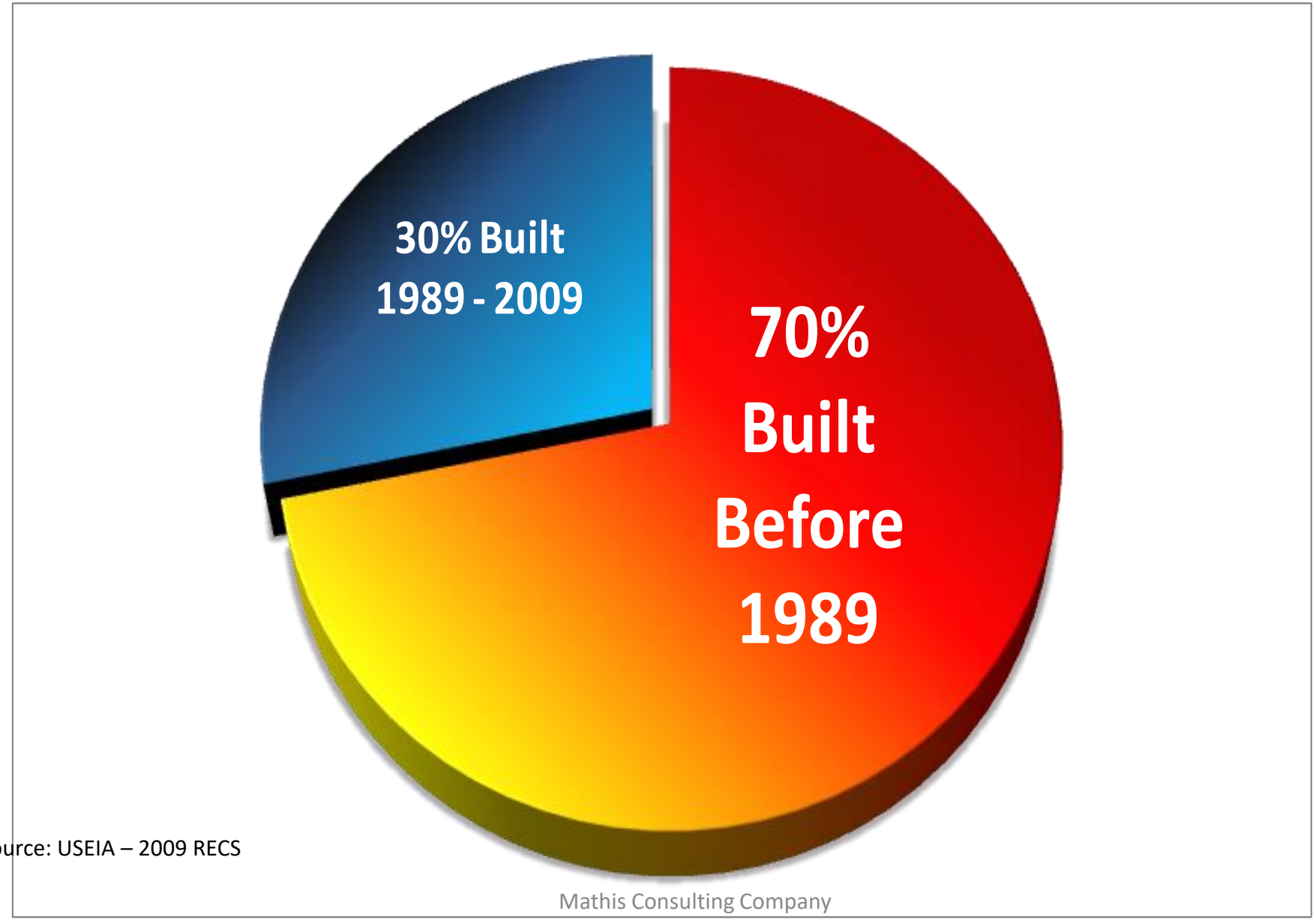
1990 to 1999

2000 to 2003

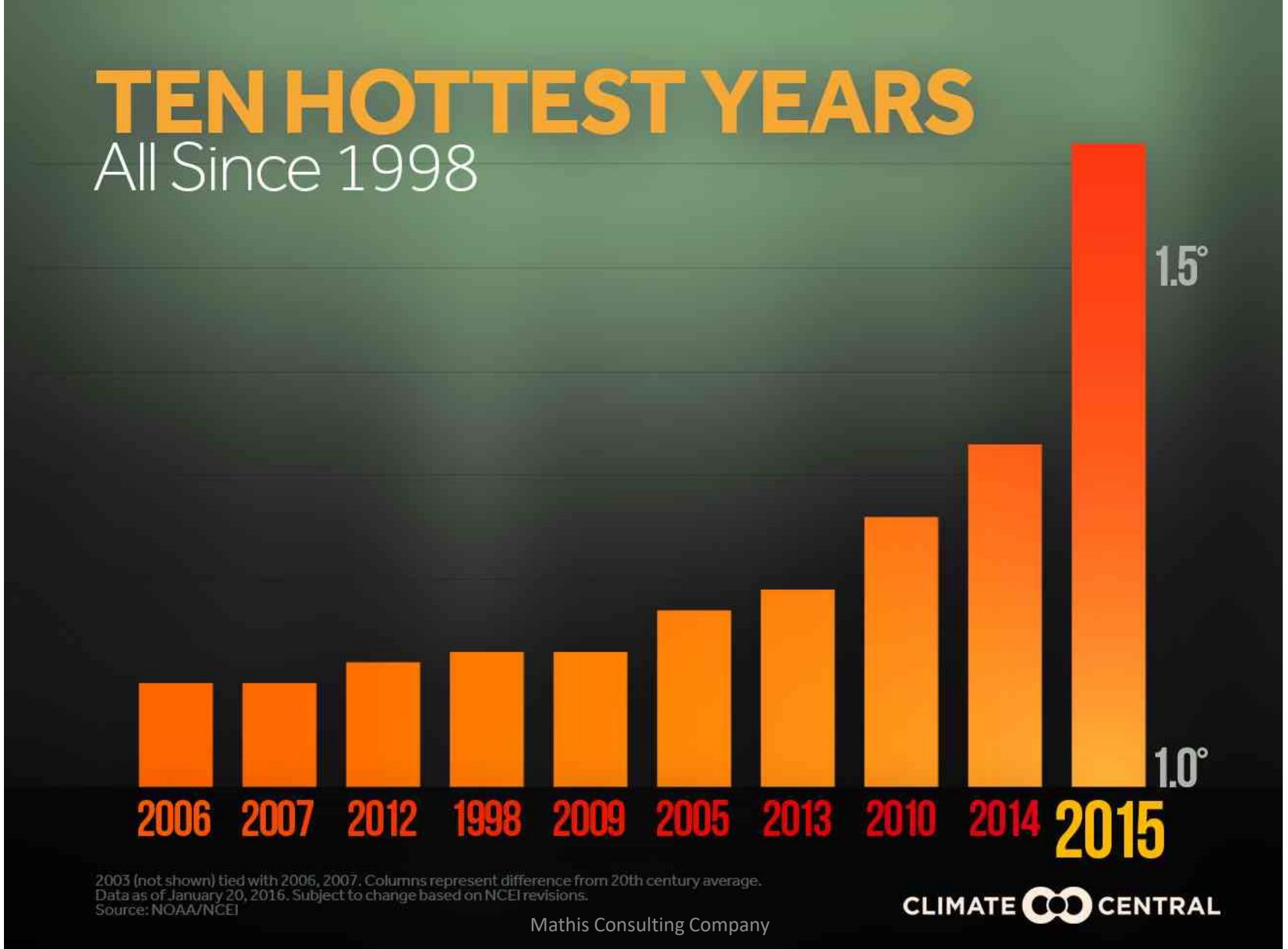
93% of our commercial building stock was built before 2003!

Source: USEIA , 2003 CBECS

Age of U.S. Homes…



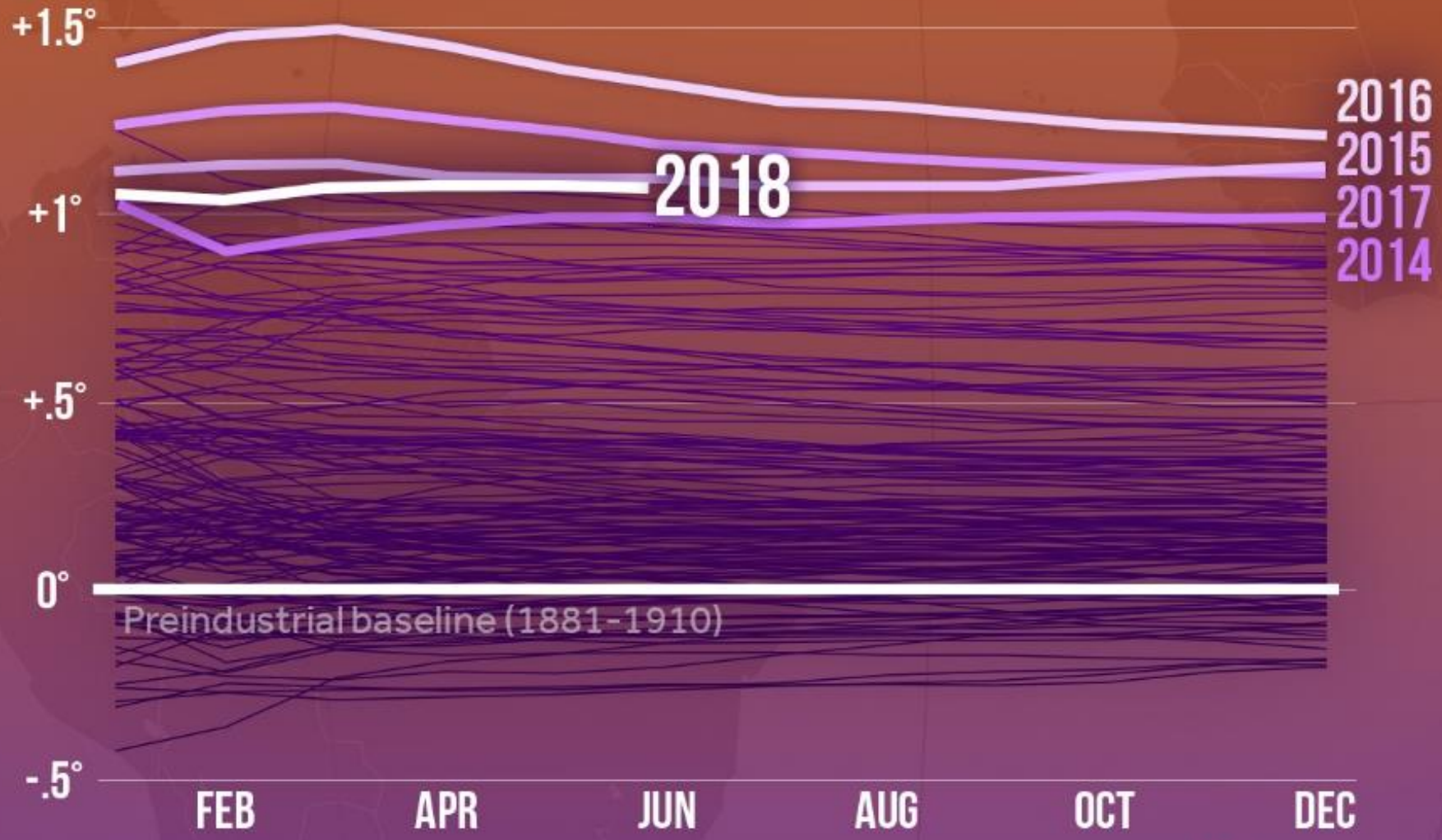
Source: USEIA – 2009 RECS


TEN HOTTEST YEARS
All Since 1998
1.5°
1.0°
2006
2007
2012
1998
2009
2005
2013
2010
2014
2015
2003 (not shown) tied with 2006, 2007. Columns represent difference from 20th century average.
Data as of January 20, 2016. Subject to change based on NCEI revisions.
Source: NOAA/NCEI
CLIMATE CENTRAL

2016: The Trend Continues…

HOTTEST YEARS

Global Year-to-Date Anomalies (°C) Since 1880



Source: NASA GISS & NOAA NCEI global temperature anomalies averaged and adjusted to early industrial baseline (1881–1910). Data as of 7/18/2018

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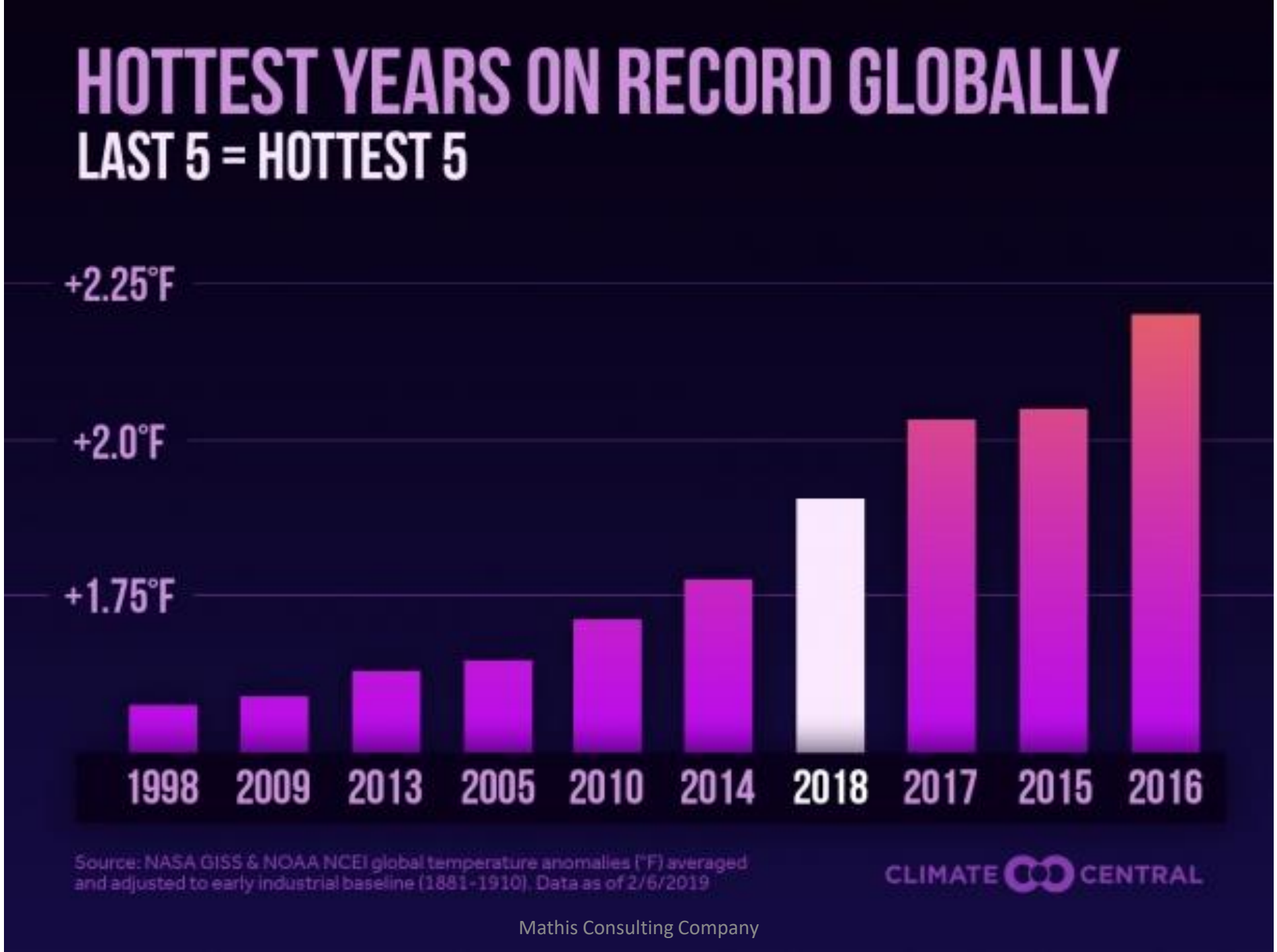
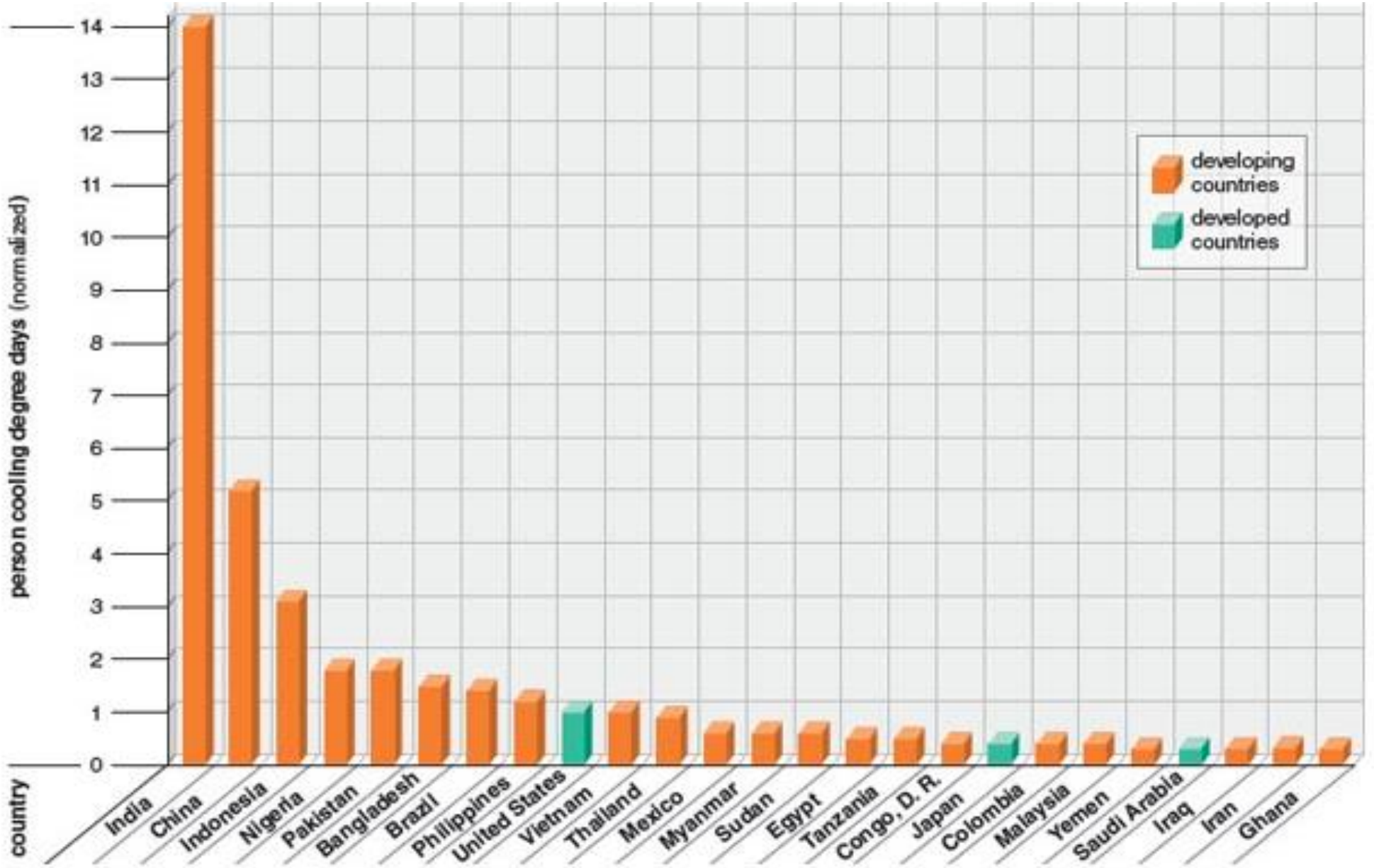
Worldwide 2018…

- Glasgow, Scotland had its hottest day on record, reaching 89°F on June 28.
- Montreal, Canada set a new all-time high, reaching 98°F on June 29.
- Ouargla, Algeria had the highest temperature on record in Africa, reaching 124°F on July 5.
  - This is believed to be the hottest temperature reliably measured in Africa.
- Tianxiang, Taiwan had the hottest temperature on record in Taiwan, reaching 105°F on July 10.


HOTTEST YEARS ON RECORD GLOBALLY
LAST 5 = HOTTEST 5
+2.25°F
+2.0°F
+1.75°F
1998
2009
2013
2005
2010
2014
2018
2017
2015
2016
Source: NASA GISS & NOAA NCEI global temperature anomalies (°F) averaged and adjusted to early industrial baseline (1881-1910). Data as of 2/6/2019
CLIMATE CENTRAL

Air Conditioning for Everyone?



Facts

"Facts do not cease to exist because they are ignored..."

Aldous Huxley

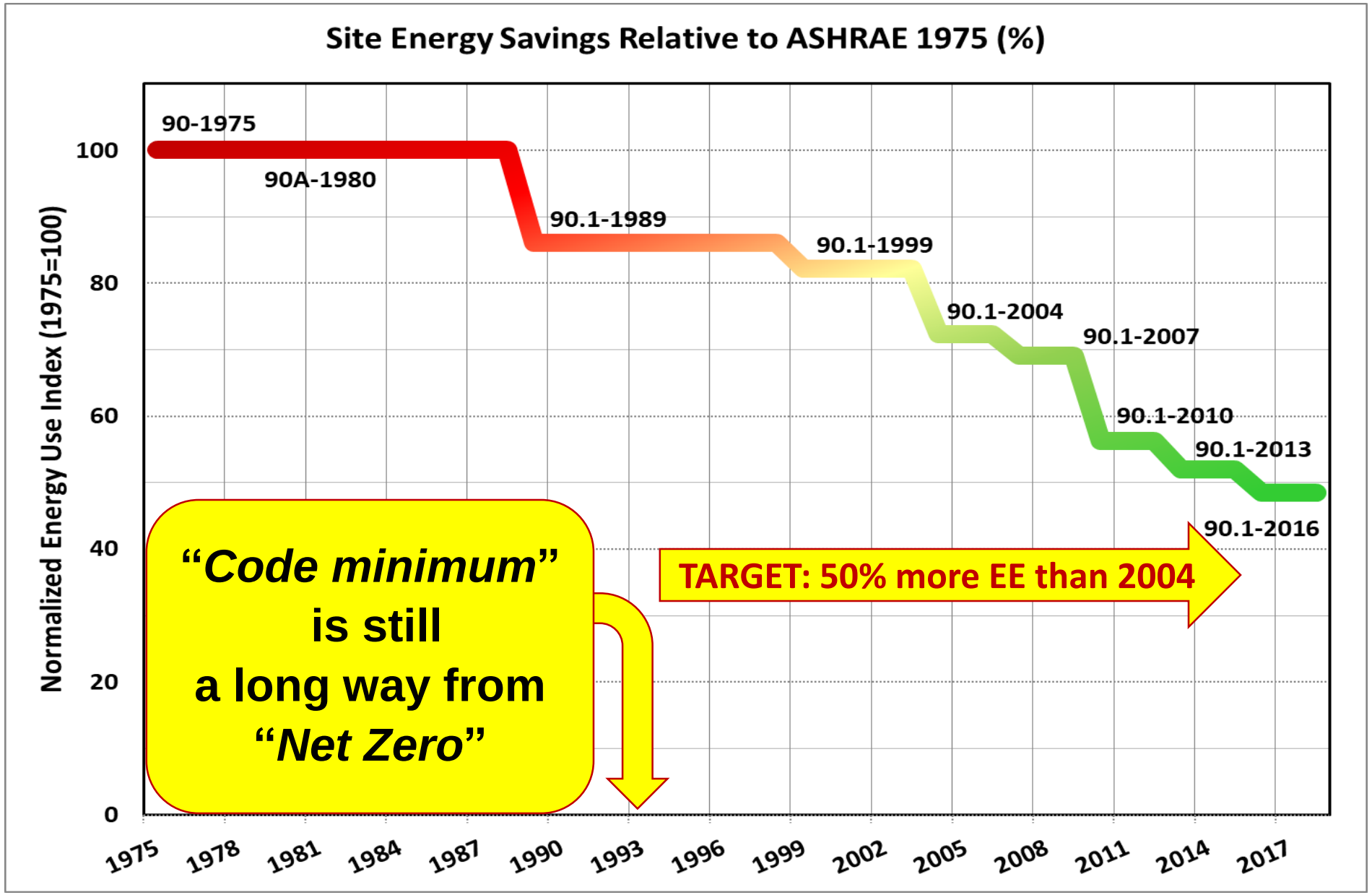
The Thermal Envelope:

Not Many Variables...

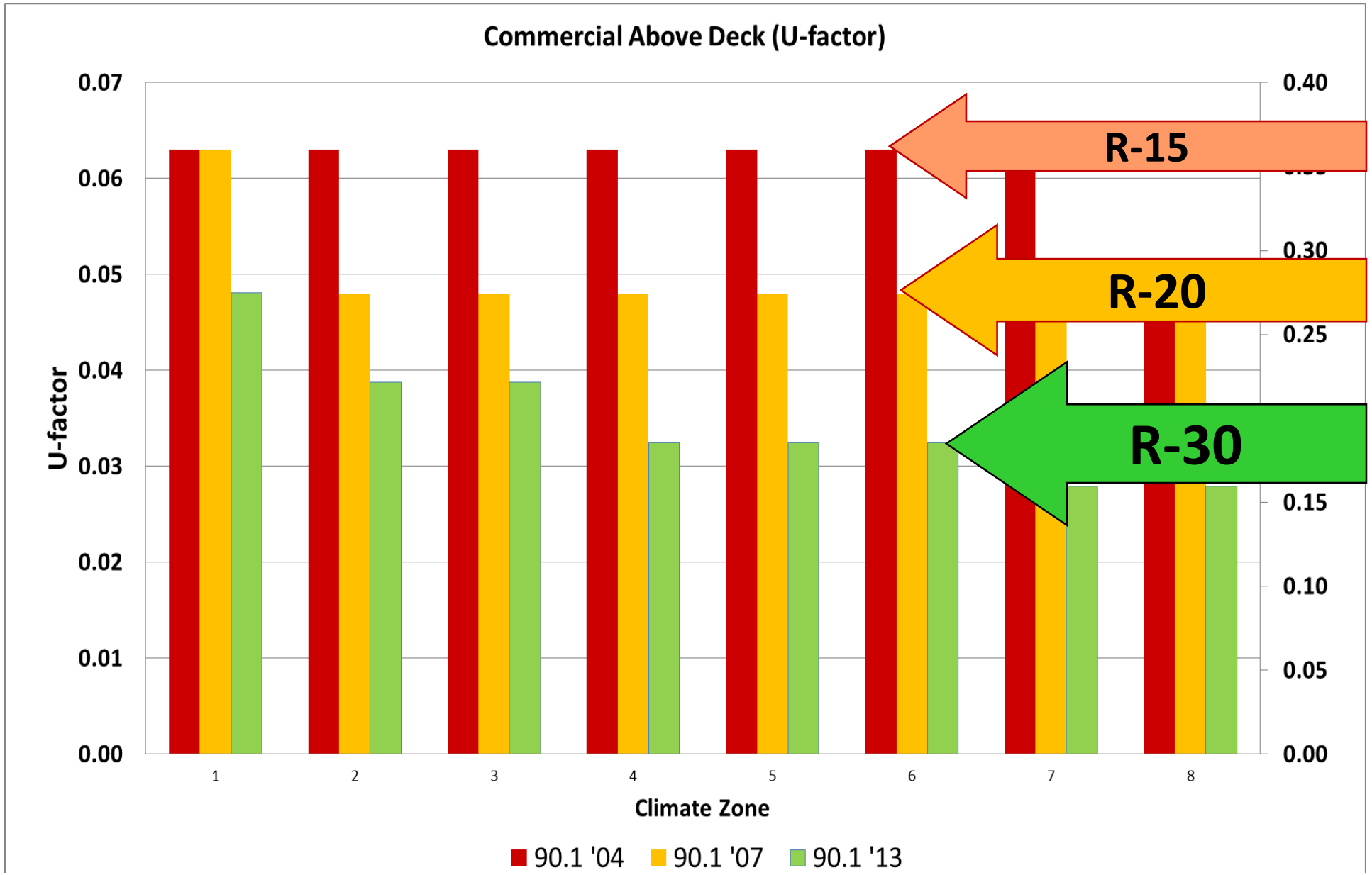
How Has the Thermal Envelope Changed Over Time?

- Opaque Elements
  - Roofs, Walls, Floors
- Fenestration
  - Windows, Doors, Skylights
- Air Leakage

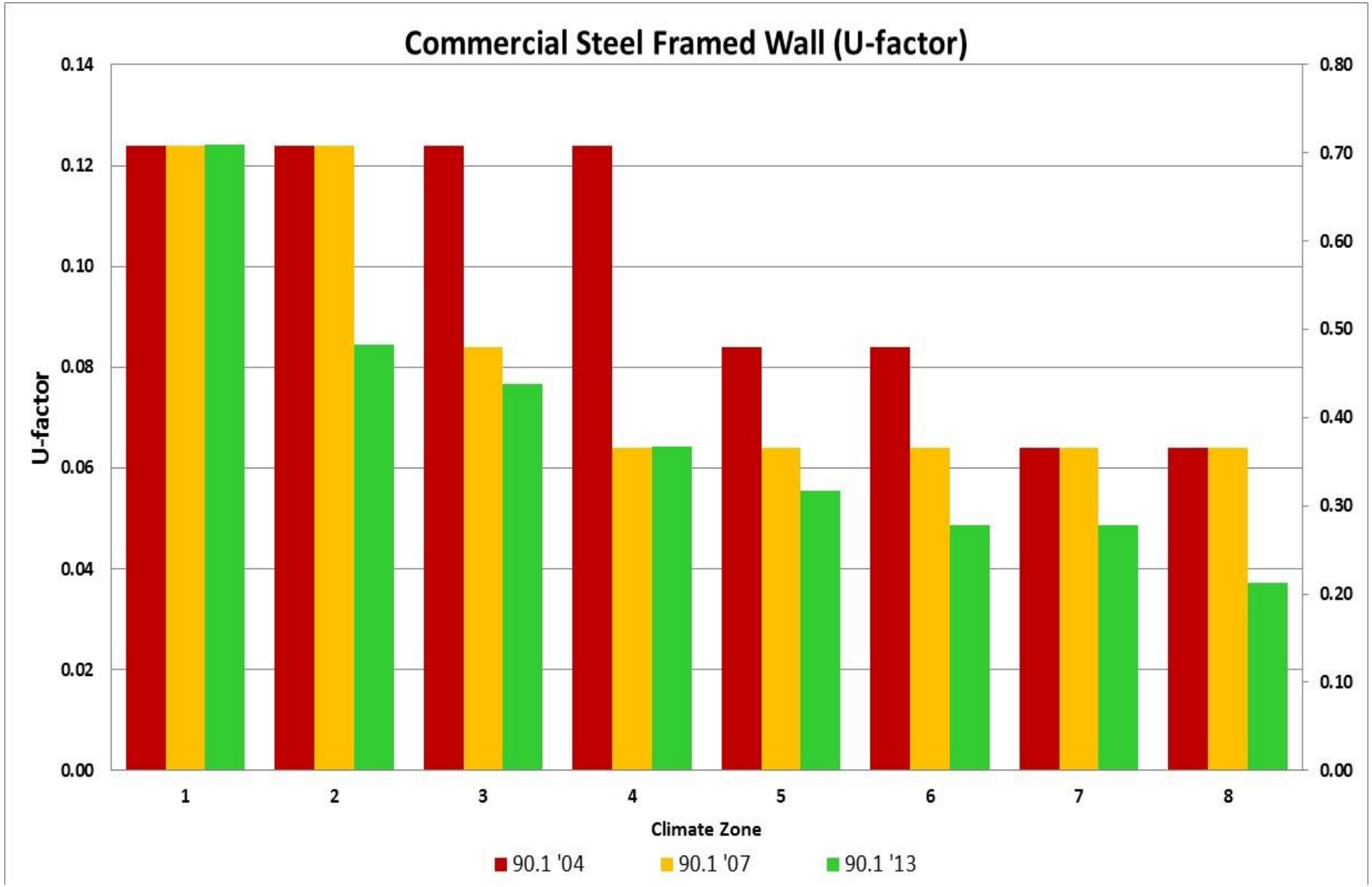
Improvements in EUI: 1975 to Present



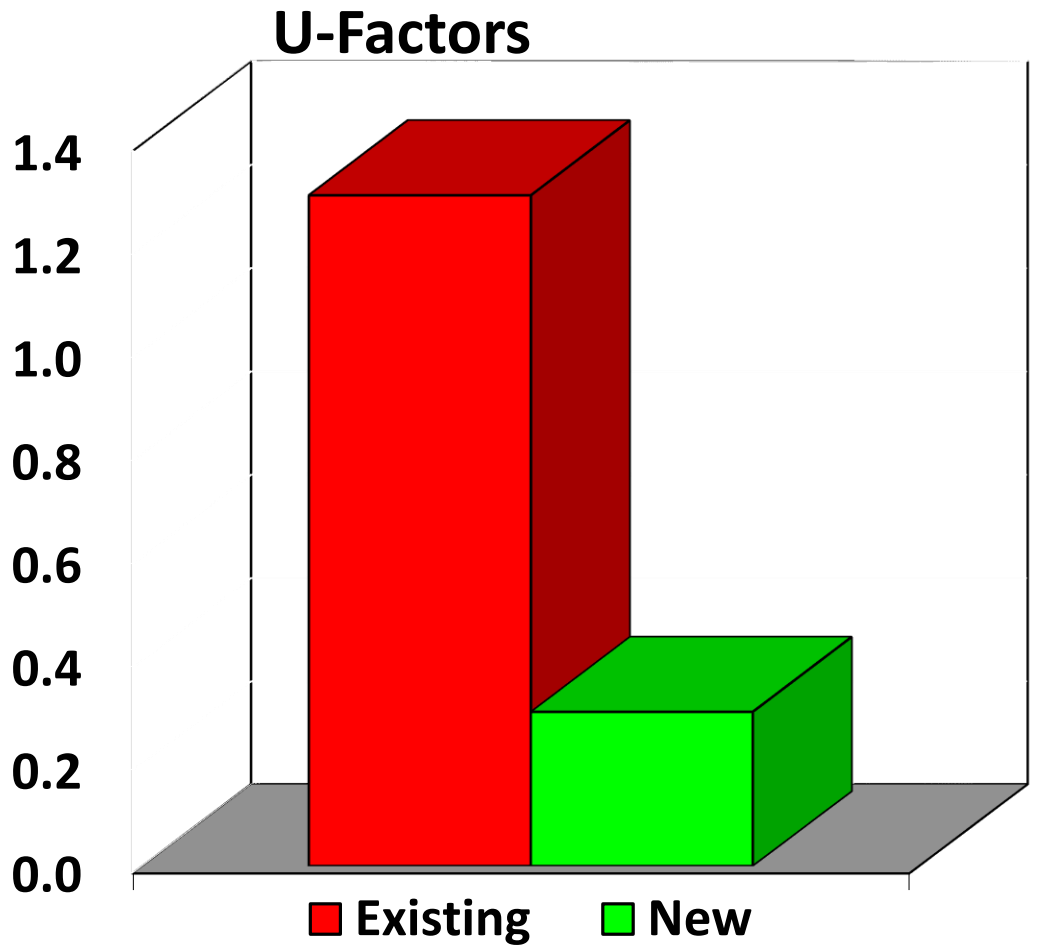
2004 to 2013: Roofs



2004 versus 2013: Walls



Heat Loss (winter)



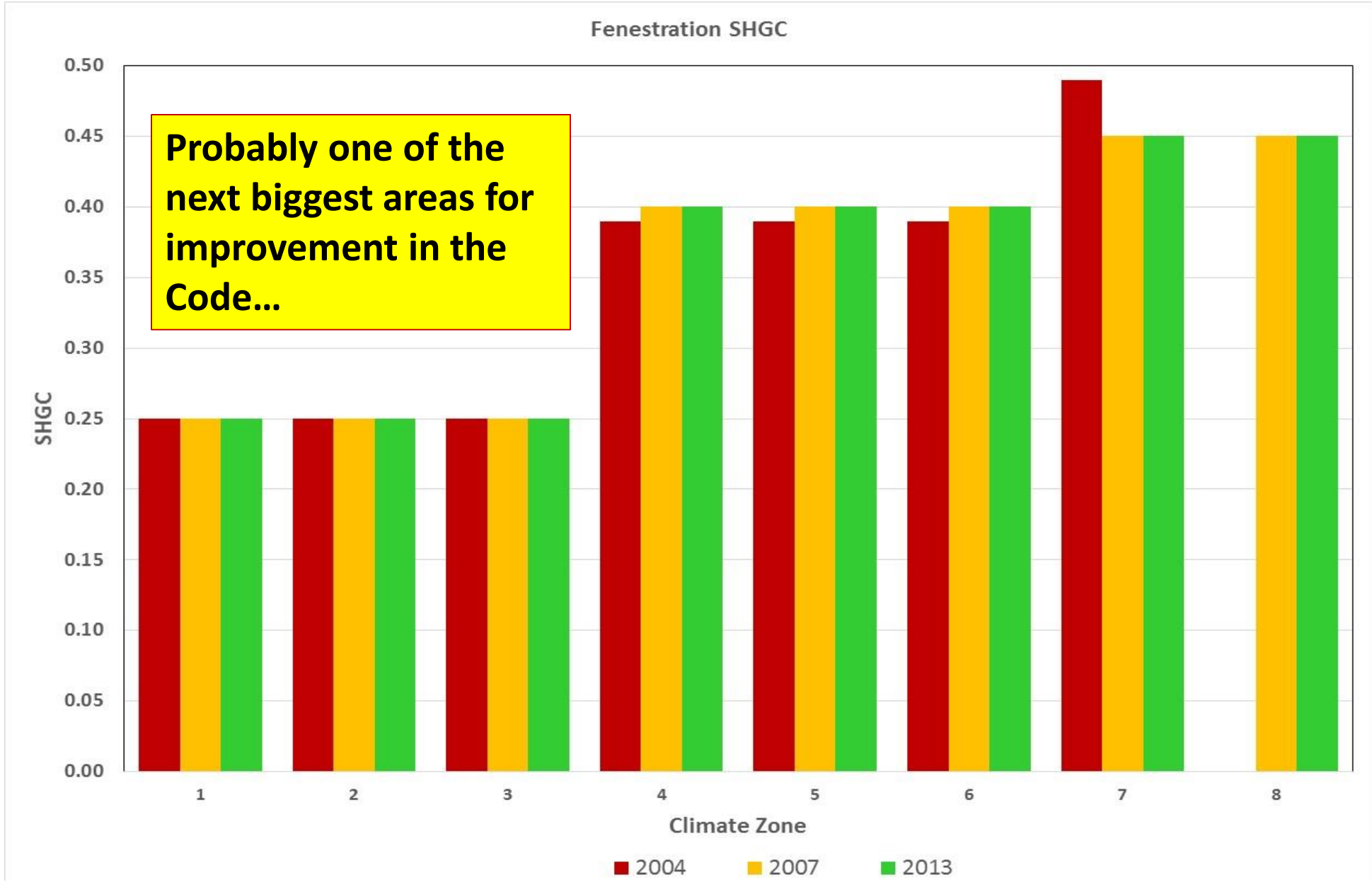
- Common aluminum-framed, single glazed windows lose 3 to 4 times more heat in winter than today's most basic energy efficient technologies
- Cold glass surfaces with recurring condensation
- BIG impact on comfort
- BIG impact on heating costs

Think About What We Build…

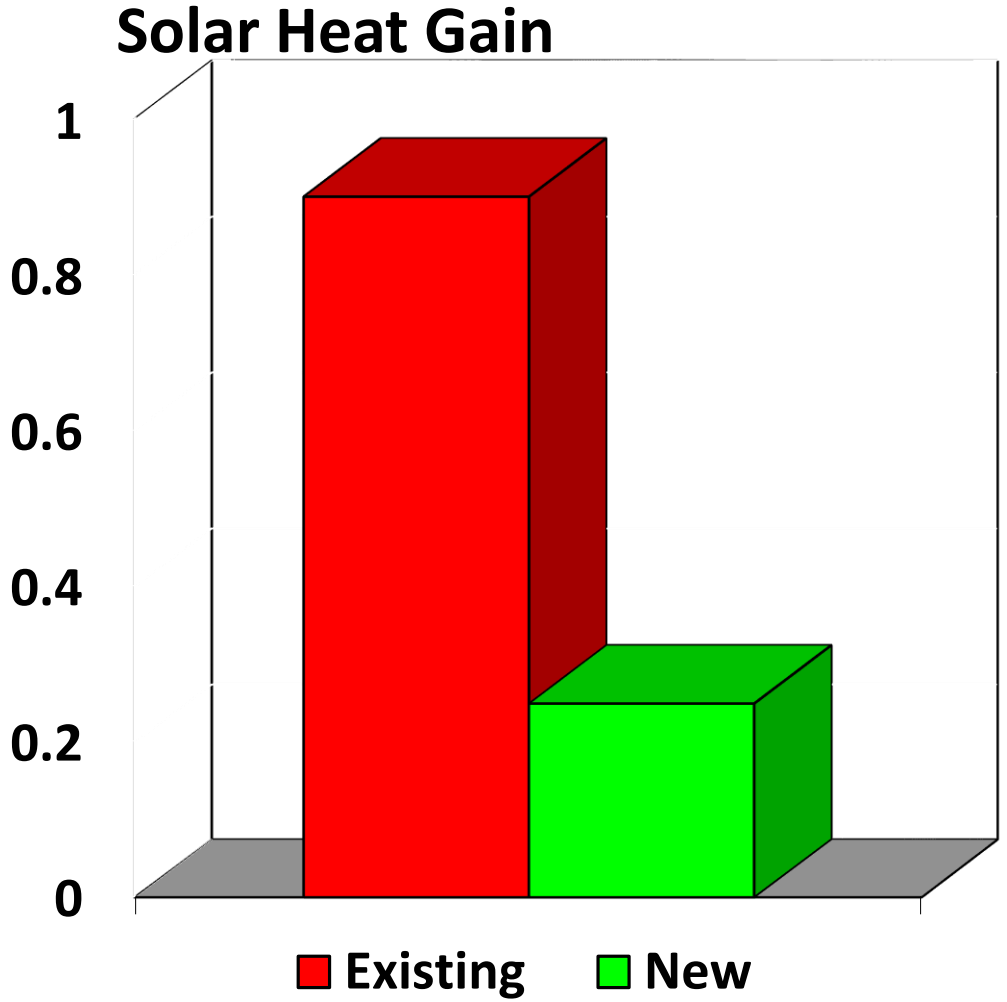
Details…

- Reliable?
- Durable?
- Compatibility?
- Water managed?
- Air leakage?
- Code compliant?
- Resilient?
- Energy?
- Peak Power?
- Comfort?

Solar Heat Gain Coefficient



Heat Gain (summer)



- Air conditioning energy is very expensive
- New window technologies are over three times more efficient at blocking unwanted heat gain than common aluminum-framed, single glazed windows
- Windows generally drive the air conditioning load (residential)
- Windows generally determine the perimeter load (commercial)

Even with Window Efficiency Increases…

Compare the Heat Transfer…

	Steel-framed Walls	Curtain Wall (metal, fixed)	
CZ 5	0.055	0.38	**6.9 times**
CZ 6	0.049	0.36	**7.3 times**
CZ 7	0.049	0.33	**6.7 times**

ASHRAE 90.1-2016

Think about…

- Comfort?
- Resilient?
- Durable?
- Code Compliant?

- Energy?
- Peak power?
- Carbon?

What We Build…

- Buildings?

  Or

- Heat Exchangers?


PLUMBING STACK VENT
BATHROOM FAN VENT
RECESSED LIGHTS
ATTIC HATCH
RECESSED LIGHTS
CHASE
KITCHEN FAN VENT
ELECTRICAL OUTLET
DRYER VENT
CRAWL SPACE
OUTDOOR FAUCET
Air leaking into the house
Air leaking out of the house

Controlling Envelope Air Leakage in ASHRAE 90.1

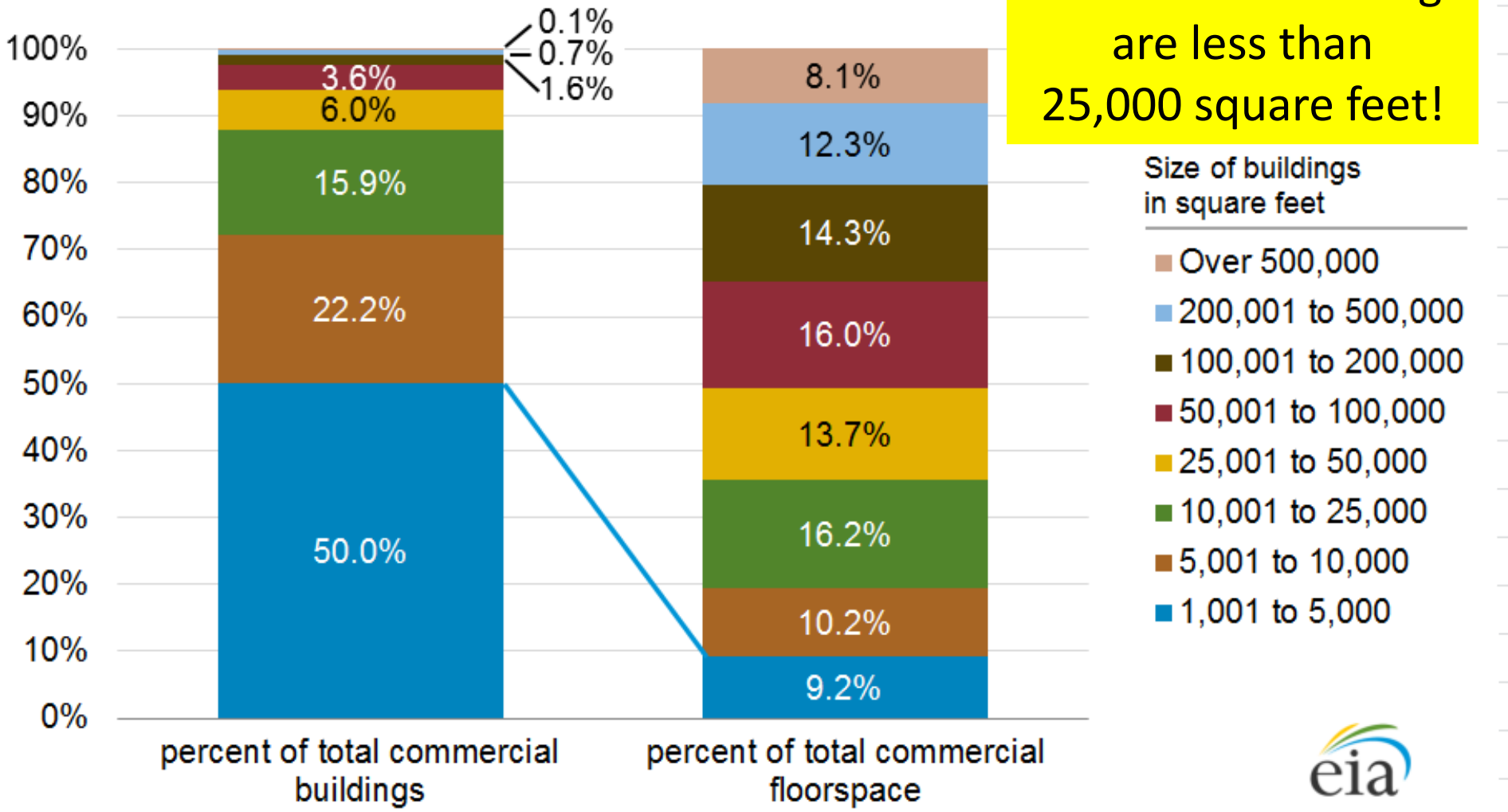
- 90.1 - 2004
  - General language about minimizing air leakage, sealing cracks, specific references to window and door leakage
- 90.1-2007
  - Same language

Controlling Envelope Air Leakage in 90.1 (2)

- 90.1 - 2010
  - A FOCUS on controlling and limiting air leakage
    - Requires a continuous air barrier
    - Lists approved materials and assemblies
    - Revised vestibule requirements, loading docks
- 90.1-2013
  - More refining air leakage language
- 90.1-2016
  - Air leakage testing or air barrier commissioning
  - Maximum leakage: 0.4 cfm/sq.ft.

Most Buildings Are SMALL!

Over 85% of US commercial buildings are less than 25,000 square feet!

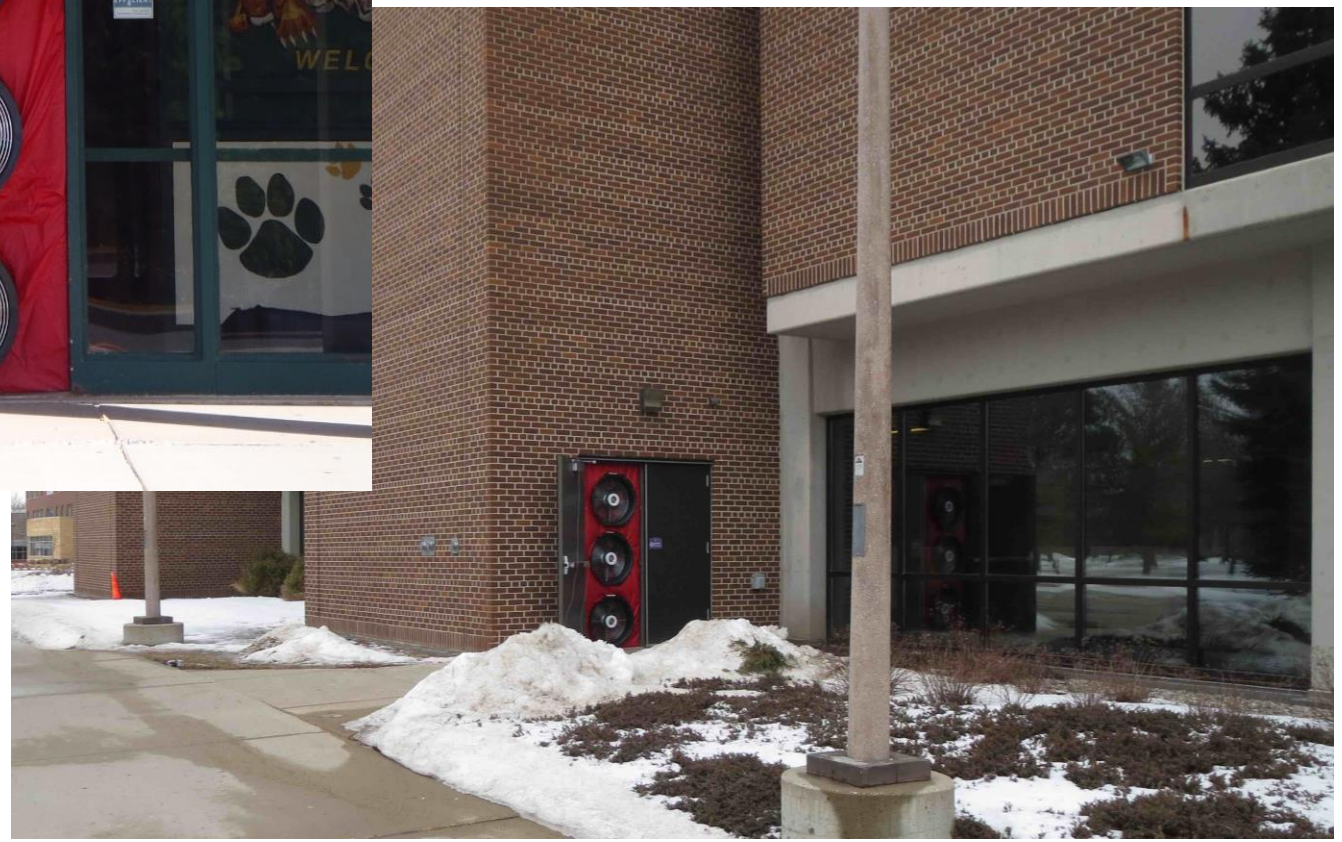


Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey

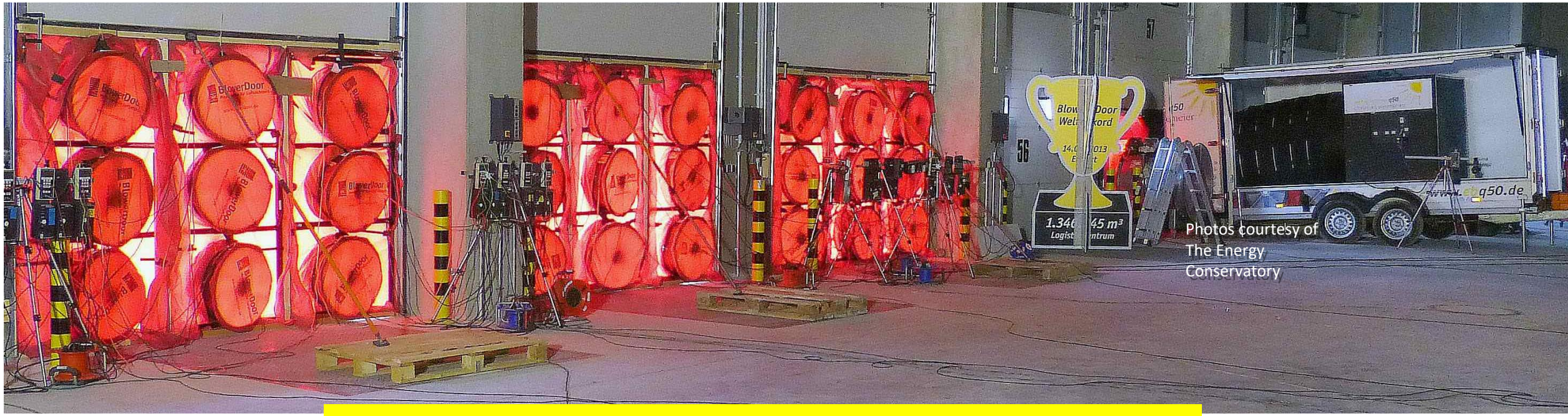
Air Leakage Testing

- We can do this…
  - Test methods
  - Standards
  - Professional development
  - Quality assurance

We CAN Test Large Building Air Leakage…



Even VERY Large Buildings!!



Remember: Over 85% of US commercial buildings are less than 25,000 square feet!

Lessons from Recent ASTM Symposium (1)

- Minimum Standards:
  - The more we test whole building air leakage, better envelopes and better building control result.
- Achieving the value of 0.4 cfm/ft2 is easy-peasy.
  - In fact some jurisdictions have voluntarily lowered that value.
  - Most new buildings are coming in much lower.
- Low-rise buildings (less than 4 stories) are easily achieving envelope air leakage values around 0.1 cfm/ft2 with building enclosure commissioning.

Recent Lessons (2)

- The US Army Corps of Engineers minimum standard of 0.25 cfm/ft2 becomes easy-peasy after a single code cycle of testing experience.
  - USACE is piloting a further target reduction to 0.15 cfm/ft2 with success.
- Multiple speakers noted that the “ASHRAE value of 0.4” is about twice what the minimum should be.
  - Several presenters promoted 0.1 for all small buildings (<50,000 ft2)
- All the speakers agreed, commissioning the envelope is key to delivered building envelope performance.

Recent Lessons (3)

- Common Leaks identified:
  - Vented roof assemblies
  - Doors, frames
    - All types: swinging, rolling, coiling, etc.
  - Mechanical penetrations
    - All.
  - Roof/Parapet intersections (Wow! Huge!)
  - Roof/Wall intersections. (Huge!)
  - Fans – especially those in elevators and stairwells
  - Ducts
  - Elevator shafts – from parking garage to roof decks.
  - Electrical penetrations
  - Chutes, shafts and chases:
    - All types: trash, laundry, roof access hatches, mechanical chases, etc.

Recap: What is the Code?

- Least safe…
- Least strong…
- Least energy efficient…

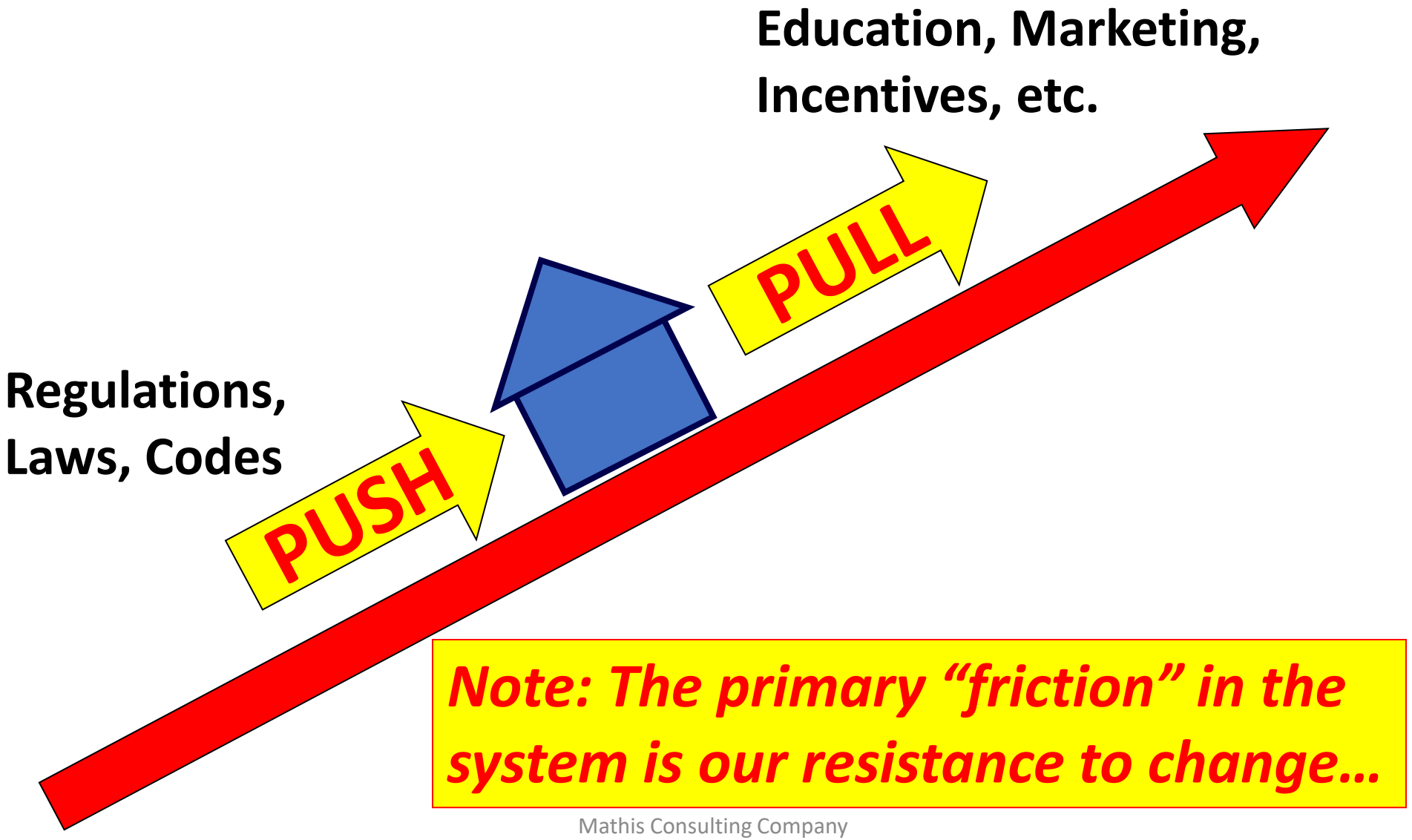
…building allowed by law.

We're not allowed to build it any crappier…!

Code Compliance
is NOT
“Higher Performance”

(It’s the MINIMUM…)

Market Transformation…



Note: The primary "friction" in the system is our resistance to change…

Impediments to Higher Performing Envelopes (1)

- Understanding and valuing “life-cycle economics”
  - Service life survey
- Understanding and using better tools
  - Modeling software survey
  - Testing equipment survey

Impediments to Higher Performing Envelopes (2)

- Confusing “generation” with “efficiency”
  - What is the life cycle of PV?
- Education takes time
  - Especially the education about change...
  - “I’ve never done this before...”

Do the thing
you fear the most
and
the death of fear
is certain.”

Mark Twain

What Does the Future Include? (1)

- Better Building Envelopes
  - The 90.1-2016 Envelope tables look very different than 2004 or 2007 or 2010
    - You should already be familiar with these changes
  - 90.1-2019 has completely different fenestration structure and values!
- Greater focus on reducing uncontrolled air leakage
  - Continuous air barrier
  - Testing or commissioning
    - (Note: This focus is continuing for the 2022 edition of the Standard)

What Does the Future Include? (2)

- Measurement!
  - New building air barrier commissioning and testing
  - New building critical systems commissioning
    - HVAC, Controls, Lighting, etc.
  - Existing building forensic investigations
    - Air leakage, IEQ, Structural, etc.
- Energy Signals!
  - Dashboards, Feedback, Real time signals...
- Other Performance Signals!
  - Advanced controls provide rapid feedback and potential to minimize risks

Sometimes the message is pretty simple...

The Good News

- We have the knowledge to deliver higher performing building envelopes!
- We have the products and skills necessary too!
- We have the POWER to do this!

Real Power

"Never doubt that
a small group of
thoughtful, committed citizens
can change the world.
Indeed,
it is the only thing that ever has."

Margaret Mead, 1901-1978

The Sobering Part

- We won’t convince everyone
  - Some will not pay the price of change, even change in their own best interests...

Sometimes change doesn't wait on us…

It is not the strongest
of the species that survives,
nor the most intelligent,
but the one
most responsive to change.

Charles Darwin


The Future is in Our Hands
Thank you!

Thank You!

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