

Addressing the Challenge of Sustainability

& The Need for Building Industry Leadership

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Audience Survey – How Long?

- House you grew up in
- House one of your parents grew up in
- House one of your grandparents grew up in
- ?Great-grandparents?
- What about the projects you are working on today? How long will they last?

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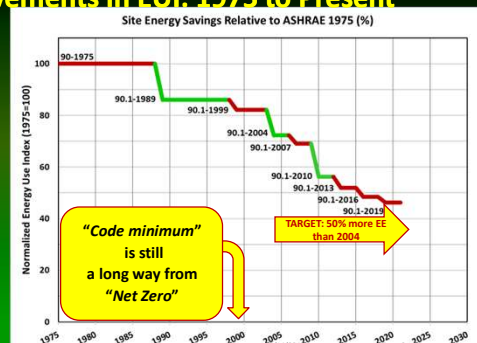


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Buildings Matter!

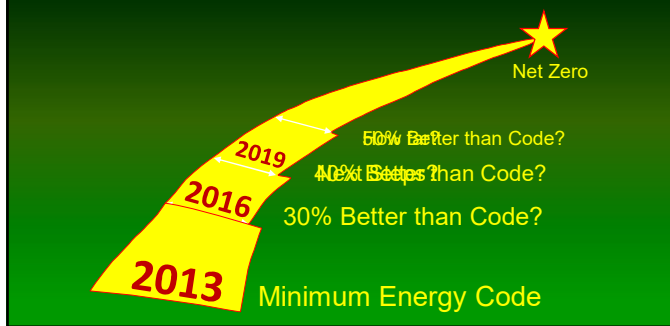
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Improvements in EUI: 1975 to Present



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The Road to "Net Zero"



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Everybody Wants to be Green...

- ASHRAE 189
- ICC International Green Construction Code

➤ "It ain't easy..."

- Standards
- Ratings
- Metrics
- Boundary Conditions
- How long?



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What About The Road to "Green"?



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What is Sustainable?



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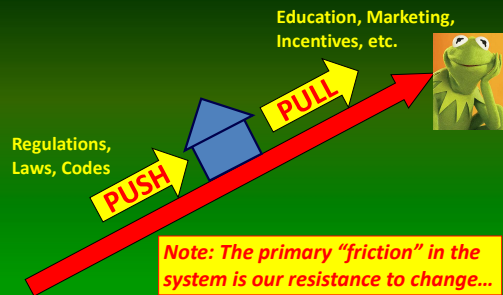
Addressing the Sustainability Challenge

- What is "sustainable"?
 - What is a "sustainable building product"?
- How do we measure it?
 - By what standard?
- What are the variables included in the measurement?
 - What matters most?



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Market Transformation...



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The Past as Prologue...



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Meaningful Metrics Require...

- Comparative ratings:
 - Determine the variables
 - (gallons, miles, kW, years, Btus, etc.)
 - Determine the measurement conditions
 - (city, highway, temperature conditions, etc.)
 - Test or calculate the variables
 - Weight the variables by importance
 - Third-party certification and labeling

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Example: Building Insulation

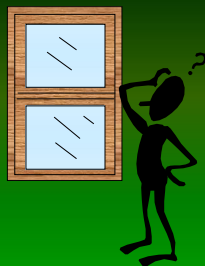
- "R-value"
 - All products tested the same way
 - Steady state
 - Fixed 75F mean temperature
 - Tested, certified and labeled for consumers
 - A means of comparison...



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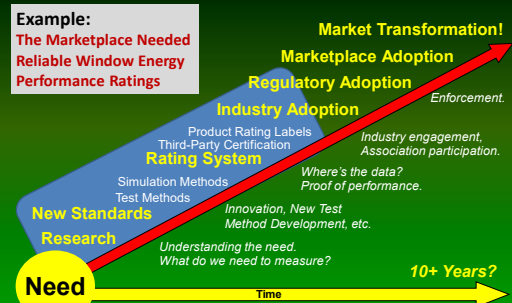
Example: Window Performance

- Does it have...
 - Low-E coatings?
 - Which one?
 - Gas fills? Which one?
 - Low-conductivity spacers?
- Does it meet...
 - Local codes?
 - Performance expectations?
 - Comfort expectations?
- Did we use the correct performance values in our HVAC sizing calculations?



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Standards in Market Transformation



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Challenging Definitions...

➤ “Environmentally Preferable Product”

- Preferable to whom?
- By what standard?
- What variables are included?
- What is most important?
- What if I value different variables?



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Creating Sustainability Ratings

- Life Cycle based?
- Energy based?
- Natural resource based?
- Job/labor based?
- Carbon based?
- When do we measure?
- What do we measure?



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What is “Sustainable”?

Can we write an equation to describe it?

$$“S” = A \sum(v_1) + B \sum(v_2) + C \sum(v_3) \dots$$

Where:

“ v_n ” is a **variable** in our Sustainability equation
(and there are MANY variables...)

A, B, C are “**importance multipliers**” on each variable

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Some Possible Variables in Our Sustainability Equation:

- | | |
|---|----------------------------------|
| ➤ Energy Efficiency | ➤ Transportation energy consumed |
| ➤ Energy Use in Manufacturing | ➤ Water consumed |
| ➤ Use of Locally-produced raw materials | ➤ Wetlands preserved |
| ➤ Use of Renewable Energy Sources | ➤ Carbon sequestered |
| ➤ Life Expectancy of the finished product | ➤ Air pollution prevented |
| ➤ Recyclability of the finished product | ➤ Durability |

Insert your favorite
green variable here...
...there are many...

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Variables/Challenges/Opportunities YOU added today...

- | | |
|--|---|
| ➤ The Cost of Discomfort | ➤ Education as a priority |
| ➤ Engagement of facilities folk from the start | ➤ Preferential lending |
| ➤ How to make performance data “cool” | ➤ Public awareness/caring |
| ➤ Getting sustainable “early on” – i.e. from the start | ➤ Shift operational cost ratio – Preventative vs Corrective |
| ➤ Capital Budget vs Operational Budget | ➤ Constructability |
| ➤ Calculating ROI – based on what value structure? | ➤ Learning curve costs |
| | ➤ Throw away culture |
| | ➤ Weather changes |
| | ➤ Push toward electrification |

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Sometimes the variables are local...

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Boundary Conditions...

Each variable may have a **different set of boundary conditions** within which the measurement occurs.

Examples:

$$\begin{array}{l} \text{ME} = x \\ \sum \\ \text{ME} = 0 \end{array} \quad \begin{array}{l} \text{Energy Use in} \\ \text{Product} \\ \text{Manufacturing} \end{array}$$

$$\begin{array}{l} \text{RC} = y \\ \sum \\ \text{RC} = 0 \end{array} \quad \begin{array}{l} \text{Recycled} \\ \text{Content} \end{array}$$



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Do This for Every Variable

Variable	Boundary Conditions
$\begin{array}{l} \text{SE} = x \\ \sum \\ \text{SE} = 0 \end{array} \quad \begin{array}{l} \text{Site Energy} \\ \text{Used in} \\ \text{Manufacturing} \end{array}$	Site energy (SE) used in the manufacture of a given building product. Measured in Btus and kWh (or total/product?)
$\begin{array}{l} \text{OE} = x \\ \sum \\ \text{OE} = 0 \end{array} \quad \begin{array}{l} \text{Source Energy} \\ \text{Used in} \\ \text{Manufacturing} \end{array}$	Source energy (OE) used in the manufacture of a given building product. Measured in Btus – pre-transmission.



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More...

Variable	Boundary Conditions
$\begin{array}{l} \text{W} = x \\ \sum \\ \text{W} = 0 \end{array} \quad \begin{array}{l} \text{Land filled} \\ \text{Waste} \end{array}$	Waste material generated that ends up land-filled. Measured in tons.
$\begin{array}{l} \text{RE} = x \\ \sum \\ \text{RE} = 0 \end{array} \quad \begin{array}{l} \text{Renewable} \\ \text{Energy} \\ \text{Used} \end{array}$	Percent of manufacturing energy used that is generated from renewable energy sources (wind, solar heat, solar electric, co-generation, etc.)



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More...

Variable	Boundary Conditions
$\begin{array}{l} \text{SL} = x \\ \sum \\ \text{SL} = 0 \end{array} \quad \begin{array}{l} \text{Service Life} \\ \text{Expectancy} \end{array}$	How long will the product perform at an expected rate. Measured in years.
$\begin{array}{l} \text{R} = 100\% \\ \sum \\ \text{R} = 0 \end{array} \quad \begin{array}{l} \text{Recyclability} \end{array}$	Percent of product that can be recycled and reused as feed stock into new material/product development. Measured in percent by weight.



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The Next Tough Job... PRIORITY

- Once the Boundary Conditions are known we must then determine the WEIGHTING or "Importance" of each variable in the overall EPP equation
- The Size of A, B, C, etc.

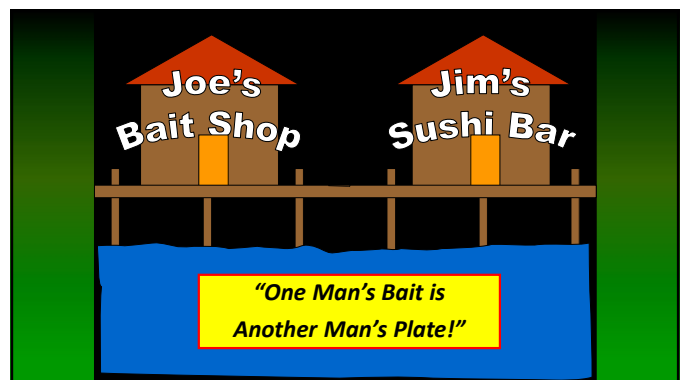
$$“S” = A\sum(v_1) + B\sum(v_2) + C\sum(v_3)...$$

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Which is More Important?

- Manufacturing Energy or Recycled Content?
- Waste Generated or Service Life?
- Transportation Energy or Water Consumption?
- Well it depends...

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And sometimes priorities change...

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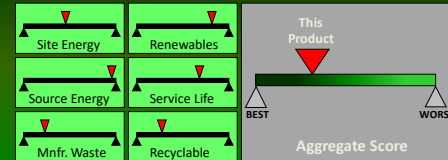
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IF...

- If we all valued the same things, we could weight each variable...
- If we all valued the same things, we could develop some Aggregate “preferability” rating...

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“One Man’s Bait...” Versus a Collective Measure



...your actual mileage may vary...

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Requires Tough Decisions

- Deciding on truly sustainable boundary conditions requires that we make particularly tough decisions...
 - Where do we measure?
 - What do we measure?
 - For how long?
- And we'd have to agree on the weights of each variable... (yeah right...)

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We've Been Here Before...

MACARONI & CHEESE			
Nutrition Facts			
Serving Size 1 cup (220g) Serving Per Container 2			
Amount Per Serving	Calories from Fat 110*		
Calories 250	% Daily Value*		
Total Fat 15g	18%		
Saturated Fat 3g	15%		
Cholesterol 30mg	10%		
Sodium 470mg	20%		
Total Carbohydrate 31g	10%		
Dietary Fiber 5g	9%		
Sugars 5g			
Protein 5g			
Vitamin A	5%		
Vitamin C	2%		
Calcium	20%		
Iron	4%		

- We prioritize different things based on our individual needs
 - Salt? Sugar? Or Carbs?
 - Vitamins A? C? or Calcium?
- Implications?

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Can We Agree on SOME Things?

- **Life Issues**
 - Air and Water Quality that supports life
 - Toxicity in Use
- **Durability Issues**
 - Buildings last a long time
 - Product performance should last

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Other Key Issues?

- **Energy Efficiency**
 - Tied to building life
 - 50? 75? 100 years? More?
 - Tied to power production
 - Air quality, water quality, carbon, etc.
 - Tied to national objectives?
 - Ex: Over 40% of US total energy use goes to buildings!

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Other Possible Variables?

- Jobs Created
- Jobs Protected
- Water Conserved
- Air Cleaned
- Power Plants Decommissioned
- Nutrition improved
- Etc...

**People Value
Different Things!**

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Risks 1

- Product vs. Assembly Performance

- We can take a series of really good products and put them together poorly – potentially compromising their performance attributes...



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Sometimes Problems Are Hidden...



*What are the
implications of
“out of sight”
performance
deficiencies?*

For a hundred years...

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Walls should not look this way after just two years...



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Small Problems in Long-Lived Systems

- Envelope deficiencies have a “trickle-down” effect on the performance of other critical building systems

- HVAC Sizing
- Controls Effectiveness
- Human Comfort

- It's easier (and cheaper) to “get it right the first time!”



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Risks 2: Delivered Performance

- Commissioning of Critical Systems

- Envelope
- HVAC
- Controls
- Lighting
- Power
- Water
- Etc.

- MEASURE IT to GET IT!

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Risks 3: For How Long?

- Different building products have different service life expectancies
 - Building envelope components (50 – 100 years?)
 - HVAC systems (12 – 15 years?), etc.
- Life Cycle Matters!
 - Products
 - Assemblies
 - Equipment
 - Whole building

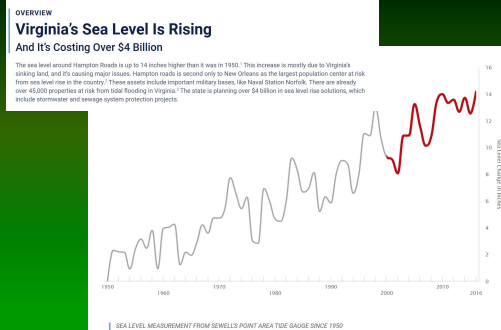
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Risks 4: Things Change...



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Virginia Sea Level Rise Since 1950...



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...and it is Speeding Up...



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Historically low water levels in Lake Mead expose intake valve

Images of one pipe that began pumping water to Nevada customers in 1971 drew attention to a worsening megadrought across much of the Colorado River Basin.



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Are we prepared for change?

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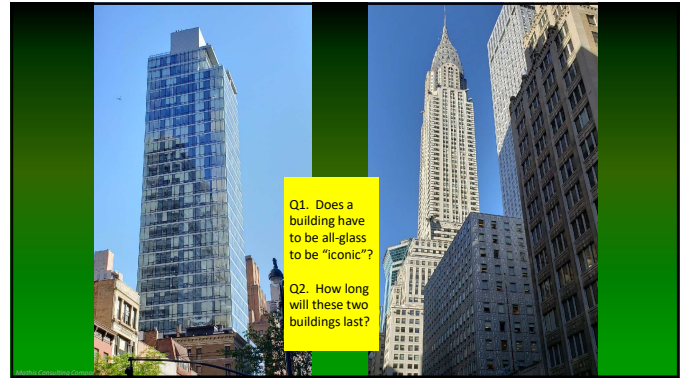
Think About What We Build...

How much energy? For how long?



What are our responsibilities as knowledgeable building professionals?

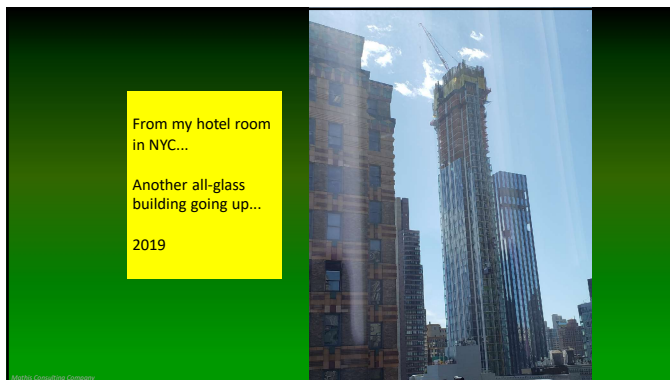
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Q1. Does a building have to be all-glass to be "iconic"?

Q2. How long will these two buildings last?

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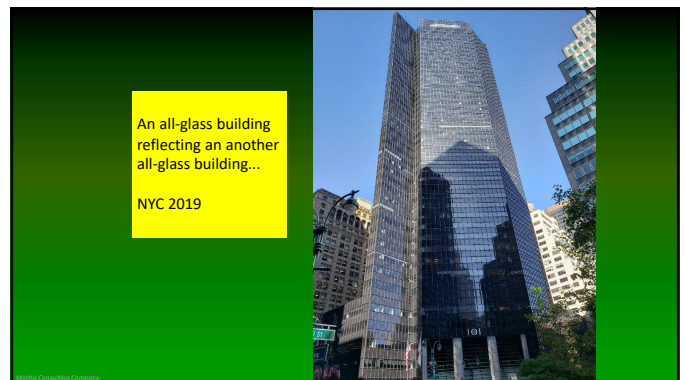


From my hotel room in NYC...

Another all-glass building going up...

2019

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An all-glass building reflecting an another all-glass building...

NYC 2019

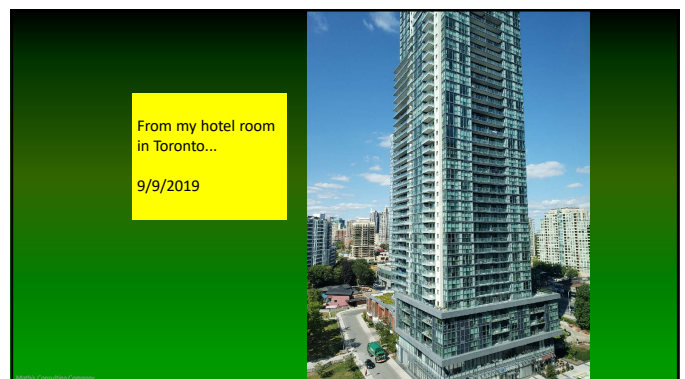
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Upon arrival in Toronto...

9/9/2019

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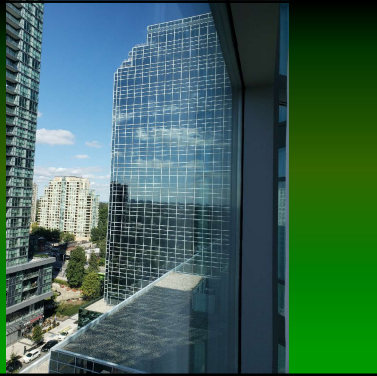
From my hotel room in Toronto...

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Also from my hotel
room in Toronto...

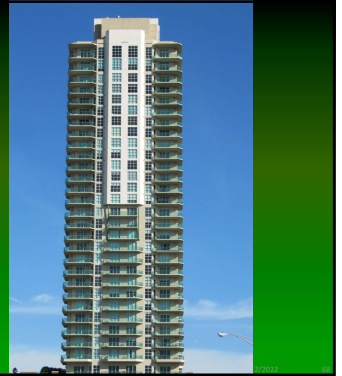
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Thermal Bridging...

- Building?
- Or
- Heat Exchanger?



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Sometimes the
message is pretty
simple...

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Sometimes Problems are Obvious...



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And we have to be willing to challenge our
notions of "Sustainability"

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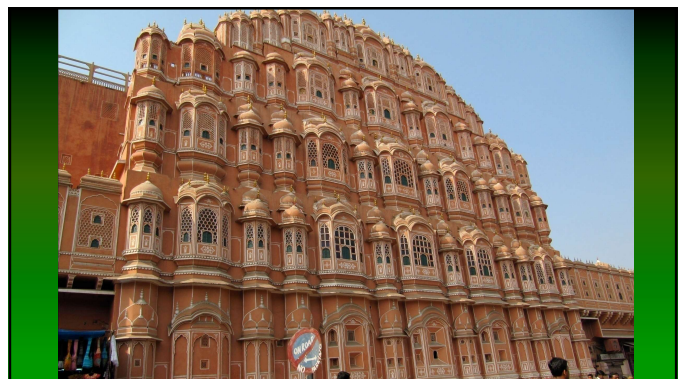
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Oldest US Buildings?

- **Palace of the Governors, Santa Fe, NM – 1610**
 - ~400 years old
 - Oldest governmental building
- **St. Luke's Church, Smithfield, VA – 1632**
 - ~382 years old
 - Oldest church
- **Fairbanks House, Dedham, MA – 1637**
 - 377 years old
 - Oldest house
- **Another hand full around 350...**

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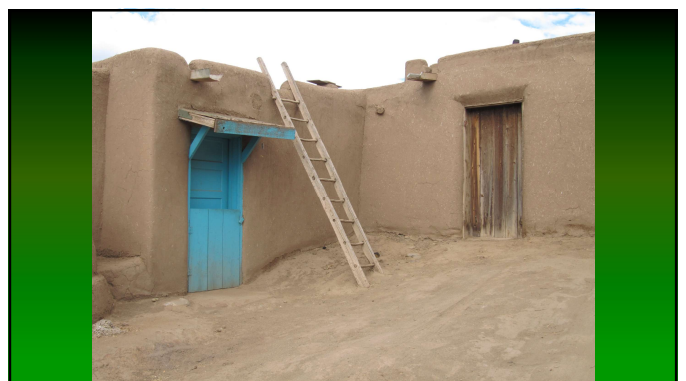
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Conclusions-1

- Developing Truly Meaningful Sustainability Metrics for Buildings and Building Products is Difficult
 - Many variables
 - Different boundary conditions
 - Different "value" depending on the buyer/user
 - "One man's bait..."
- ..and things change...
 - Former norms no longer reliable...

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Conclusions 2

- Sustainability goals demand consideration of:
 - End use
 - Service life
 - Delivered Energy Efficiency
 - Life Cycle/Life Expectancy
 - Changing boundary conditions

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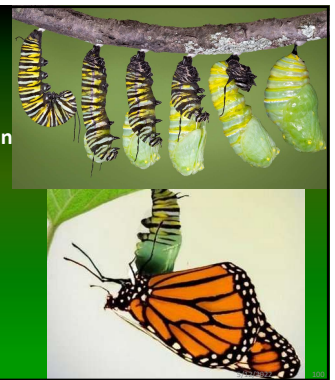
Conclusions 3

- Metrics Should Support Different Users Needs and Priorities
 - Addresses multiple variables
 - Can make decisions based on broad or specific consumer priorities
 - Can address broad national and international objectives
 - Can be flexible, resilient, responsive to changing conditions...

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We Must Change...

- Change is hard
- Change is risky
- Change usually brings opposition
- Change MAY create allies
- Change MAY bring benefits
- Change may NOT be what we originally envisioned...



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Teach Children Now!



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SHOW What the Building is Doing!



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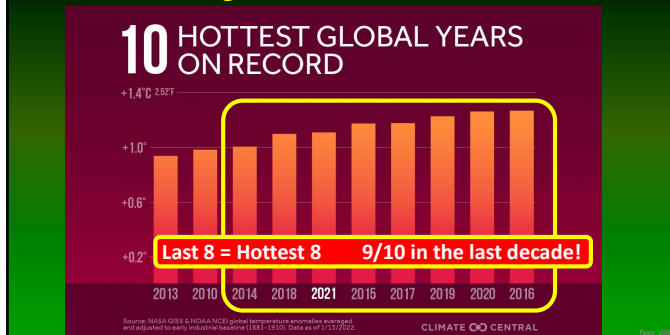
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The Sobering Part

- We won't convince everyone
 - Some will not pay the price of change, even change in their own best interests...
- High Performance Building Envelopes are just PART of the puzzle
 - We must integrate across all building disciplines
 - Integrated Design, Commissioning, Verification, Maintenance
 - Occupant behavior modification

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Sometimes change doesn't wait on us...



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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

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Remember...

- The Code is the MINIMUM
- Not exemplary...
- Not "Best Practices"...
- Minimum.

111

Remember...

- Buildings Matter!

112

Remember...

- 1% New
- 99% Existing

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Remember...

- ...for over a hundred years...

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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

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The Future is in Our Hands



Thank you!

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