



*thirsty*  
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OTHER **UPCOMING EVENTS**

**NGA Glass Conference: Chicago**  
Jul 18-20, 2022 | Northbrook, IL

**Webinar with Architectural Record**  
Aug 18, 2022 | online

**GlassBuild America**  
Oct 18-20, 2022 | Las Vegas, NV

**NGA Glass Conference: Miramar Beach**  
Jan 24-26, 2023

**Counting Carb(ons)**  
**Embodied vs. Operational Carbon**



**Dr. Kayla Natividad**  
Pilkington | NSG

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**NGA GLASS CONFERENCE™ CHICAGO**

JULY 18-20, 2022  
REGISTER NOW @ [GLASS.ORG](https://glass.org)



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**Answer "I Go to GlassBuild to...?!"**  
*email to [mduettmer@glass.org](mailto:mduettmer@glass.org)*

**Trade Show Registration FREE to NGA Members**

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## Counting Carb(on)s Embodied vs Operational



Dr. Kayla Natividad  
Pilkington | NSG

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# What makes a building sustainable?

Sustainability ↔ Resiliency

“Meeting the needs of the present without compromising the ability of future generations to meet their own needs.”

- United Nations Brundtland Commission, 1987



“ The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.”

- United Nations Office for Disaster Risk Reduction

Protecting the environment from human impacts to sustain livable conditions for future generations.

Protecting humans from environmental impacts to sustain livable conditions for future generations.



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# What makes a building sustainable?

The collage features three news snippets:

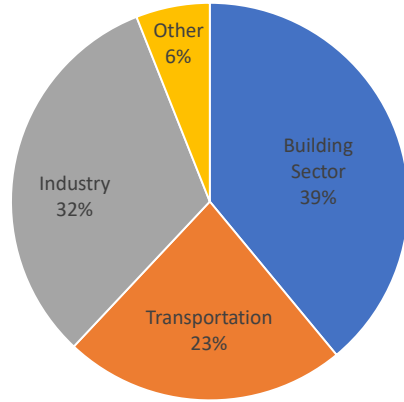
- The New York Times:** "19 Killed in New York City's Deadliest Fire in Decades" - Nine children were among those who died when a space heater...
- Environment Texas:** "Report: Rooftop solar could have played role in reducing impact of 2021 Texas freeze power crisis" - BY STACY RICKARD | DALLAS, UPDATED 2:30 PM CT FEB. 19, 2022 | PUBLISHED 7:00 AM CT FEB. 19, 2022
- Los Angeles Times:** "Editorial: Climate change fuels deadly heat waves. Ranking them like hurricanes could save lives" - Subscribe Now \$1 for 6 months

More than half of U.S. commercial buildings were built before 2000 and do not meet today's more efficient codes or have the most energy-saving products or technologies.



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## Where's the Impact?

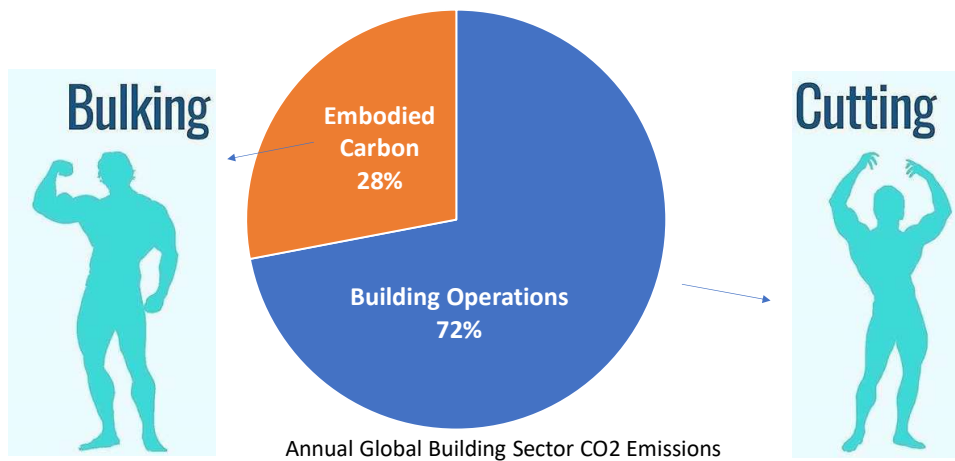


- Buildings account for almost 40% of global CO2 emissions
- 80% of buildings that will exist in 2050 already exist today.
- Existing buildings account for >65% of NYC emissions



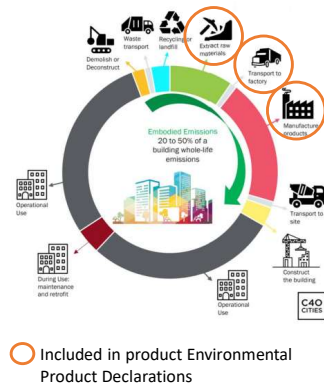
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## Carbon Counting: Embodied vs Operational



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## Carbon Counting: Embodied Carbon



### Long Term Solutions

- Hydrogen / Alternative Fuel
- Recycling / Increased Cullet
- Renewable Energy
- Carbon Reduction Targets

## Façade Design Breakdown – Immediate Impacts

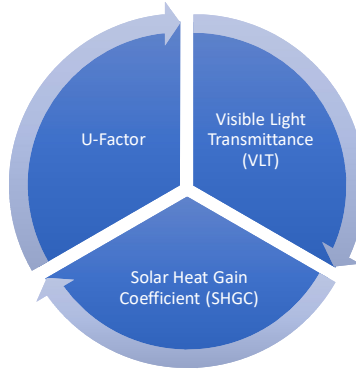
- Embodied Carbon
  - Structural Elements = body
  - Façade = shell of building
  - Reduce New Materials
- Operational Carbon
  - Improve operational performance by reducing energy use



# Glass Performance

## U-Factor & SHGC

- Improve occupant comfort
- Reduce HVAC load requirements
- Improve building resiliency



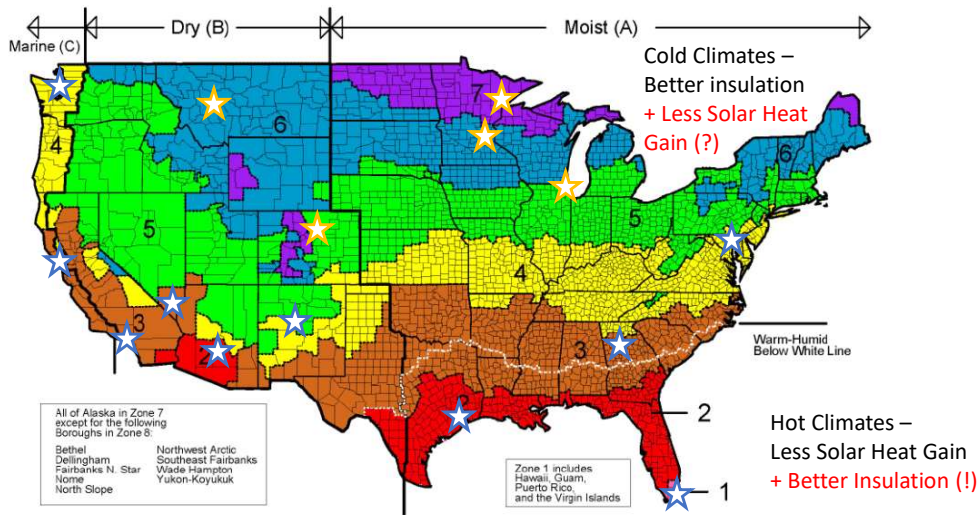
## Visible light transmission:

- Improve quality views
- Reduce need for artificial lighting
- Improve occupant health and productivity



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# No "one size fits all"



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## Design Approach

Reuse existing buildings/material

Reduce amount of new material

Rethink what glazing can do



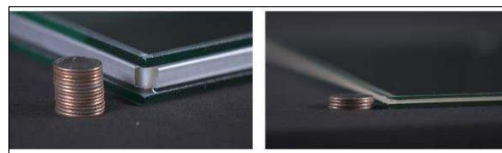
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## Carbon Reduction – Reuse

### Vacuum Insulating Glazing

- Reuse existing monolithic sash
  - Low embodied carbon impact
  - Maintain operability
- Improve glass performance
  - Monolithic ¼" Glass
  - IGU Performance

Albert Kahn Building – Detroit, MI



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## Small Office Building Energy Impact

CLIMATE ZONE	REPRESENTATIVE CITY	6mm Clear			6.2mm Pyrolytic VIG			6.2mm Sputter VIG		
		SO Heat	SO Cool	SO Total	SO Heat	SO Cool		SO Heat	SO Cool	
1A	Miami, Florida	0%	0%	0%	14%	5%	2%	8%	11%	5%
2A	Houston, Texas	0%	0%	0%	11%	5%	3%	7%	11%	5%
2B	Phoenix, Arizona	0%	0%	0%	9%	7%	4%	3%	14%	6%
3A	Atlanta, Georgia	0%	0%	0%	10%	5%	4%	6%	14%	5%
3B-Coast	Los Angeles, California	0%	0%	0%	10%	6%	2%	2%	18%	5%
3B	Las Vegas, Nevada	0%	0%	0%	8%	7%	4%	2%	15%	6%
3C	San Francisco, California	0%	0%	0%	10%	8%	3%	2%	24%	5%
4A	Baltimore, Maryland	0%	0%	0%	9%	6%	5%	6%	15%	5%
4B	Albuquerque, New Mexico	0%	0%	0%	9%	7%	4%	4%	18%	5%
4C	Seattle, Washington	0%	0%	0%	13%	8%	5%	9%	24%	6%
5A	Chicago, Illinois	0%	0%	0%	9%	6%	5%	7%	15%	5%
5B	Boulder, Colorado	0%	0%	0%	9%	8%	4%	6%	19%	5%
6A	Minneapolis, Minnesota	0%	0%	0%	10%	7%	6%	7%	16%	5%
6B	Helena, Montana	0%	0%	0%	9%	8%	5%	7%	19%	6%
7	Duluth, Minnesota	0%	0%	0%	9%	8%	5%	7%	20%	5%
		<b>SHGC</b>	<b>Ufactor</b>		<b>SHGC</b>	<b>Ufactor</b>		<b>SHGC</b>	<b>Ufactor</b>	
		0.819	6.17		0.693	2.738		0.706	3.79	

Higher SHGC allows for more passive heat, reducing heating load

Low U-factor better insulates so reduces cooling load



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## Carbon Reduction – Reuse

### Secondary Window System

- Addition to existing glazing
  - Reduce operational carbon by improving U-factor and SHGC
- Interior and Exterior Solutions
- Drawback
  - Lose operability



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# Small Office Building Energy Impact

CLIMATE ZONE	REPRESENTATIVE CITY	6mm Clear			6mm Interior Storm (Clear)			6mm Interior Storm (Pyrolytic Low-e surface 3)			6mm Interior Storm (Pyrolytic VIG)		
		SO Heat	SO Cool	SO Total	SO Heat	SO Cool		SO Heat	SO Cool		SO Heat	SO Cool	
1A	Miami, Florida	0%	0%	0%	7%	4%	2%	8%	6%	3%	11%	8%	4%
2A	Houston, Texas	0%	0%	0%	6%	4%	2%	7%	6%	3%	9%	8%	4%
2B	Phoenix, Arizona	0%	0%	0%	4%	5%	3%	5%	8%	4%	6%	11%	5%
3A	Atlanta, Georgia	0%	0%	0%	5%	5%	3%	6%	8%	4%	8%	10%	5%
3B-Coast	Los Angeles, California	0%	0%	0%	5%	6%	2%	5%	10%	3%	6%	13%	4%
3B	Las Vegas, Nevada	0%	0%	0%	4%	6%	3%	4%	9%	4%	5%	12%	5%
3C	San Francisco, California	0%	0%	0%	5%	8%	2%	5%	13%	3%	6%	17%	4%
4A	Baltimore, Maryland	0%	0%	0%	5%	5%	3%	6%	8%	4%	8%	11%	5%
4B	Albuquerque, New Mexico	0%	0%	0%	4%	6%	3%	5%	10%	4%	7%	13%	5%
4C	Seattle, Washington	0%	0%	0%	8%	8%	4%	9%	13%	5%	11%	17%	6%
5A	Chicago, Illinois	0%	0%	0%	5%	5%	3%	6%	8%	4%	8%	11%	5%
5B	Boulder, Colorado	0%	0%	0%	5%	7%	3%	6%	11%	4%	8%	14%	5%
6A	Minneapolis, Minnesota	0%	0%	0%	5%	6%	3%	6%	9%	4%	8%	12%	5%
6B	Helena, Montana	0%	0%	0%	5%	7%	3%	6%	11%	4%	8%	14%	5%
7	Duluth, Minnesota	0%	0%	0%	5%	7%	3%	6%	11%	4%	8%	14%	5%
		SHGC	Ufactor		SHGC	Ufactor		SHGC	Ufactor		SHGC	Ufactor	
		0.819	6.17		0.647	3.2		0.58	2.49		0.489	2.43	

Using lightweight / thin high-performance materials as storm significantly improves performance.

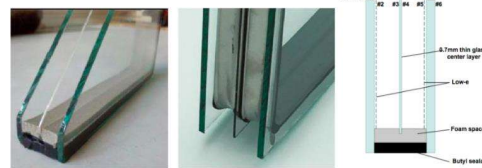


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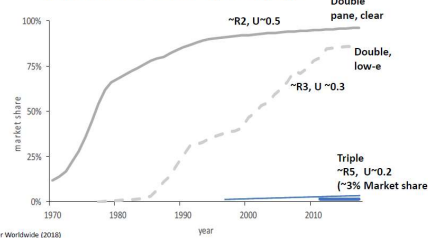
# Carbon Reduction – Reduce

## Thin Triple IGU

- Improve operational performance
- Thin center lite reduces embodied carbon impacts
  - Fits in standard double IGU system
- Reduce weight compared to traditional triple



Residential Market Share By Glazing Type



\*Ducker Worldwide (2018)



Credit – Steve Selkowitz, LBNL

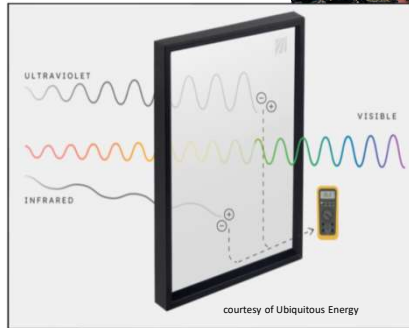


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# Carbon Reduction – Rethink

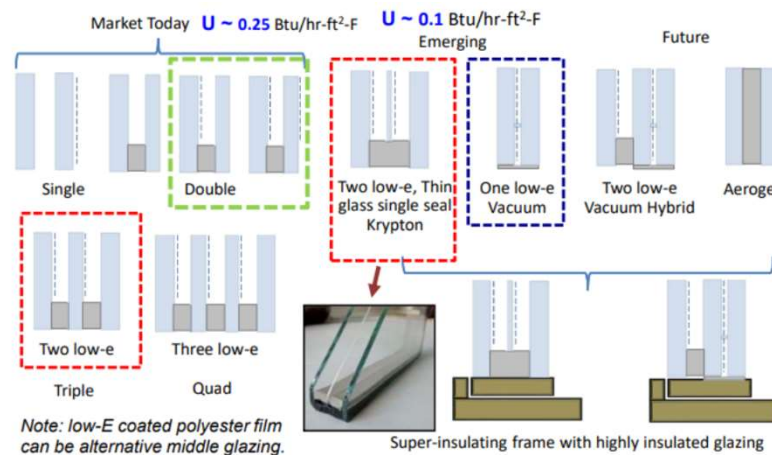
## Transparent Photovoltaics

- Rooftop area vs Façade area
- Passive IGU Benefits
- Dynamic Window Area
  - Embodied energy payback
  - Net zero building performance



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# Highly Insulating Glazing Solutions

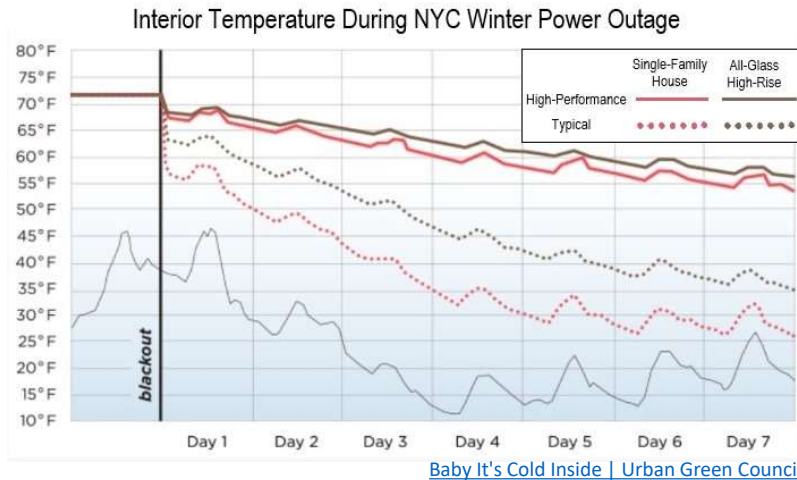


Credit – Steve Selkowitz, LBNL



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## What about Resiliency?



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## Summary

### Existing Buildings

- Minimize additional embodied carbon impacts
- Improve operational performance
  - Upgrade building envelope for passive building performance improvements + resiliency
    - Lead to smaller HVAC systems and cost savings.

### New Construction

- Wide variety of available technologies.
  - R-20, double skins, VIG, TGU, 4x silver
- Carbon payback
  - Operational savings > embodied addition
- Design for the future

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## Counting Carb(on)s Embodied vs Operational



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