

Resilient Design

Another Reason for Passive House



*Hurley/Kawahara Passive House, Santa Cruz, CA
Photo: Alex Wilson*

Passive House California
March 26, 2014

Alex Wilson, Founder
BuildingGreen, Inc.
Resilient Design Institute

Superstorm Sandy



Ocean Grove, New Jersey, Oct. 29, 2012, Photo: Pameley Palma, New York Times

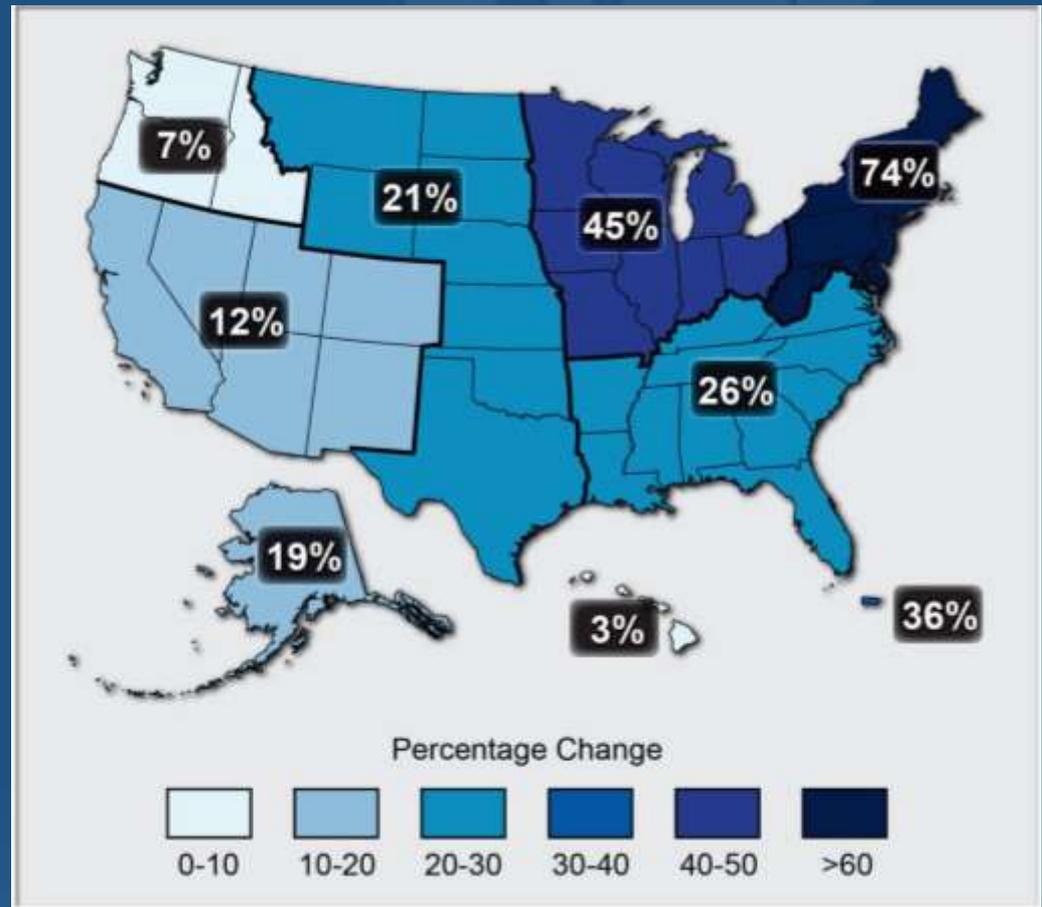
Tropical Storm Irene in Vermont, 2011



Route 4 in Killington, VT, Sept. 2011. Photo: LarsGange and Mainsfield Heliflight

More intense storms and flooding

- 74% increase in intense storms in the Northeast from 1958 – 2011
- Similar trend in other regions—though not as extreme
- Even in areas where there may be less total rainfall, it is coming in more intense storms
- Causes river valley as well as coastal flooding

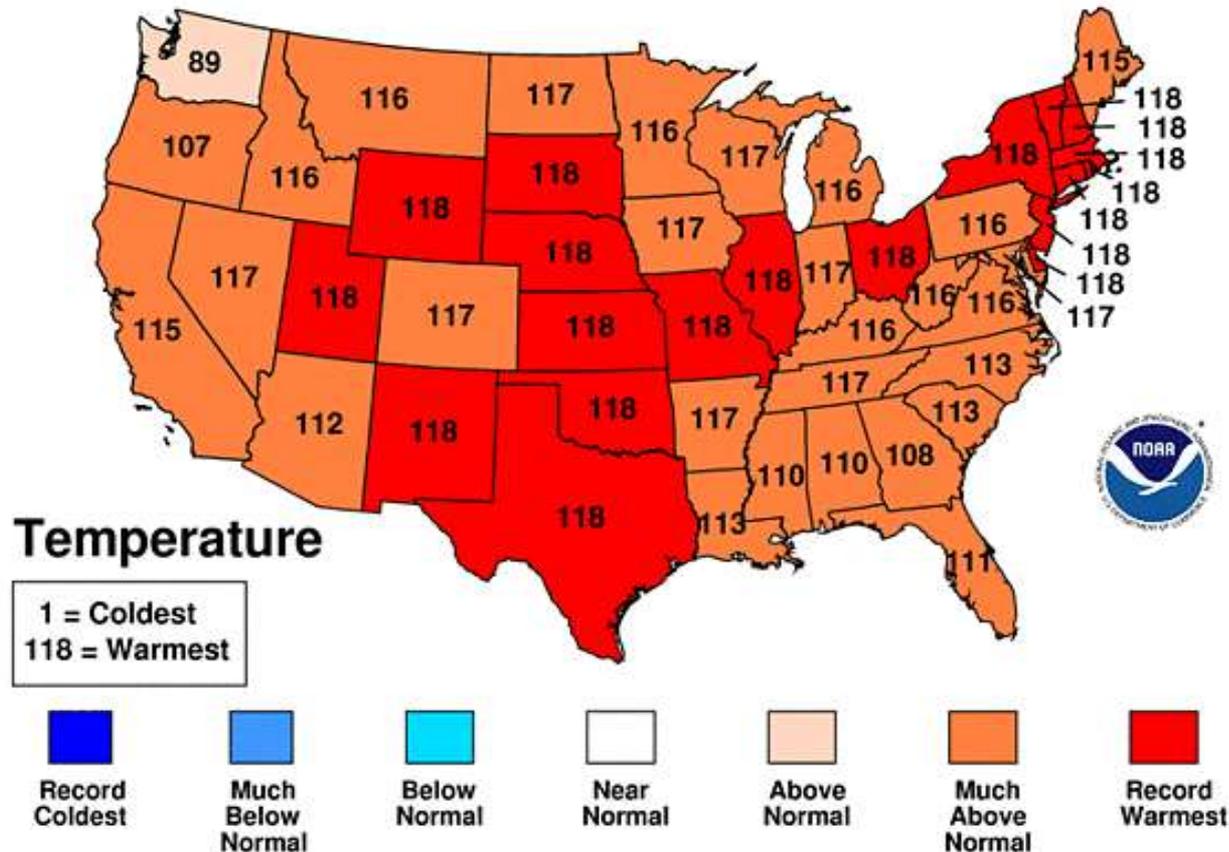


Percent increase in very heavy precipitation 1958-2011 (defined as the heaviest 1% of all events). Source: Nat'l Climate Assessment Draft (January 2013)

Higher temperatures

January-December 2012 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



NOAA National
Climate Data
Center – 1/8/12

Tornados

- Joplin tornado on May 22, 2011
- F-5 tornado
- 3/4-mile-wide track lasting 6 miles
- 157 fatalities
- The deadliest of 1,691 tornados in 2011
- \$1.3 billion in claims – largest insurance event in Missouri's history

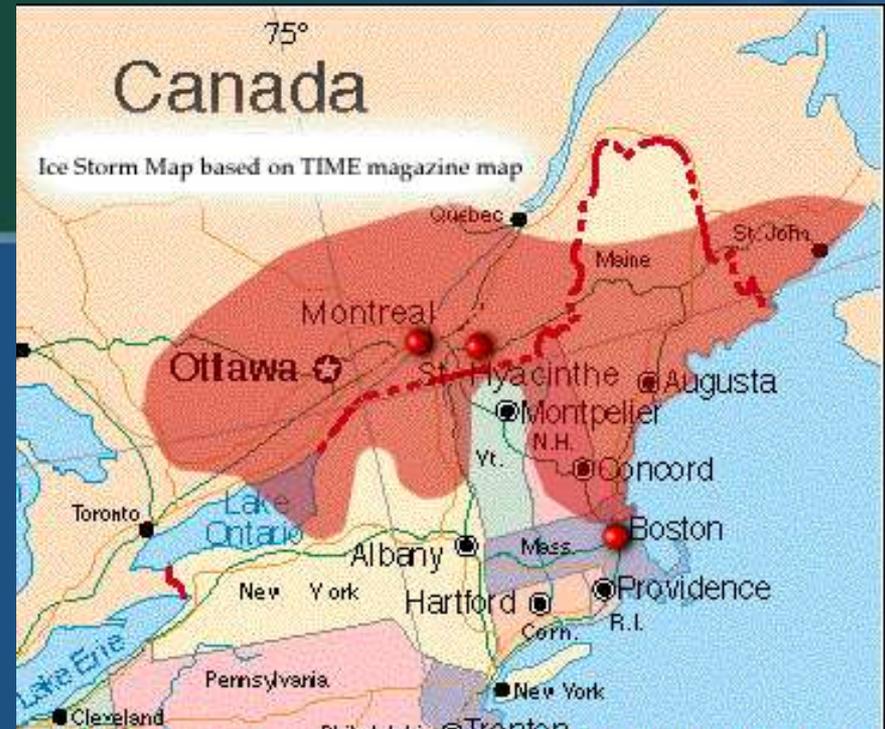
*Joplin, Missouri, May 24, 2011.
Photo: Charlie Riedel, AP*



1998 Ice Storm



Hydro Quebec pylon - Drummondville, Quebec - January, 1998



- 3-4 inches of freezing rain January 5-10, 1998
- 130 power transmission towers and 30,000 utility poles destroyed
- 4 million homes lost power; 600,000 families forced from their homes

Drought & Water Shortages



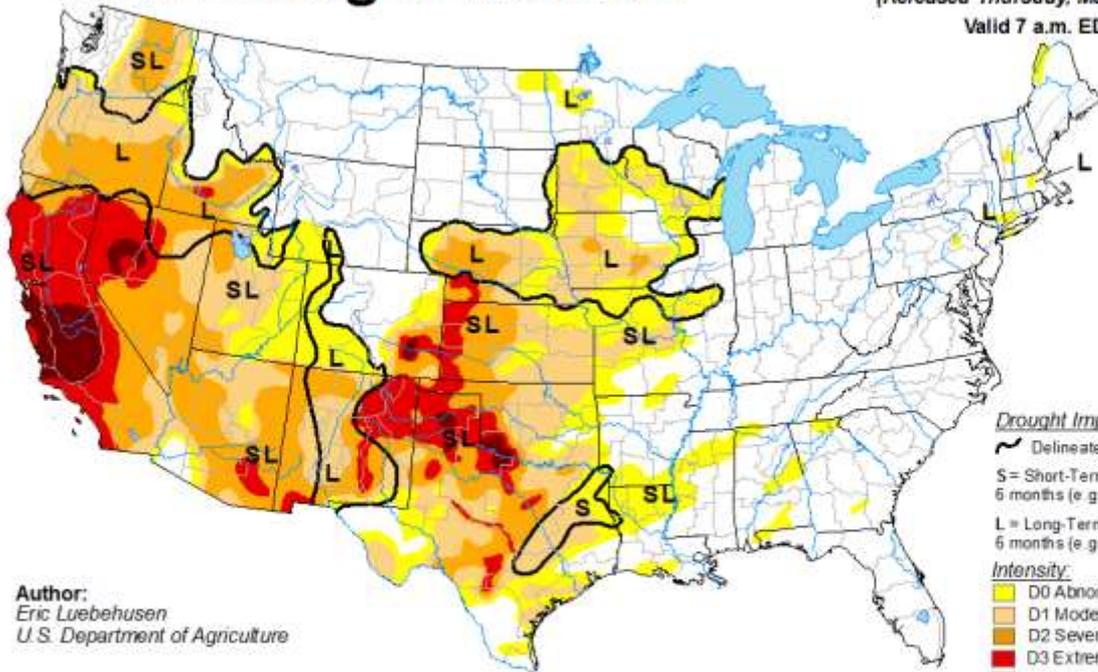
Lake Mead, October 2007, Ken Dewey photo



*Lake Lanier, September, 2007
Washington Post photo*

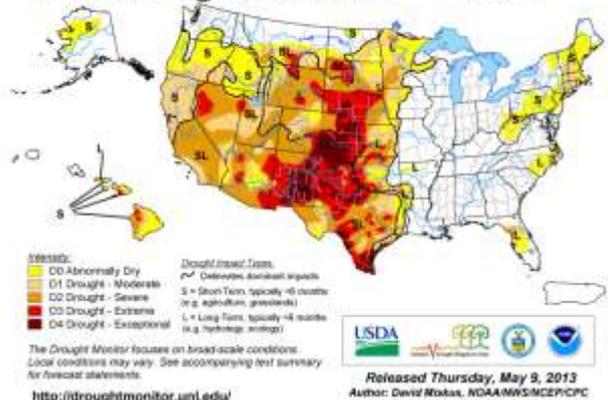
U.S. Drought Conditions

U.S. Drought Monitor



U.S. Drought Monitor

May 7, 2013
Valid 7 a.m. EDT



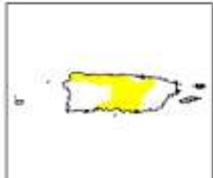
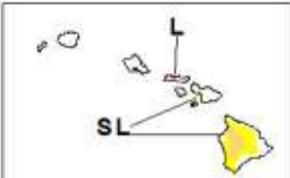
Drought Impact Types

- ~ Delineates dominant impacts
- S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



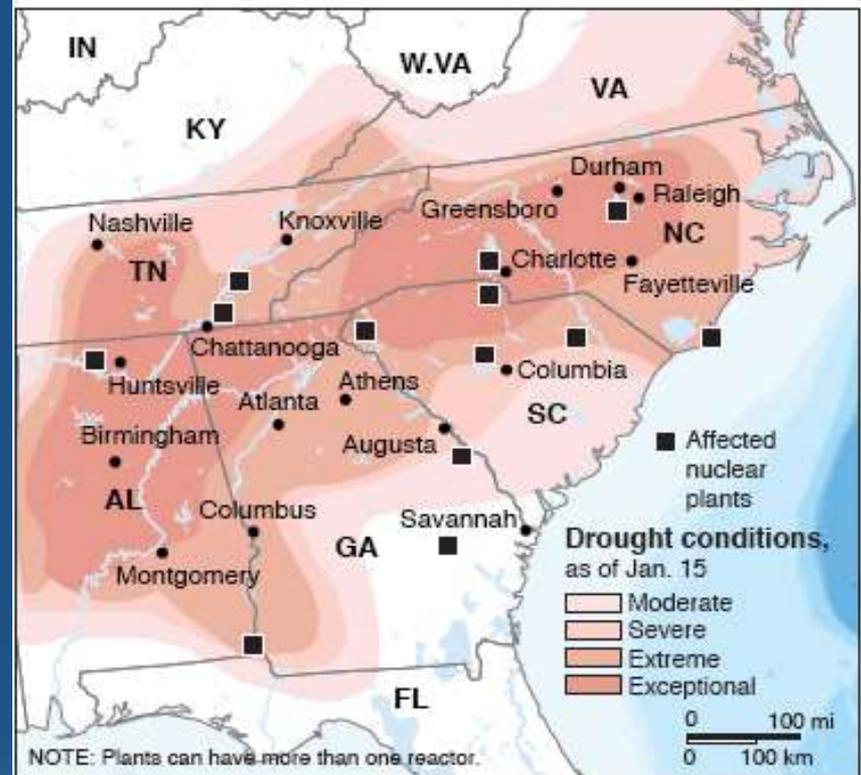
<http://droughtmonitor.unl.edu/>

Drought Puts Power Plants at Risk

- 89% of U.S. electricity generation from thermal-electric power plants
- 40% of U.S. fresh water extractions in the U.S. used for power plants
- Vast majority of power plants on rivers
- A nuclear plant in CT shut down briefly in 2012 due to temp of cooling water
- In 2003 drought and heat wave in Europe more than a dozen plants shut down or output reduced

Drought affecting nuclear plants

Twenty-four of the nation's 104 nuclear reactors are in areas experiencing the most severe levels of drought. Rivers and lakes supply power plants with the cooling water necessary to operate.



SOURCES: Nuclear Regulatory Commission; TerraServer USA

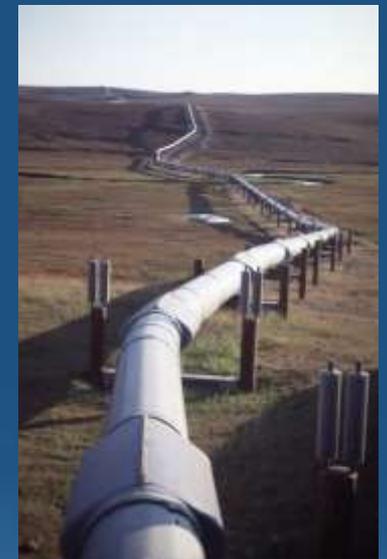
AP

1/23/08 AP story on MSNBC

Energy Distribution in the U.S.



- 160,000 miles of high-voltage power lines
- 3,400 power plants
- 150 refineries, half in the Gulf Coast
- 2.5 million miles of oil and gas pipelines



Blackout of 2012 - New York City



New York City on October 29, 2012 – photo: Eric Chang

Cascading impacts: gasoline shortages



Gas line in Woodbridge, NJ on November 1, 2012 – photo: AP

Cascading impacts: gasoline shortages



Gas line in New Jersey, November 1, 2012 – photo: Getty Images

Achieving Resilience

- Given these concerns, we should be designing buildings and communities that
 - Are resistant to damage from storms
 - That will maintain livable conditions in the event of power outages or loss of fuel or water
- An issue both at the building scale and the community scale
- Is resilience the new “sustainability”?

Designing for flood resilience



Flat Street, Brattleboro, Vermont, Sept, 2011. Photo: Charlie Boswell

- Design buildings to withstand reasonably expected storms
- Build to Miami - Dade County Building Code, or comparable—even if not required
- Install flood barriers
- Use materials that can be wetted and then dry out
- Increase use of nonporous materials (e.g., polished concrete)

Surviving floods



*New England Youth Theater, Brattleboro.
Photo: Jerry Stockman*



*New England Youth Theater, Brattleboro.
Photo: Jerry Stockman*

Surviving floods



Flood barrier from the European company EKO Flood - photo: EKO Flood USA

Surviving floods



Tiger Dam vinyl tubes being filled with a fire hose - photo: U.S. Flood Control

Providing for increased stormwater flows



Larger culverts installed after Hurricane Irene. Photo: Vermont Dept. of Transportation

Elevating buildings above the ground



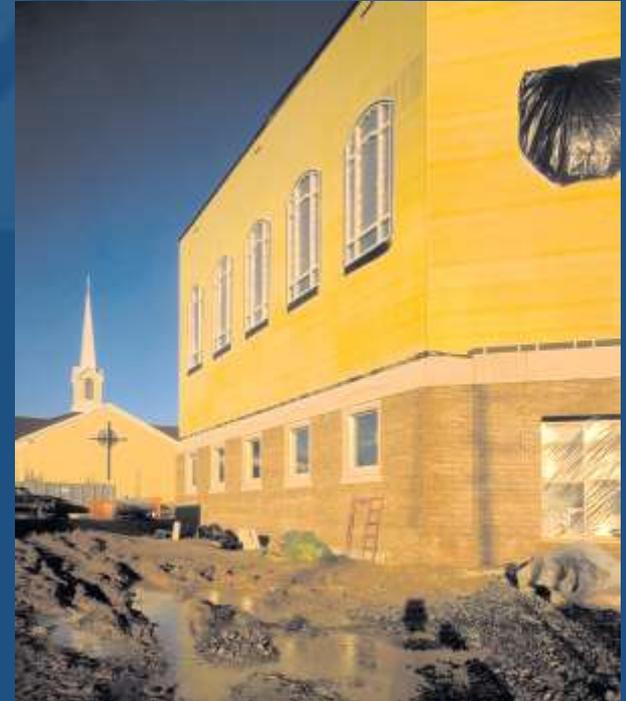
- Most important in flood-prone areas
- Can use pier foundations
- Break-away coverings on piers
- Also elevate mechanicals and electric panels

Post-Katrina home in New Orleans' Lower 9th Ward that is raised 4 feet. Global Green project & photo

Specifying materials that can survive wetting



Polished concrete floor - RetroPlate photo



Georgia-Pacific DensGold

Fire Resistance

- Do not to build in the most fire-prone locations
- But if one must build, there are ways to make buildings more fire resistant
 - Removal of brush immediately around building
 - Use of fire-resistant siding and roofing
 - FireWise construction practices



*Fort Davis, Texas. A few days after wildfire
Photo: Alex Wilson*

Designing for Wildfire

- Specifying Class A roofing
- Eliminating gutters
- Avoiding vented roofs or designing to exclude embers
- Installing tempered insulated glass
- Avoiding decks or using fire-safe materials
- Installing noncombustible siding
- Fire-safe landscaping



Rancho Santa Fe Fire Protection District, California

Superb energy performance is critical for resilience *after* the event

- Reasonable “drift temperature” – to protect occupants from cold and heat in the event of lost power or heating fuel
- Extremely high insulation levels
- Extremely tight buildings (with ventilation)
- Passive solar gain and thermal storage



Dan Whitmore's Passive House in Seattle

Maintaining habitable temperatures

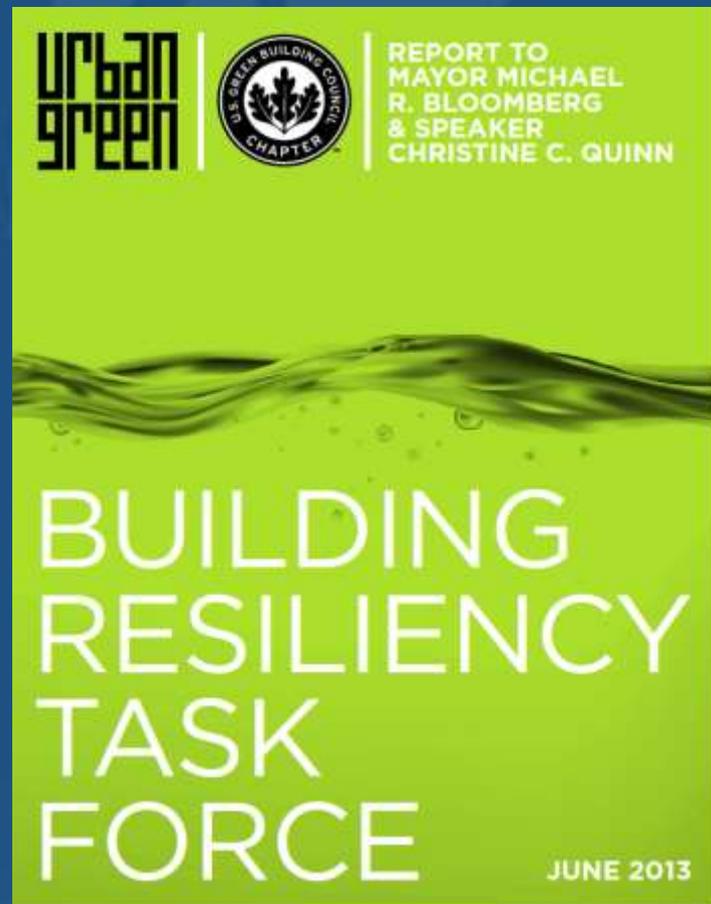
27 Maintain Habitable Temperatures Without Power

Issue: Utility failures often disable heating and cooling systems, leaving interior building temperatures dependent on whatever protection is provided by the insulation and air sealing of a building's walls, windows, and roof.

Recommendation: Extend the mandate of the Task Force through Fall 2013 to develop a multiyear strategy for ensuring that new and substantially altered buildings maintain habitable temperatures during utility failures. Clarify requirements for tightly sealing new windows and doors and upgrading roof insulation during roof replacement.

+ further action

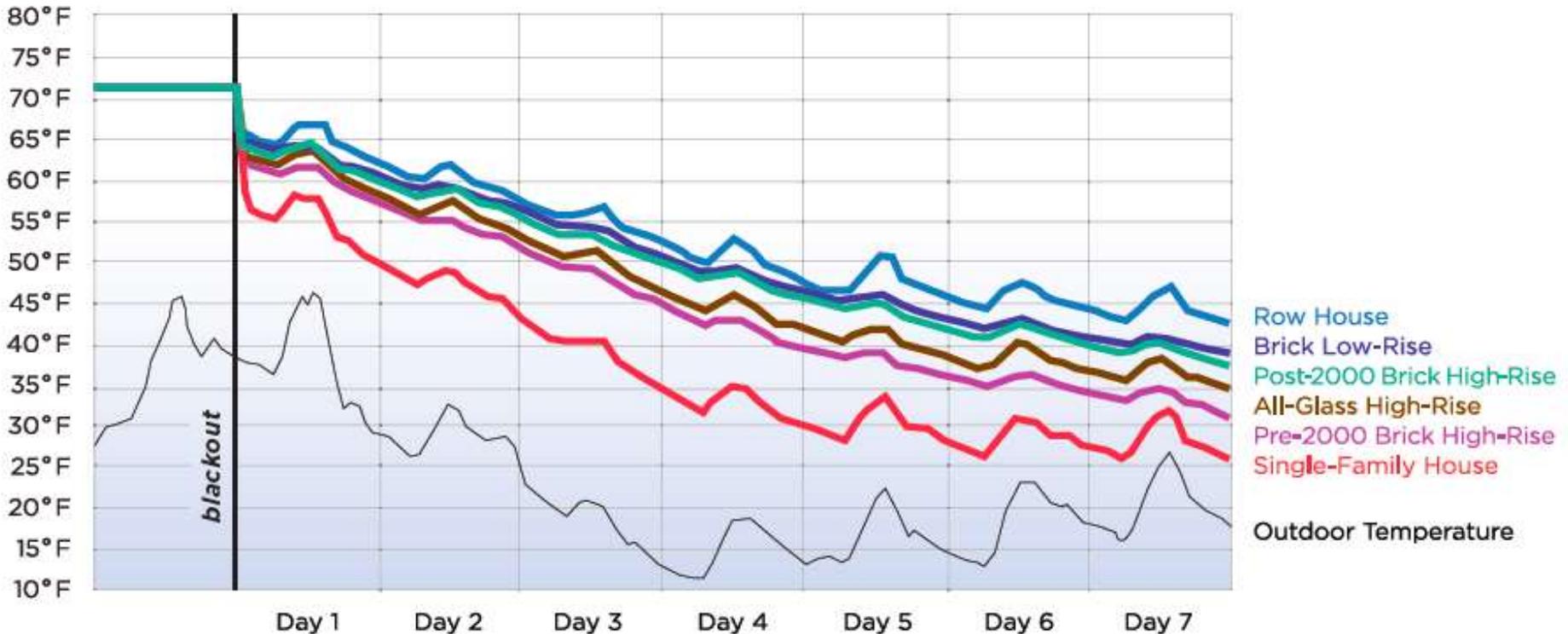
Recommendation from the Building Resiliency Task Force



Building Resiliency Task Force in New York City – Final Report, June, 2013

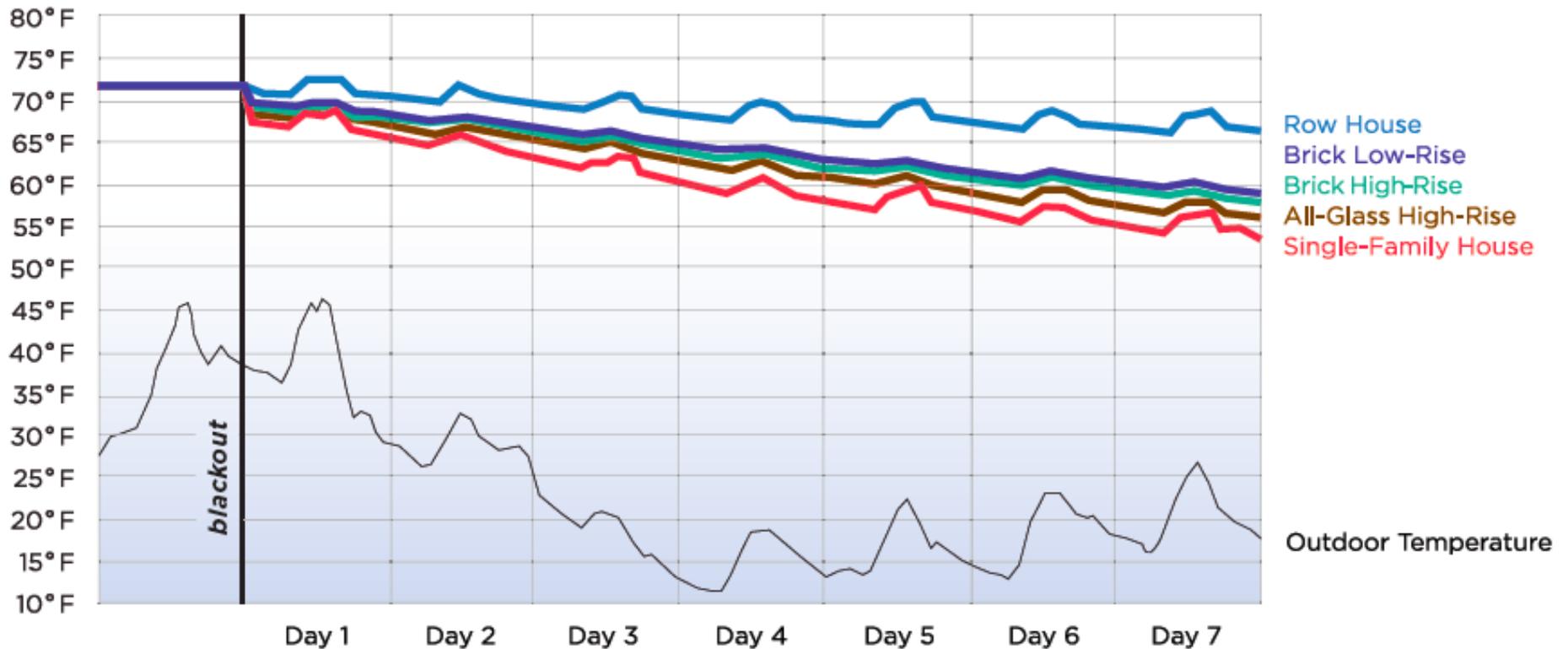
Drift temperatures

Typical Building



Drift temperatures

High-Performing Building



High insulation levels – lots of options



FoamGlas - photo: Alex Wilson



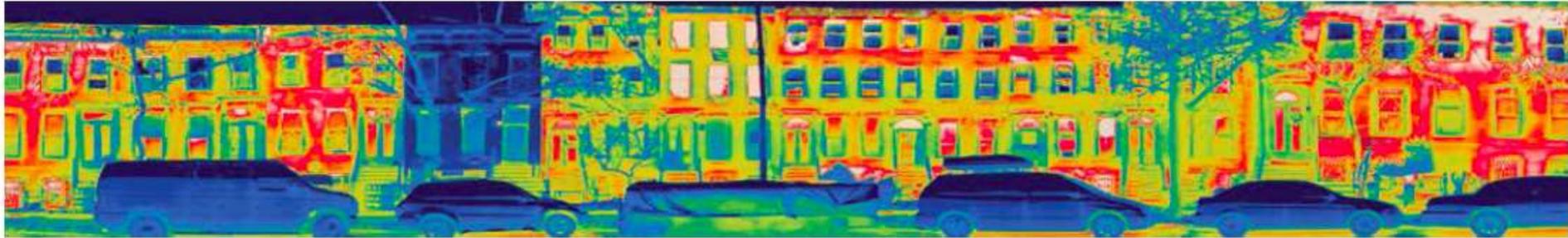
*Cork insulation
photo: Alex Wilson*

High insulation levels – lots of options



Johns Manville Spider spray fiberglass insulation – photos: A Wilson

Resilience benefits of passive house



Row houses in Brooklyn, NY. Find the Passive House! – photo: Sam McAfee, sgBUILD.com



Passive House retrofit of 1880s Brownstone in Brooklyn, NY. Photos: Prospect Architecture, PC

High-Performance Glazings

- Huge advances last several decades
- Low-e coatings
 - New low-e coating that can go on the warm side of the window
 - R-5 performance with double glazing and two low-e coatings
- Low-conductivity gas-fill
- Triple glazing
- Tighter construction



*Passive House window in Palo Alto
Photo: Alex Wilson*

Passive Solar Heating

- Most important with smaller, skin-dominated buildings
- Direct-gain + thermal mass
- It's hard to achieve Passive House performance without passive solar – except in Coastal CA
- Energy modeling is key to success (e.g., Energy Plus, REM-Design, PHPP)



Jenny Way, Martha's Vineyard - Photo: South Mountain Co.

Cooling Load Avoidance – Vernacular Design



Passively cooled home in Tupelo, MS. Photo: E.L. Malveney

- Orient buildings on an east-west axis
- Less glass on east & west
- Sun-control glazing
- Exterior window treatments, awnings, roller blinds, overhangs
- Reflective roofs
- Deep overhangs or wrap-around porches
- Vernacular design
- Natural ventilation

Cooling-load avoidance - shading

- Simple shutters
- Can provide some hurricane resistance as well as sun shading
- Common-sense solutions



Simple sun shutter in Matlacha, FL. Photo: Alex Wilson

Cooling-load avoidance – shading

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WINDOW COVERINGS & ATTACHMENTS

Intelligent and unbiased guidance on the best window covering for your climate, your needs, your windows.

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I live in:

North

My windows are:

Single-pane clear

Show what works with:

No covering

[Show Only](#) [Select All](#) [Deselect All](#) [Interior Only](#) [Exterior Only](#)[Start Over](#)

Interior

- Interior panel
- Interior solar screen
- Cellular shade
- Louvered blind
- Drape/Curtain
- Pleated shade
- Applied film
- Interior roller shade
- Window quilt
- Interior louvered shutter
- Sheer shade
- Roman shade

Exterior

- Exterior storm
- Exterior roller shade
- Retractable awning
- Exterior louvered shutter
- Exterior solar screen
- Fixed awning
- Roller shutter

Recommended Window Coverings

[print this list](#)Some other coverings have better scores [Include in Results](#)**Cellular shade:** multi-cell, side trackScore: **79%**

Recommended Options

[opaque - manual operation - bottom-up](#)[semi-opaque - manual operation - bottom-up](#)

These are important to me:

Thermal

crucial
important

- Insulation
- Airtightness
- Solar Heat Control
- Winter Comfort
- Summer Comfort
- Condensation Resistance

Cooling-load avoidance – cool roofs



Volunteers painting a dark roof with reflective white elastomeric paint on the Bowery Mission in New York City, 2010 – photo: David Epstein

Wood heat as back-up

- In more rural areas, install wood heat at least for emergency use
- Choose low-pollution models (less than 3 grams per hour EPA rating)
- Avoid use during high-pollution days



*Smallest Jötul
wood stove we
could find
Photo: Alex Wilson*

Daylighting

- Balance of natural light without too much unwanted heat gain
- Exterior windows
- Skylights, clerestory windows, roof monitors
- Tubular skylights
- Proper glazing specification is key (high visible light transmittance, low SHGC)
- Reflective ceilings and walls
- Lightshelves to distribute light deeper into building



*Project FROG modular building in San Francisco
Photo: Alex Wilson*

Minimizing Water Consumption

*Delta H2Okinetics 1.5
gpm showerhead*



*Duet clothes washer and
dryer from Whirlpool*



*Niagara Stealth 0.8 gpf
vacuum-assist toilet*

- Water-conserving toilets
- Low-flow showerheads
- Water-conserving faucets
- Water- and energy-efficient clothes washers and dishwashers
- Xeriscaping (landscaping note dependent on irrigation)

Minimizing Water Consumption



Xeriscaping near Phoenix - photo: Alex Wilson

Rainwater Harvesting



Rainwater cisterns at the Chesapeake Bay Foundation headquarters. Photo: Alex Wilson



Rain barrel - photo: Kelly Lerner

Access to water – hand pumps



Deep-well pump. Photo: Simple Pump



A hand pump that can be installed in the same well will an electric pump. Photo: Alex Wilson

Photovoltaic (solar-electric) power

- Can be the ultimate in resilience during power outages
- Most grid-connected systems don't work during an outage
- Greatest resilience with battery back-up



Dummerston, Vermont barn with 18 kW “group-net-metered” PV system - photo: Alex Wilson

PV power with battery back-up

- Sunny Island 5048 inverter
- Combined with a standard inverter to provide “islanding” operation during power outage
- Some battery storage required to generate the waveform voltage after grid power is lost
- Expensive!



*Sunny Island inverters from SMA Americas
with battery bank – photo: Alex Wilson*



New SMA transformerless inverter

- Lighter-weight, quieter inverter
- TL inverter in 3, 4, and 5 kW sizes
- Outlet can provide up to about 15 amps when the sun is shining, even if the grid is down
- Ideal for charging cell phones, laptop computers, powering cable modem and wireless router
- “Soft-start” refrigerator or freezer using extension cord



Photo: Alex Wilson

Other aspects of resilience: compact, walkable, bikable communities

- Pedestrian-friendly places more livable if gasoline shortages
- Higher density in town centers
- Bicycle lanes and pathways
- Eco-villages, cohousing communities foster reliance on neighbors



A pedestrian-friendly street in Lund, Sweden. Photo: Alex Wilson

Creating community – the most important resilience strategy?



Great Barrington, MA town green – photo: Alex Wilson

Local food & resilience

- Integrating food production into the built environment
- Enhanced food security
- Opportunities
 - Urban farms
 - Rooftop greenhouses
 - Home gardens
 - Community gardens



Photo: City Farm, Chicago

Urban Farming



40,000 sf rooftop farm on the Brooklyn Grange in Queens, NY – photo: Cyrus Dowlatshahi

Urban Farming



Gotham Greens, Brooklyn, NY – photo: Gotham Greens

Urban Farming

- Gotham Greens
Greenpoint,
Brooklyn
- 15,000 sf rooftop
greenhouse built in
2011
- Hydroponics
- Harvested rainwater
- Powered by 60 kW
onsite PV array
- Advanced energy
conservation
- Produces 100 tons
per year of greens



Gotham Greens, Brooklyn, NY – photo: Gotham Greens

Community gardens



Community Gardens, Holyoke, MA – Photo: Nuestras Raices

Resilient Design Institute

www.ResilientDesign.org

The image is a screenshot of a web browser displaying the Resilient Design Institute website. The browser's address bar shows the URL www.resilientdesign.org. The website has a green header with the logo "RESILIENT DESIGN INSTITUTE" and a navigation menu with links for "About RDI", "Resilient Design", "Programs", "Client Services", "News & Blogs", and "Contact".

The main content area features a large image of a river with a collapsed bridge and debris. A text box overlaid on the image reads:

Designing Homes for More Intense Storms

Anybody who was in Vermont one year ago this week and witnessed the raging floodwaters of Hurricane Irene and the havoc they wreaked, understands the vulnerabilities we face from intense storms and flooding. In the Northeast, there was a 67% increase in heavy rainfall events...

[Read More](#)

Below the image is a quote:

"If they lose electricity, few buildings in the U.S. can provide as much comfort as my backpacking tent."

— Terry Brennan, Westmoreland, New York, quoted in the *Environmental Building News* feature article, "Passive Survivability: A New Design Criterion for Buildings," May, 2006

Thank you! - Questions?



Old Lyme, Connecticut - Alex Wilson photo