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

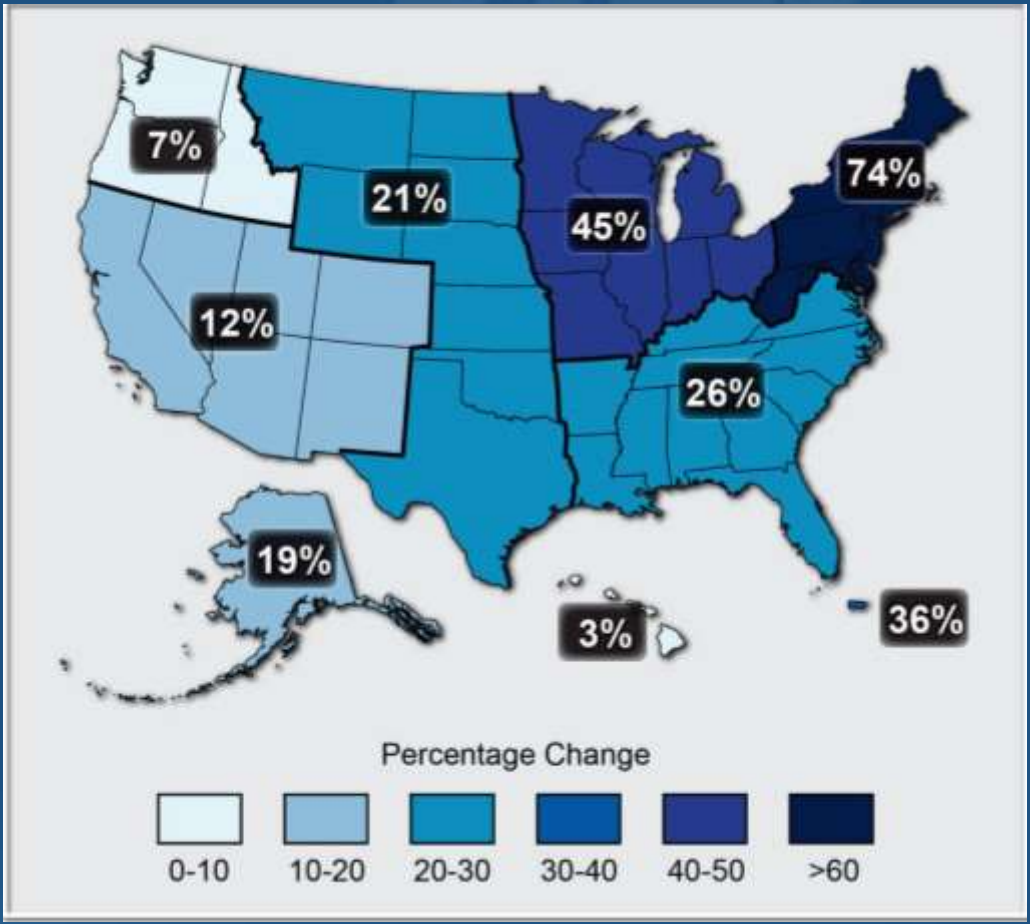
Ocean Grove, New Jersey, Oct. 29, 2012, Photo: Pamely Palma, New York Times

Tropical Storm Irene in Vermont, 2011

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

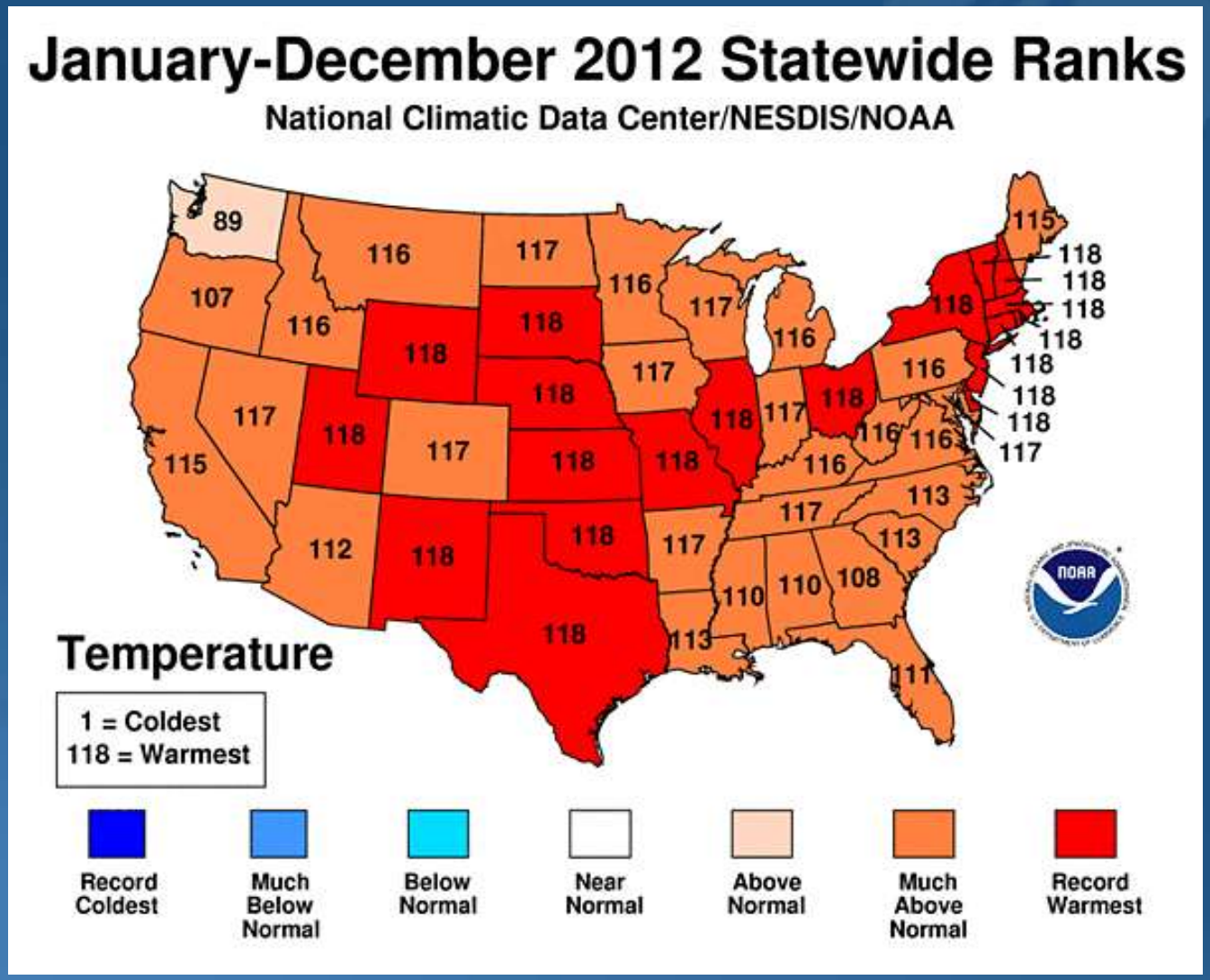
More intense storms and flooding

- 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



NOAA National Climate Data Center – 1/8/12

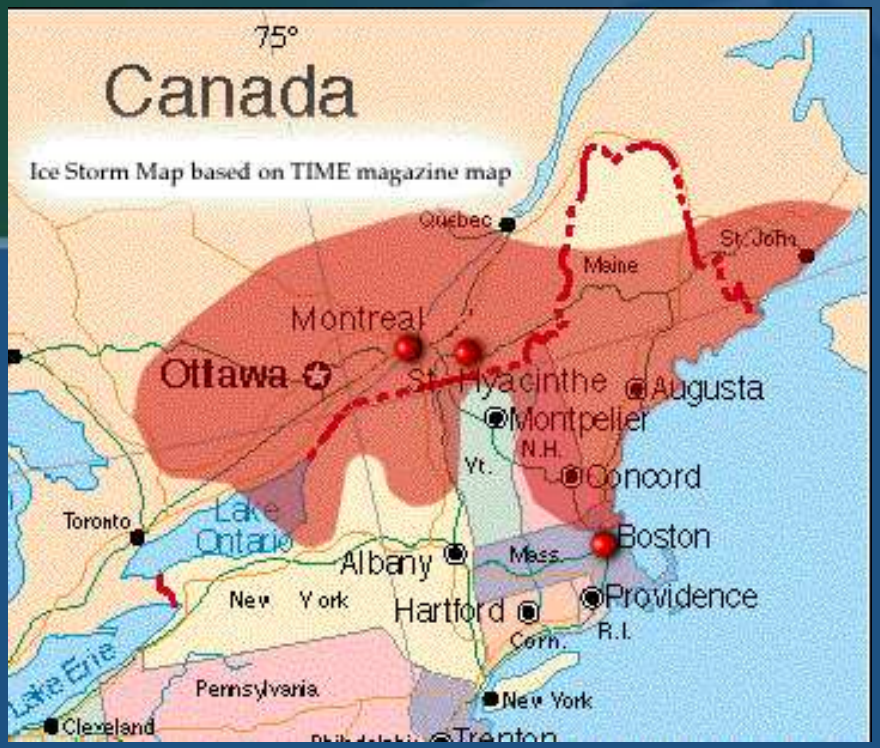
Tornados

- 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



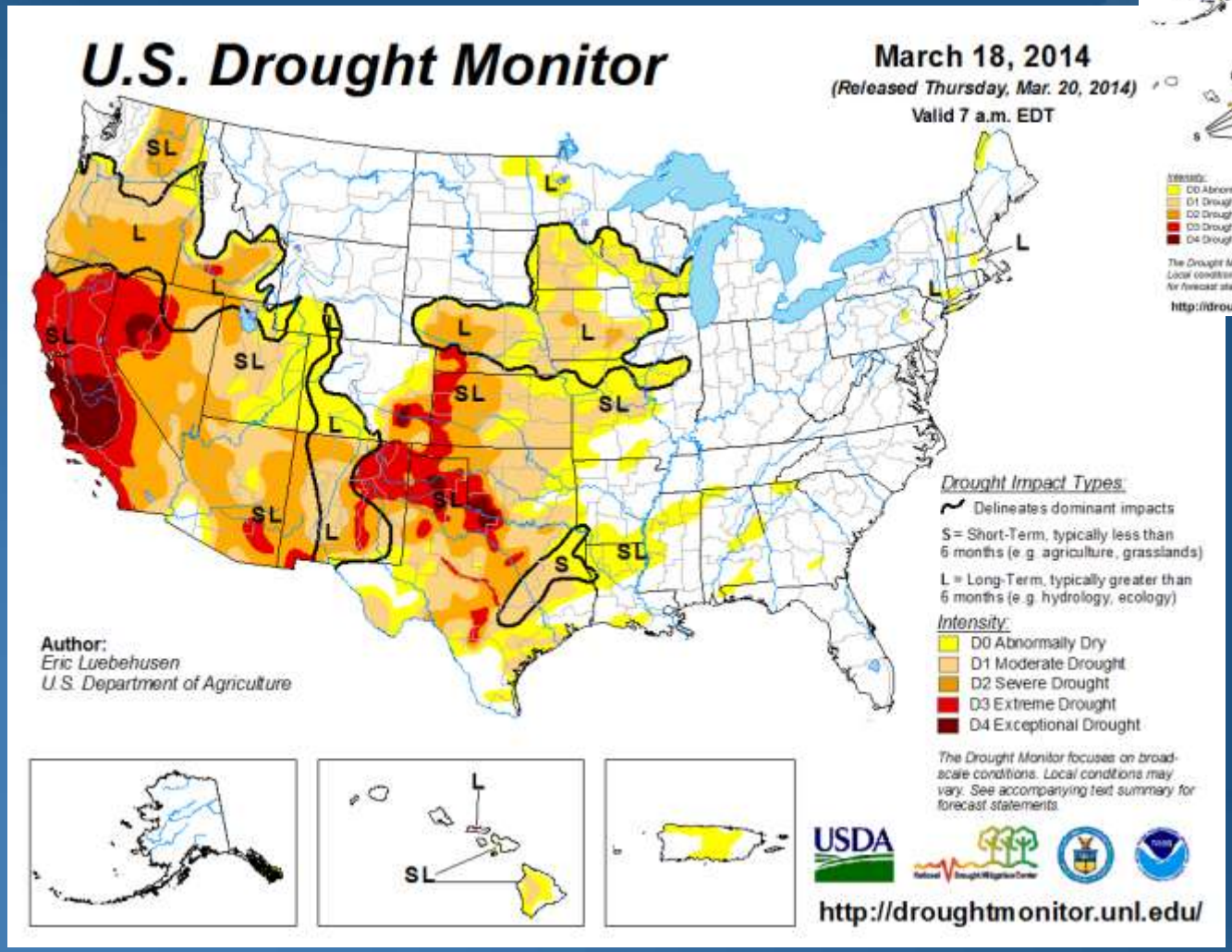
- 3-4 inches of freezing rain January 5-10, 1998
- 130 power transmission towers and 30,000 utility poles destroyed
- 4 million homes lost power; 600,000 families forced from their homes

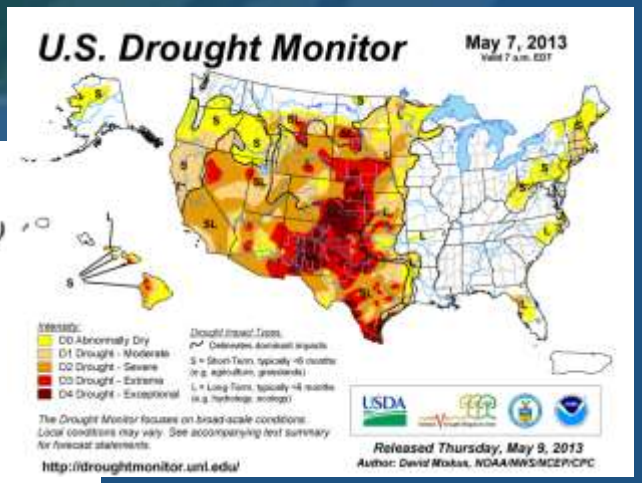
Drought & Water Shortages

Lake Mead, October 2007, Ken Dewey photo

Lake Lanier, September, 2007
Washington Post photo

U.S. Drought Conditions

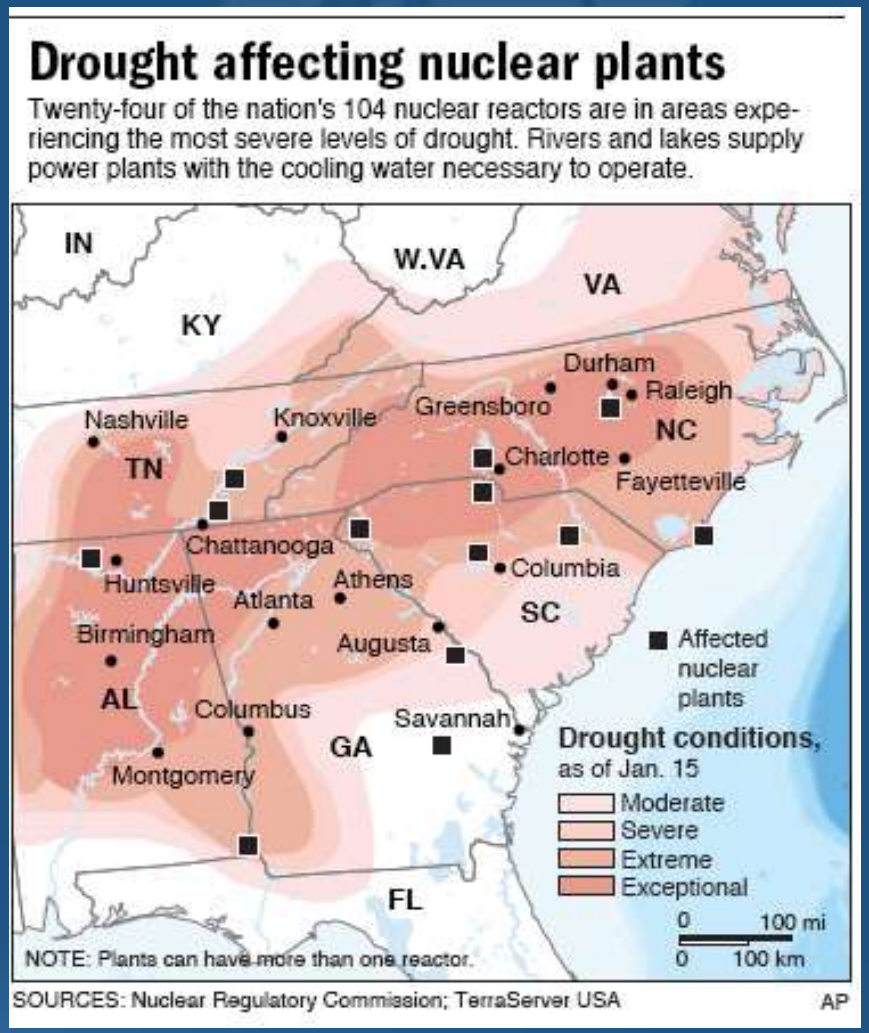




Source: National Drought Mitigation Center - University of Nebraska - Lincoln

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



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

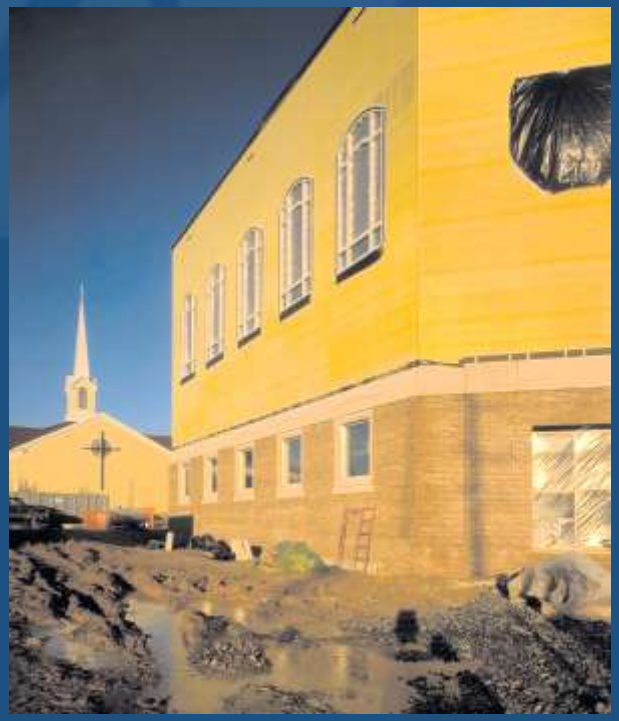
Elevating buildings above the ground

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

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

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

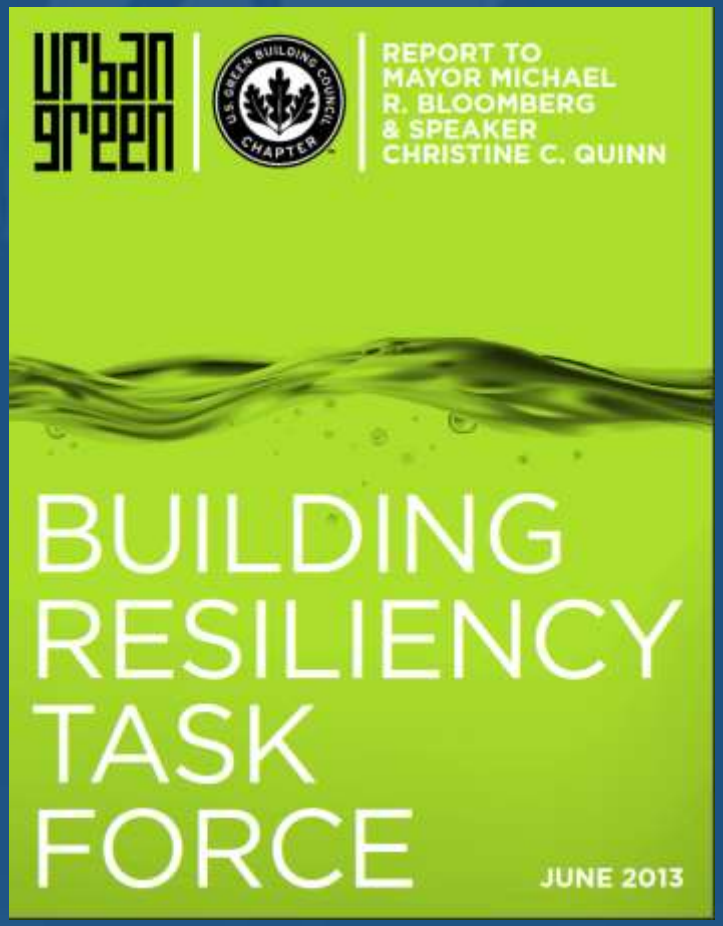
27 Maintain Habitable Temperatures Without Power

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.

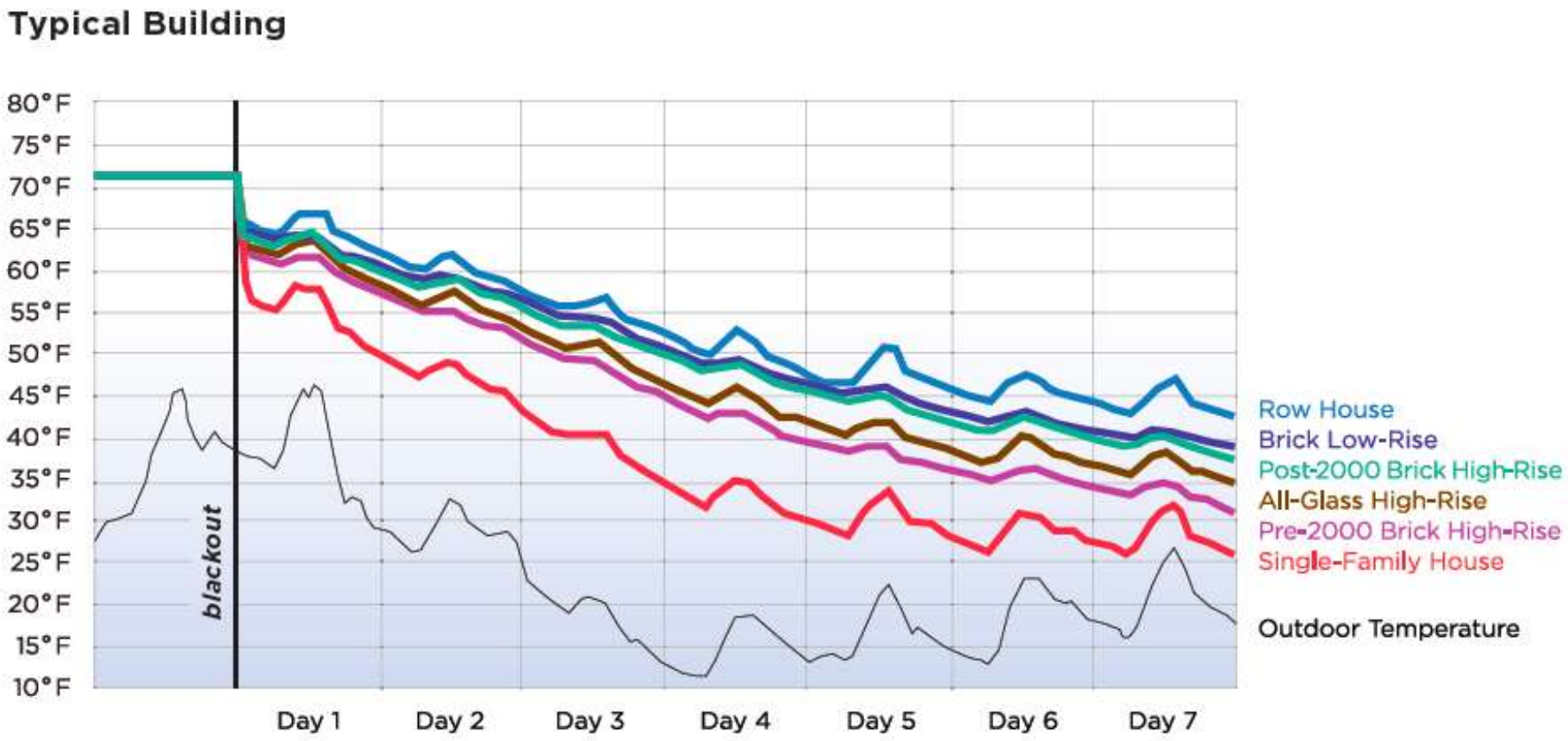
+ further action

Recommendation from the Building Resiliency Task Force



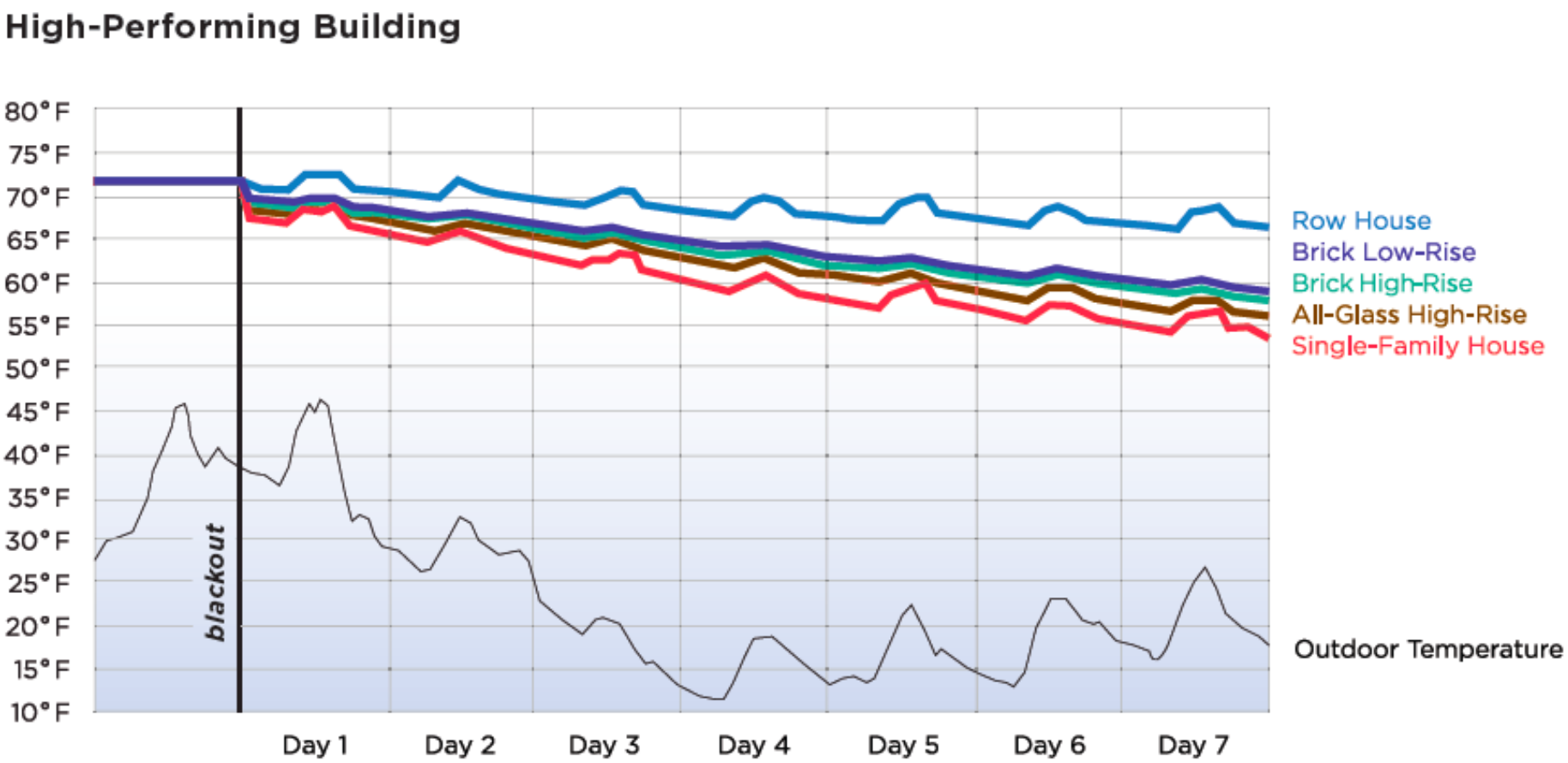
Building Resiliency Task Force in New York City – Final Report, June, 2013

Drift temperatures



Temperature modeling by Atelier Ten for the report "Baby It's Cold Inside," Urban Green, NYC

Drift temperatures



Temperature modeling by Atelier Ten for the report "Baby It's Cold Inside," Urban Green, NYC

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

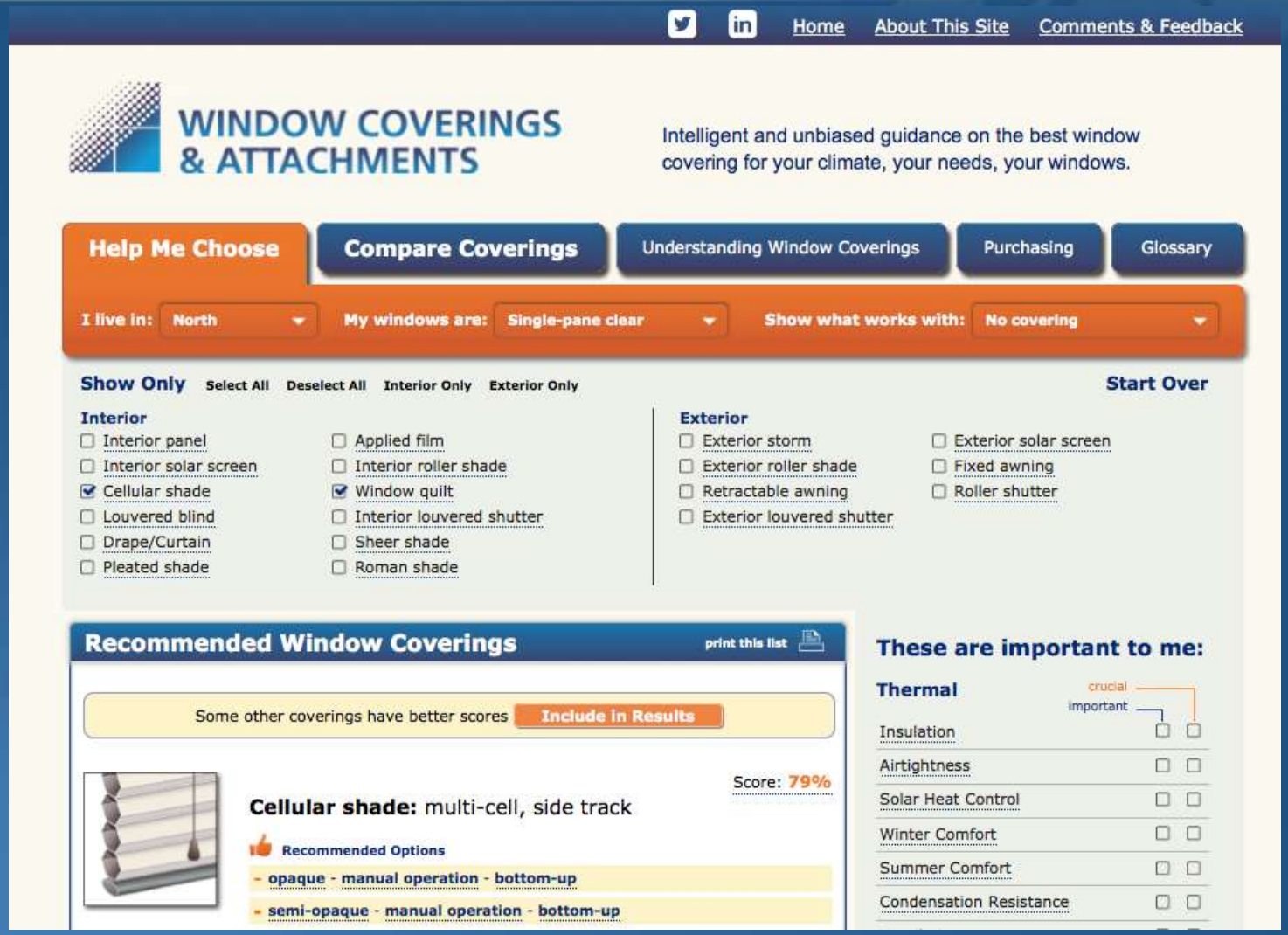
- Orient buildings on an east-west axis
- Less glass on east & west
- Sun-control glazing
- Exterior window treatments, awnings, roller blinds, overhangs
- Reflective roofs
- Deep overhangs or wrap-around porches
- Vernacular design
- Natural ventilation

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



Screen shot from EfficientWindowCoverings.gov.

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

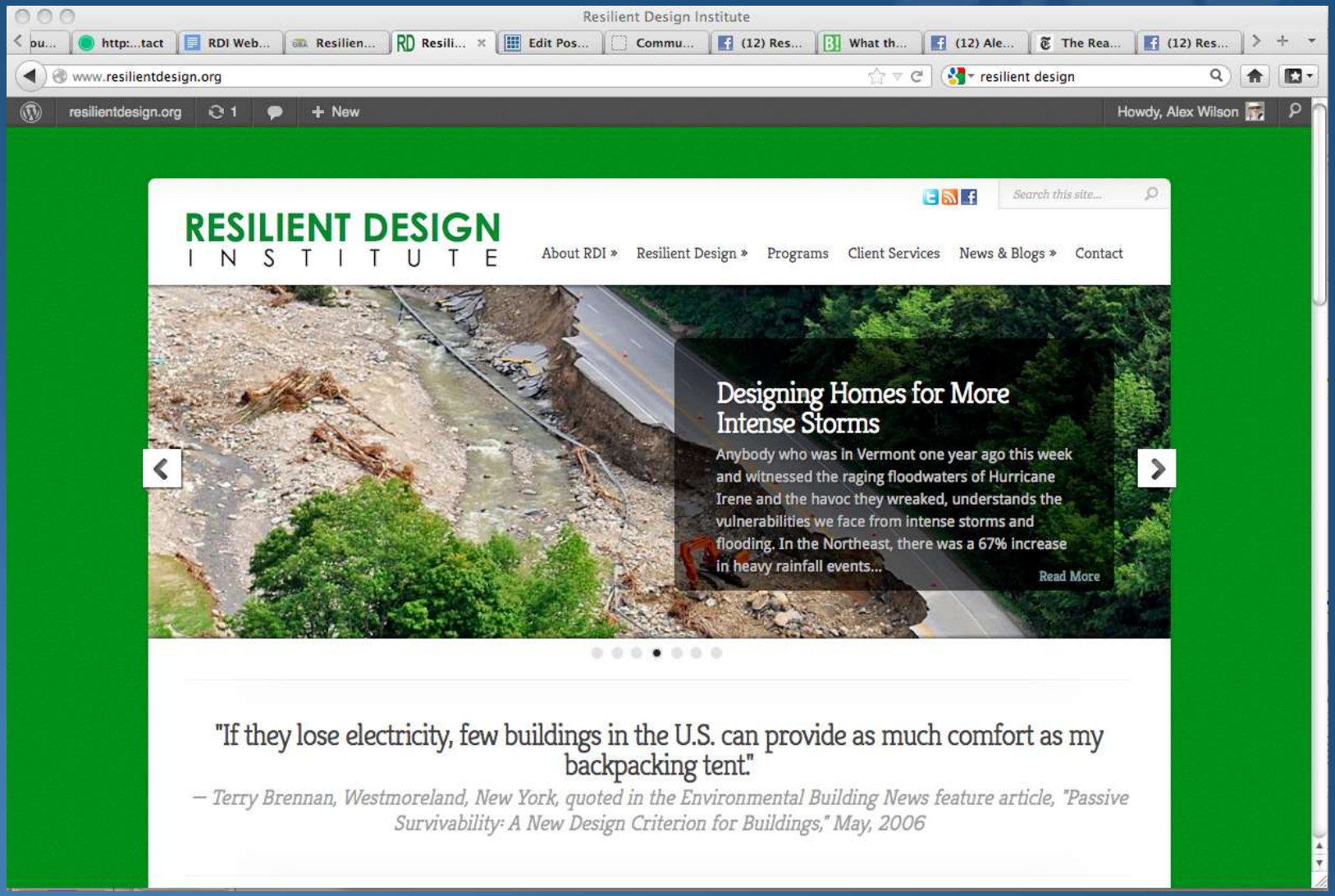
- Gotham Greens Greenpoint, Brooklyn
- 15,000 sf rooftop greenhouse built in 2011
- Hydroponics
- Harvested rainwater
- Powered by 60 kW onsite PV array
- Advanced energy conservation
- Produces 100 tons per year of greens

Gotham Greens, Brooklyn, NY – photo: Gotham Greens

Community gardens

Community Gardens, Holyoke, MA – Photo: Nuestas Raices

Resilient Design Institute
www.ResilientDesign.org



Thank you! - Questions?

Old Lyme, Connecticut - Alex Wilson photo