Resilient Design

Transitioning to the New Built Environment

Eliakim's Way, Martha's Vineyard Massachusetts
photo: South Mountain Company

Local Solutions:
Northeast Climate Change Preparedness Conference

May 19, 2014

Alex Wilson, President
Resilient Design Institute
Founder, BuildingGreen, Inc.

Superstorm Sandy

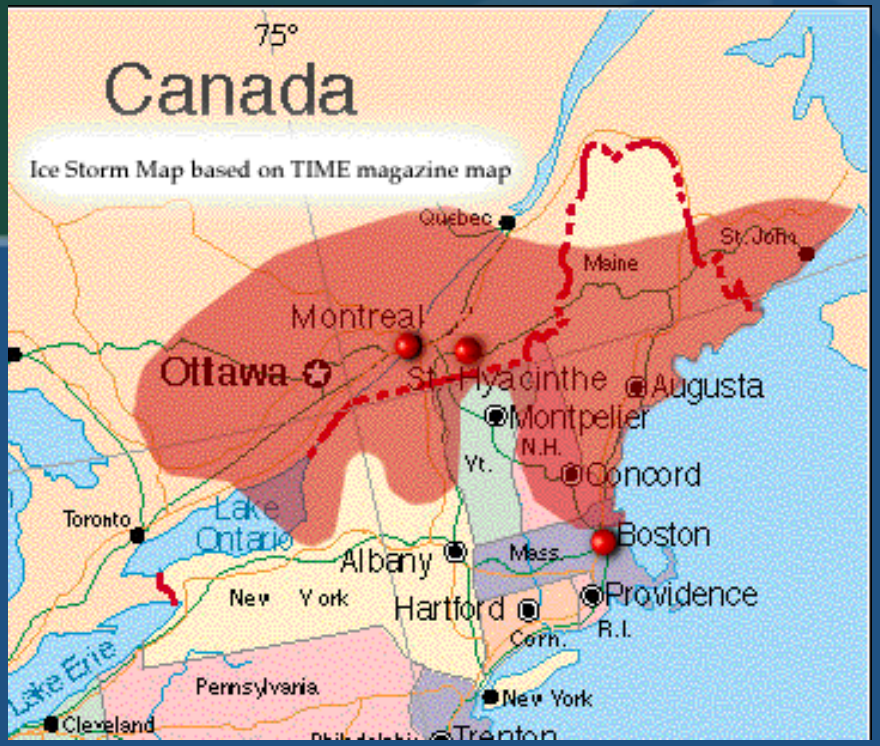
Ocean Grove, New Jersey, Oct. 29, 2012, Photo: Pamely Palma, New York Times

Blackout of 2012 - New York City

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

1998 Ice Storm

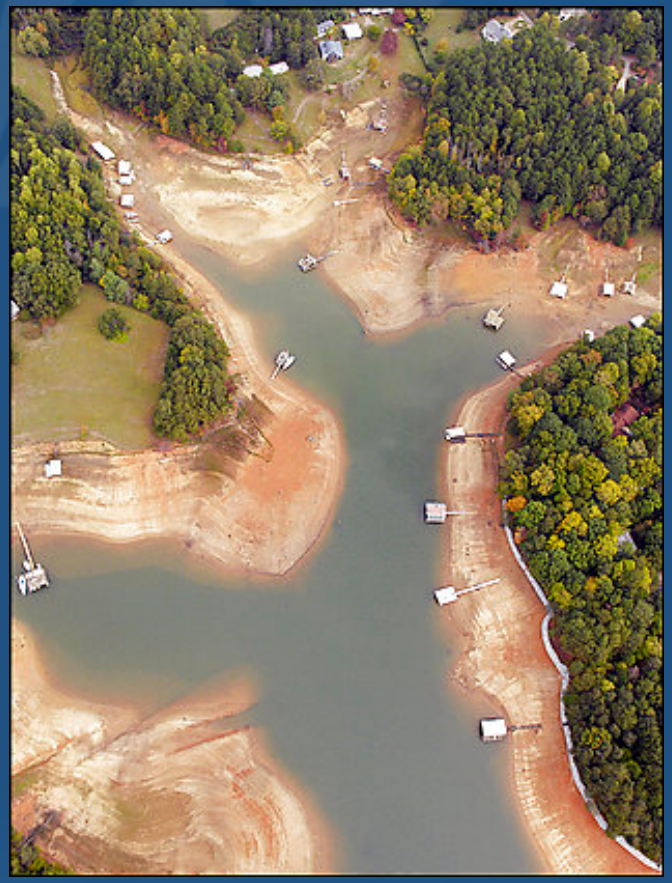
Hydro Quebec pylon - Drummondville, Quebec - January, 1998



- 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

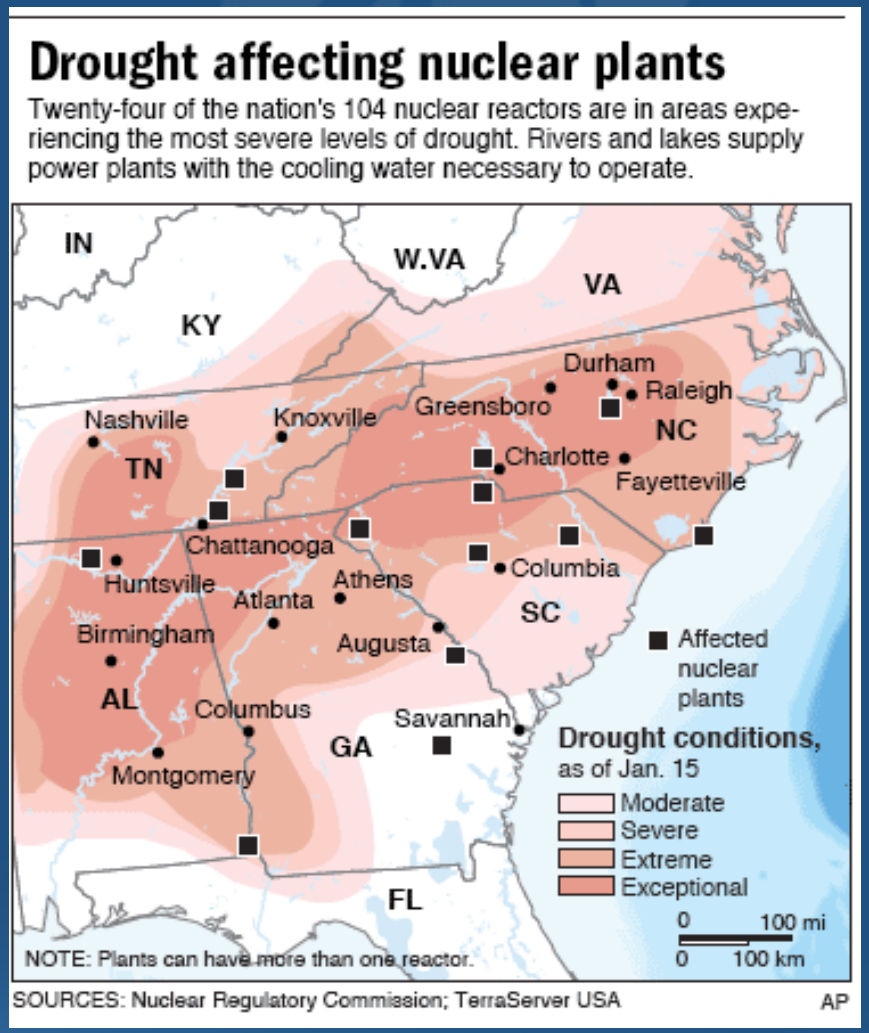
Lake Mead, October 2007, Ken Dewey photo



Lake Lanier, September, 2007
Washington Post photo

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

Designing resilient buildings

- Given these concerns, we should be designing buildings and communities
  - That are resistant to damage from storms
  - That will protect occupants from reasonably expected events
  - 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

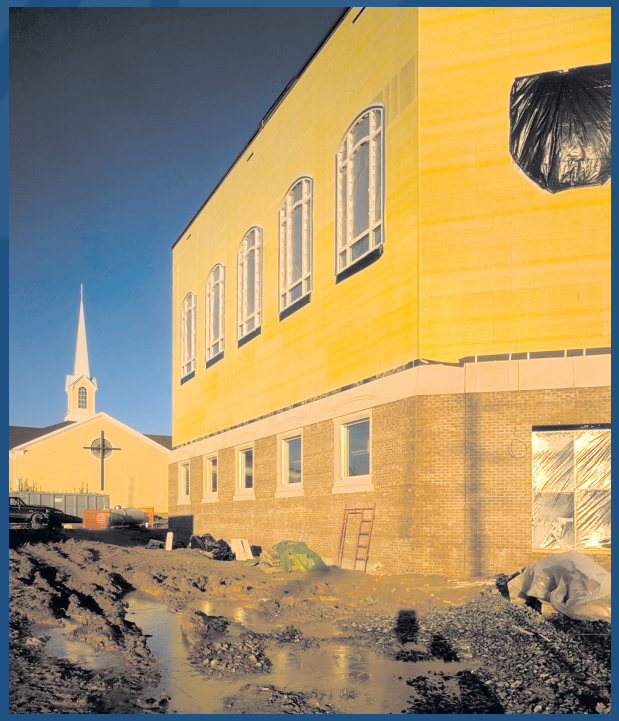
Elevating buildings above the ground

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

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

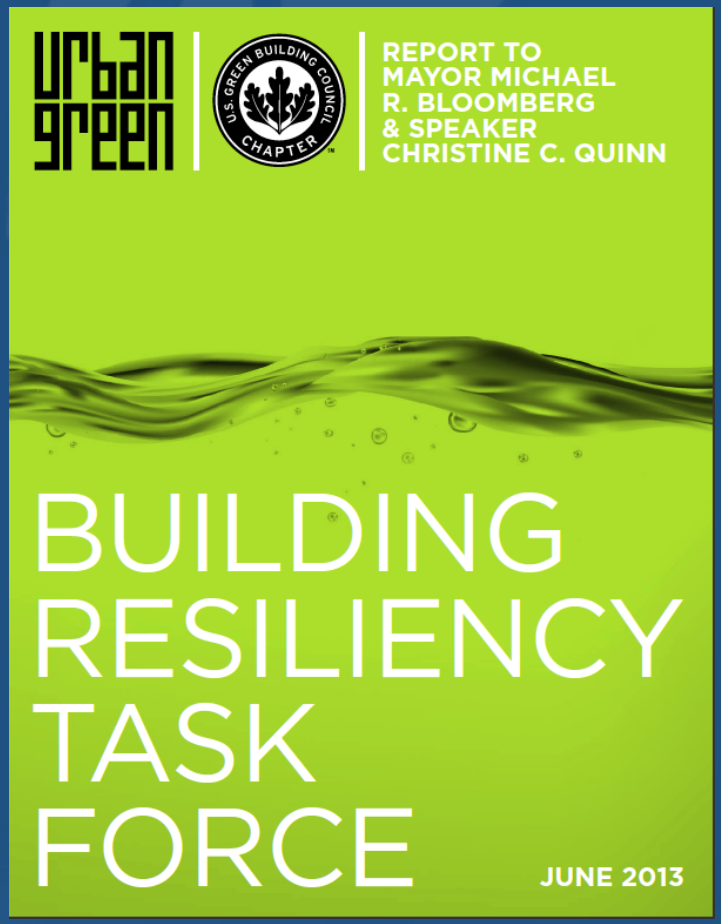
27 Maintain Habitable Temperatures Without Power

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



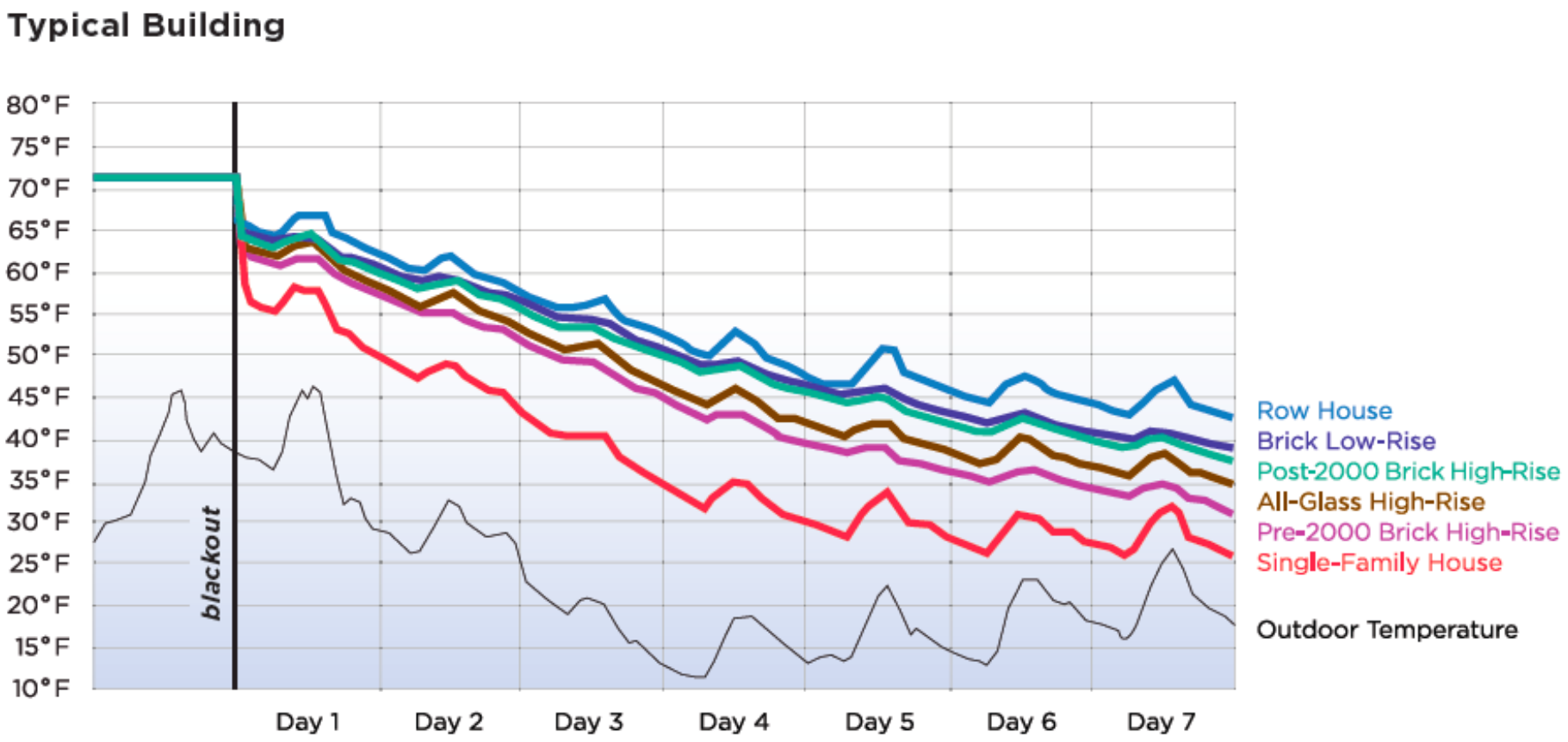
Building Resiliency Task Force in New York City – Final Report, June, 2013

Drift temperatures

- Modeling high and low drift temperatures
- How quickly will a building heat up or cool down if it loses power or heating fuel?
- Is it just temperature, or do other factors come into play, like humidity and air flow?
- Atelier 10 carried out modeling for the Buildings Resiliency Task Force in NYC

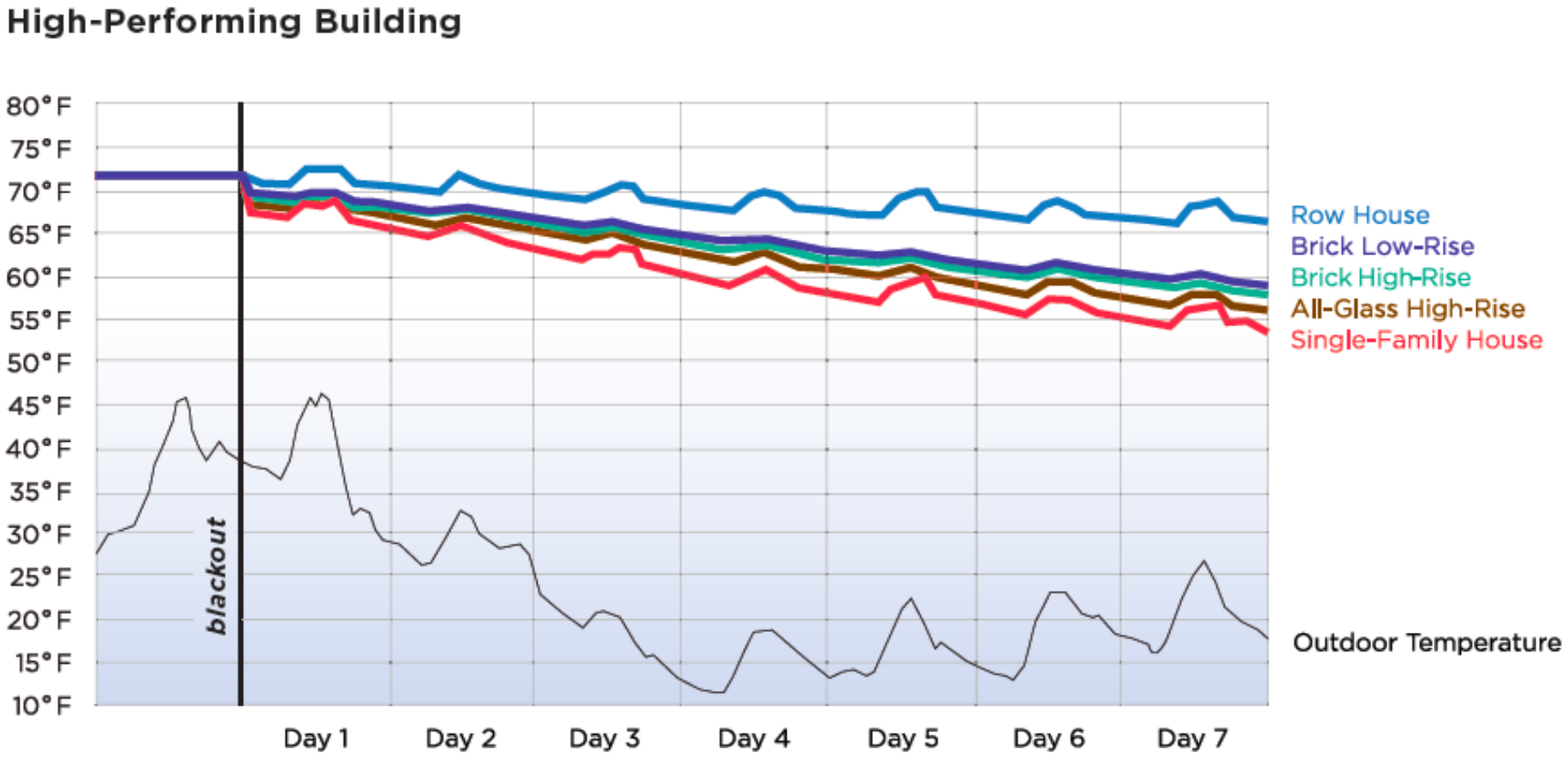
Report from Urban Green in NYC

Drift temperatures



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

Drift temperatures



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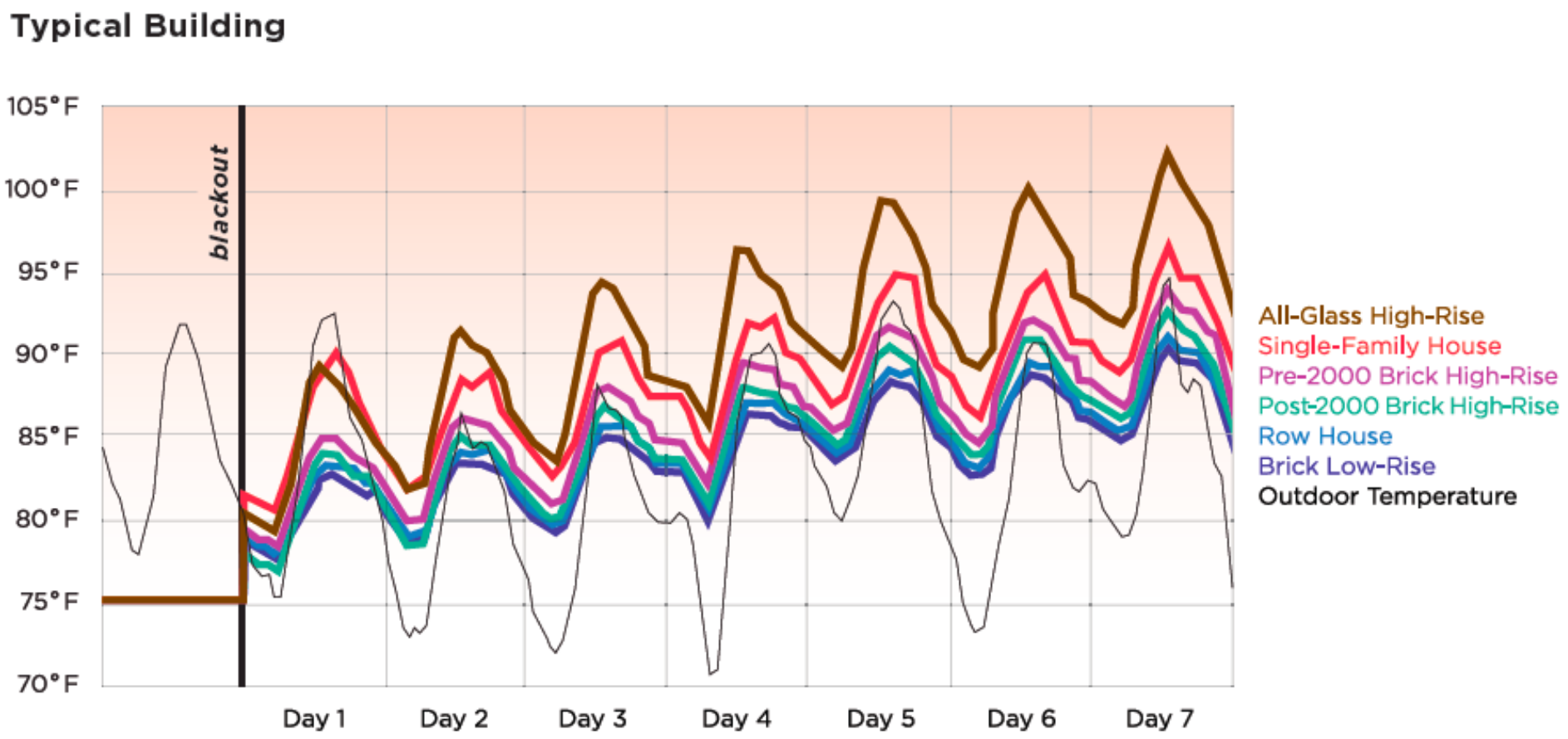
Drift temperatures during outages - summer



Temperature modeling: Atelier Ten, New York City in "Baby It's Cold Inside," Urban Green Council

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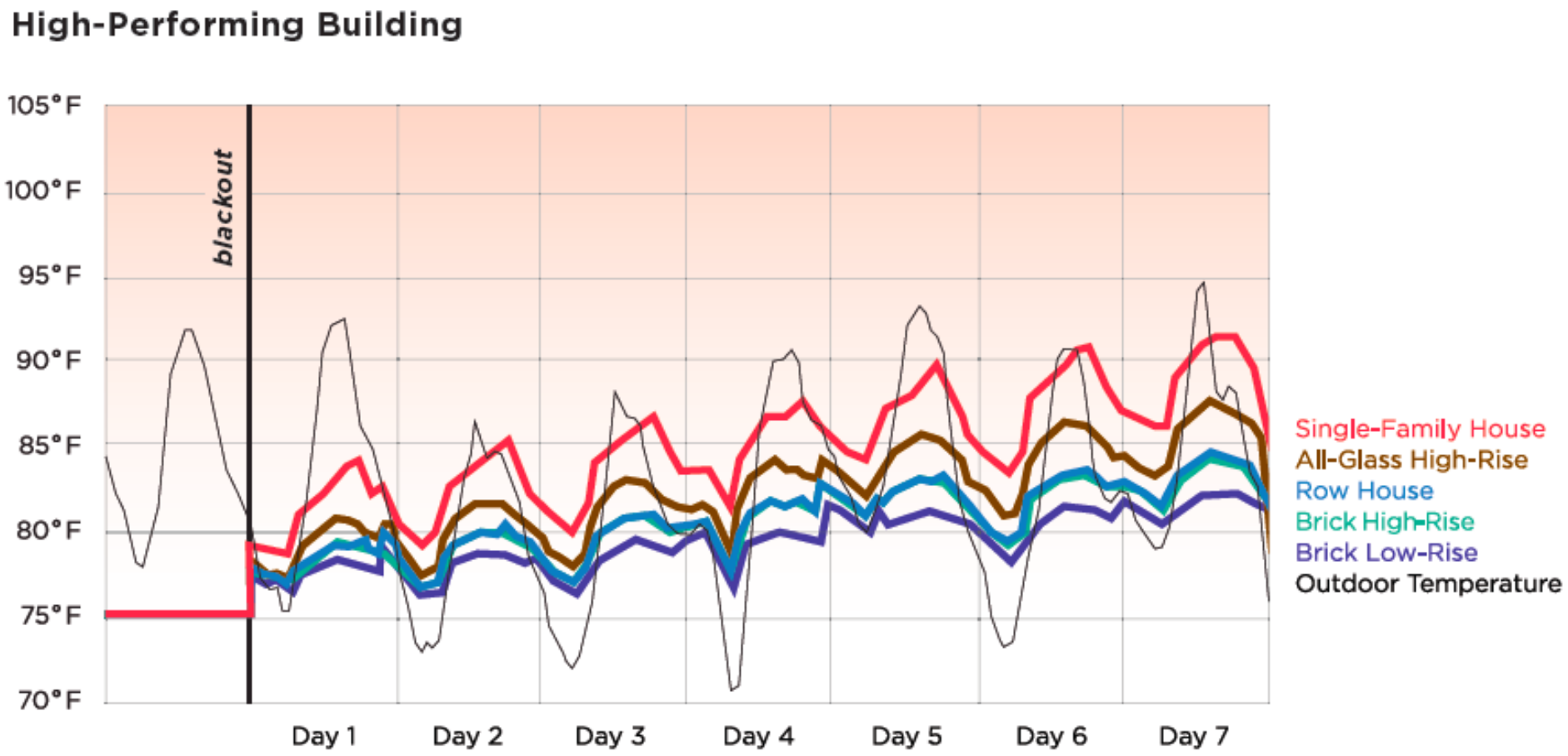


Temperature modeling: Atelier Ten, New York City in "Baby It's Cold Inside," Urban Green Council

High insulation levels – lots of options

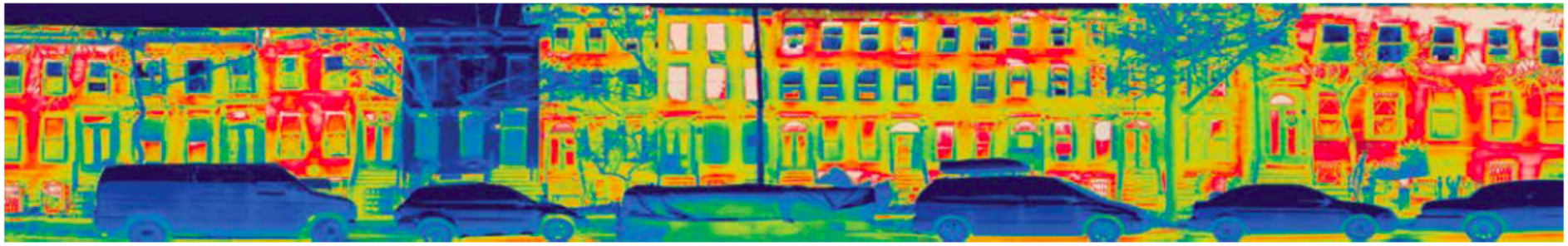
FoamGlas - photo: Alex Wilson

Cork insulation
photo: Alex Wilson

High insulation levels – lots of options

Johns Manville Spider spray fiberglass insulation – photos: A Wilson

Low-energy passive house will stay safe



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
- 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

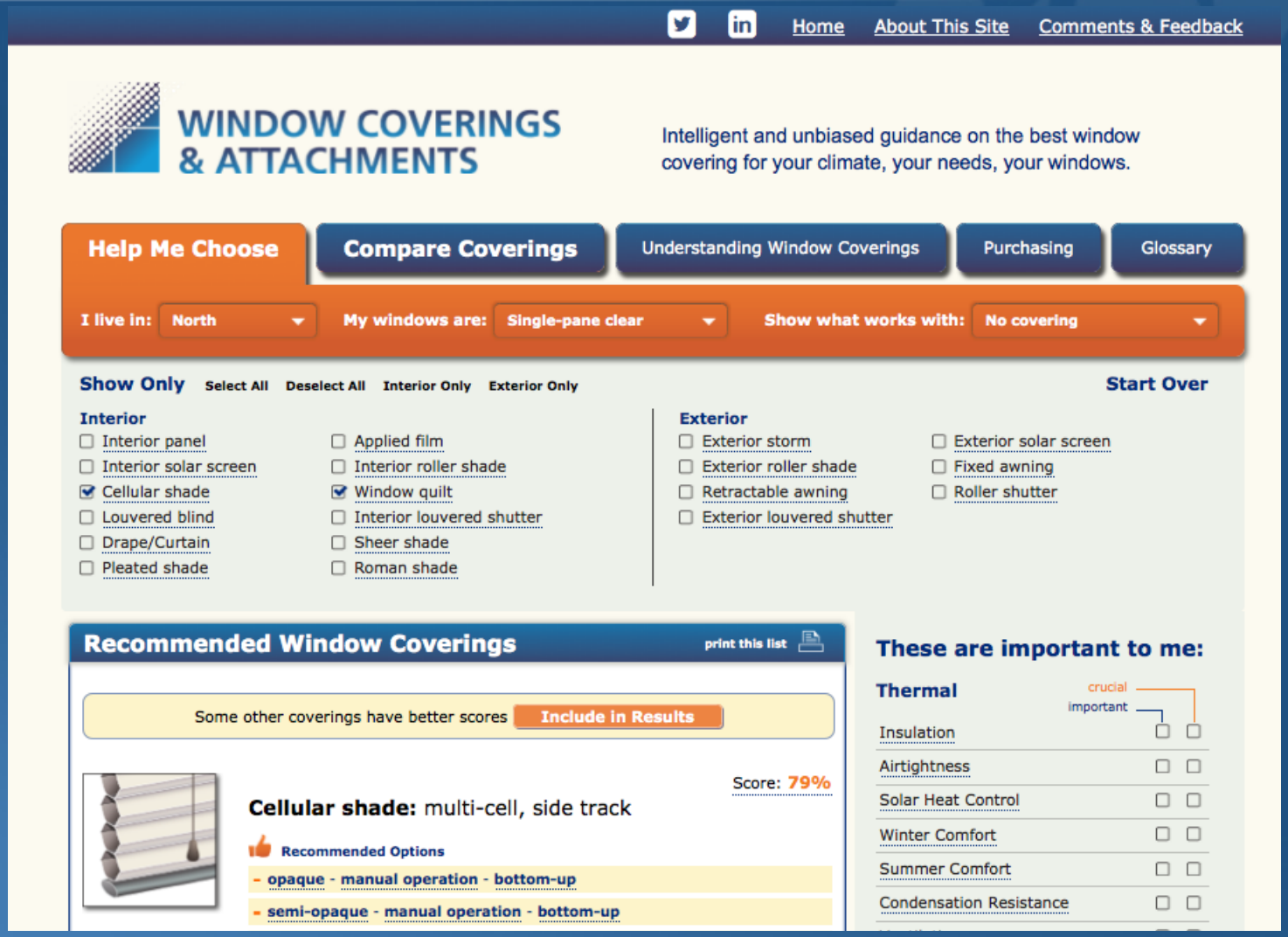
- Orient buildings on an east-west axis
- Less glass on east & west
- Sun-control glazing
- Exterior window treatments, awnings, roller blinds, overhangs
- Reflective roofs
- Deep overhangs or wrap-around porches
- Vernacular design
- Natural ventilation

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)

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

Less expensive option provides some access to solar power during outages

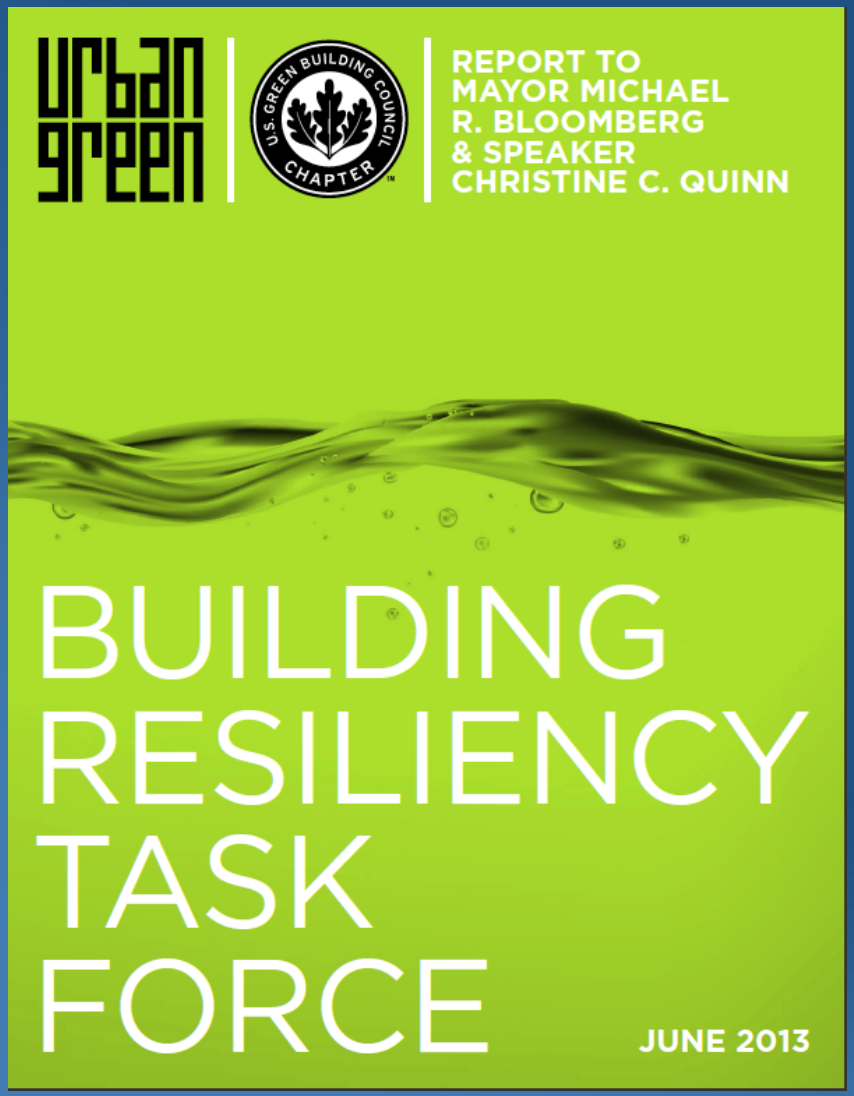
Photo: Alex Wilson

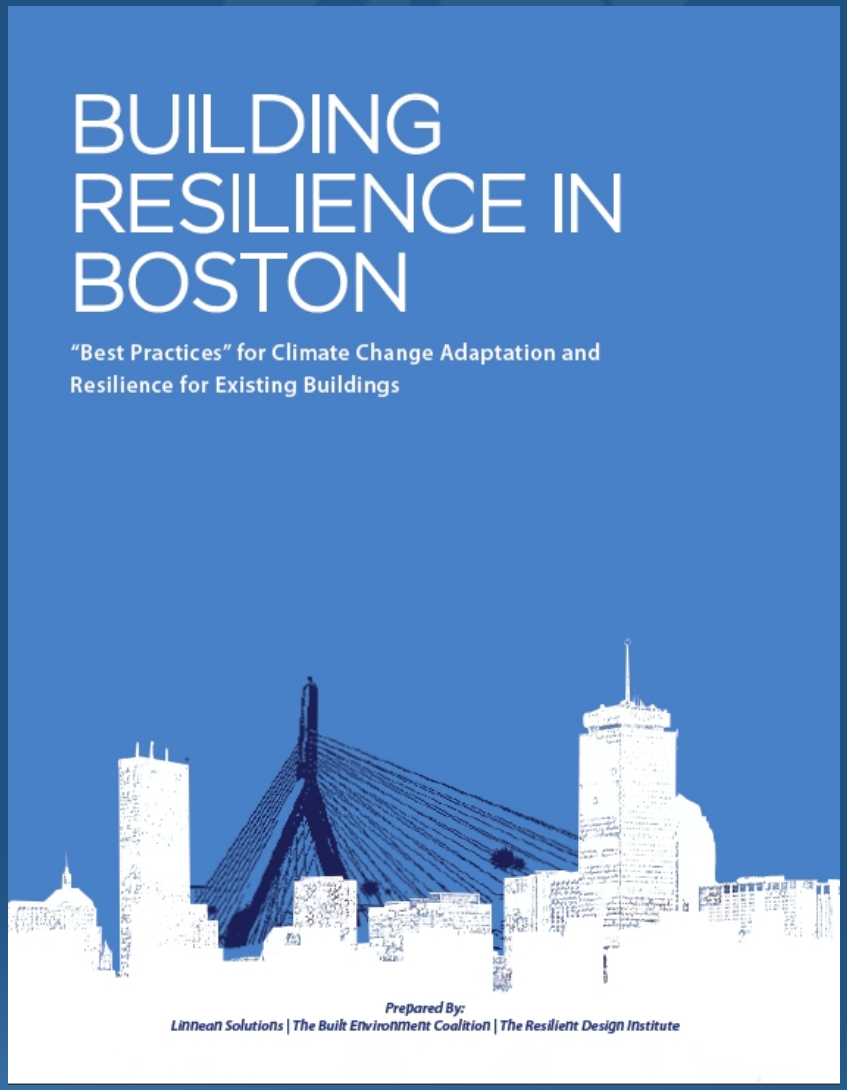
New SMA transformerless inverter

- 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

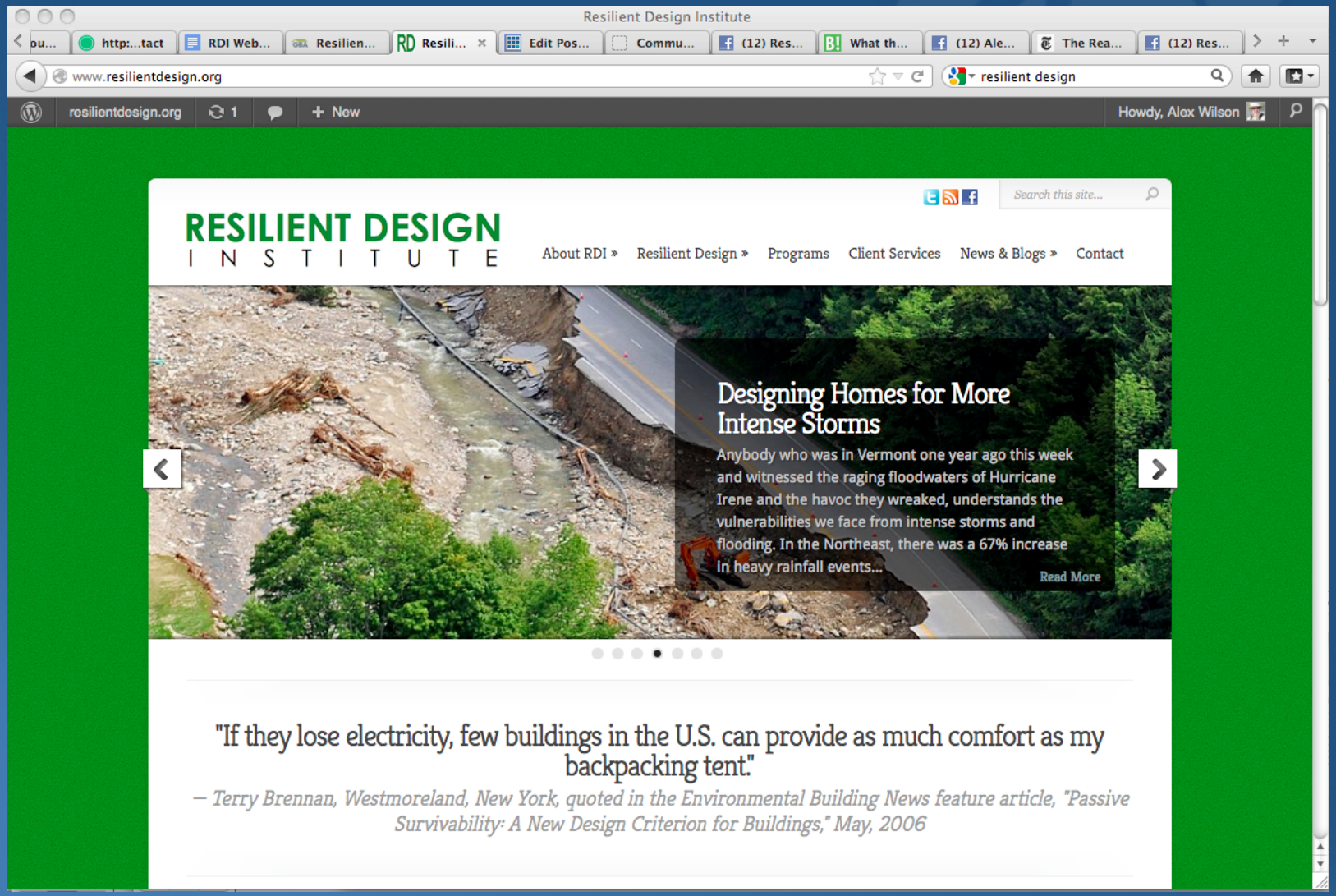
Photo: Alex Wilson

Resilience Reports





Resilient Design Institute
www.ResilientDesign.org



Thank you! - Questions?

Old Lyme, Connecticut - Alex Wilson photo