Resilient Design

Transitioning to the New Built Environment

Local Solutions:
Northeast Climate Change Preparedness Conference
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Eliakim’s Way, Martha’s Vineyard Massachusetts
photo: South Mountain Company
Superstorm Sandy

1998 Ice Storm

- 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

Hydro Quebec pylon - Drummondville, Quebec - January, 1998
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
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

- 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)

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

- 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
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
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*
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

Typical Building

Temperature modeling by Atelier Ten for the report “Baby It’s Cold Inside,” Urban Green, NYC
Drift temperatures

High-Performing Building

Temperature modeling by Atelier Ten for the report “Baby It’s Cold Inside,” Urban Green, NYC
Drift temperatures during outages - summer

Temperature modeling: Atelier Ten, New York City in “Baby It’s Cold Inside,” Urban Green Council
Drift temperatures during outages - summer

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

- 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

Passively cooled home in Tupelo, MS. Photo: E.L. Malveney
Cooling-load avoidance - shading

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

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

Delta H2Okinetics 1.5 gpm showerhead

Duet clothes washer and dryer from Whirlpool

Niagara Stealth 0.8 gpf vacuum-assist toilet
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!
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

BUILDING RESILIENCY TASK FORCE

JUNE 2013

BUILDING RESILIENCE IN BOSTON

“Best Practices” for Climate Change Adaptation and Resilience for Existing Buildings

Prepared by:
UItama SolarCats | The Built Environment Coalition | The Resilient Design Institute
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...

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

Thank you! - Questions?

Old Lyme, Connecticut - Alex Wilson photo