Resilient Design

Another Reason for Passive House

Passive House California
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Hurley/Kawahara Passive House, Santa Cruz, CA
Photo: Alex Wilson
Superstorm Sandy

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
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

- 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
Cascading impacts: gasoline shortages
Cascading impacts: gasoline shortages
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

- 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

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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 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*
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

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
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

- 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

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