Roofs that Carry Their Weight

Jean Ascoli, ARCHITECT, LEED® AP
SEDAC, Building Research Council
School of Architecture
University of Illinois at Urbana-Champaign
Why Talk About Roofs in the First Place?

The prime functions of a roof are to provide:

- Shelter
- Moisture Control
- Solar and Thermal Control
- Indoor Air Quality Control
- Security
- Fire Resistance
- Acoustics
- Cost Effectiveness
- Aesthetics

Adapted from the Whole Building Design Guide - www.wbdg.org
Why Talk About Roofs in the First Place?

Meanwhile we also use rooftops for:

- Mechanical Equipment
- Lightning Protection
- Communications Equipment
- Vents and Exhaust Fans
Why Talk About Roofs in the First Place?

Now we are beginning to expect roofs to provide:

- Enhanced Insulating Properties
- Daylighting
- Reduction in Urban Heat Island Effects
- Solar Shading to Building Façades
- Protection and Conservation of Water Resources
- Usable Outdoor Space
- Landscaping
- Hot Water Generation
- Energy Generation
Why Talk About Roofs in the First Place?

And on many projects we also want roof materials with:

- High Recycled Content
- High Recyclability or Reusability
- Low Embodied Energy
- Minimal Negative Environmental Impacts
Primary Roof Functions

A SUSTAINABLE ROOF =

WELL DESIGNED AND CONSTRUCTED

To provide:
- Shelter
- Moisture Control
- Solar and Thermal Control
- Indoor Air Quality Control
- Security
- Fire Resistance

- Acoustics
- Cost Effectiveness
- Aesthetics
Primary Roof Functions
Secondary Roof Functions

A SUSTAINABLE ROOF = WELL DESIGNED AND CONSTRUCTED

Considering the impacts of:
- Rooftop Mechanical Equipment
- Lightning Protection
- Communications Equipment
- Vents and Exhaust Fans
Secondary Roof Functions

Considerations
- Roof Penetrations
- Structural Capacity
- Air Tightness Issues
- Poor Energy Efficiency of Rooftop Mechanical Systems (80% max.)
Enhanced Roof Functions

A SUSTAINABLE ROOF = WELL DESIGNED AND CONSTRUCTED

To provide:
- Enhanced Insulating Properties
- Daylighting
- Reduction in Urban Heat Island Effects
- Solar Shading to Building Façades
- Protection and Conservation of Water Resources
Current ‘State of the State’ (Code)
- Insulate Roofs to at least R-20 continuous, Attics to R-30. Floors over unconditioned spaces to R-10 continuous, R-19 Joists Framing.

Current ‘State of the Art’ (Future Code)
- Insulate Roofs to at least R-30 continuous, Attics to R-40. Floors over unconditioned spaces to R-30.
- Highly Efficient ‘Passive’ Buildings will have values which exceed these.
Daylighting

Options
- Skylights
- Monitors
- Solar Tubes
- Translucent Roof

Considerations
- Net Energy Loss vs. Gain
- Maintenance
- Roof Penetrations
Reduction in Urban Heat Island Effects

Options

- Highly Reflective / Low Emissivity Roofing
- Green Roofs

Considerations

- Net Energy Loss vs. Gain
- Maintenance
Solar Shading to Building Façades

Options
- Deep Overhangs

Considerations
- Net Energy Loss vs. Gain
- Costs
- Aesthetics
Protection and Conservation of Water Resources

Options
- Green Roofs
- Filtering
- Grey Water Collection

Considerations
- Maintenance
- Costs
- Aesthetics
Enhanced Roof Functions

A SUSTAINABLE ROOF = WELL DESIGNED AND CONSTRUCTED

To provide:
- Usable Outdoor Space
- Landscaping
- Hot Water Generation
- Energy Generation
Usable Outdoor Space and Landscaping

Options
- Roof Gardens and Patios
- Rooftop ‘Rooms’

Considerations
- Structural Capacity
- Maintenance
- Costs
- Aesthetics
Hot Water Generation

- Solar thermal uses solar collectors to heat water.
- More economical than PV.
- Return on investment can be great.
- Used for:
  - Service hot water
  - Pools
  - Space heating:
    - Forced air
    - Radiant hot water
Service Hot Water System
Typical system $100 to $150/square foot (costs are for total system).

Examples:
- Residential system - $4,200 for 48 sf (80 gal)
- $6,100 for 96 sf (120 gal)
- Large laundromat - $150,000 for 1,440 sf
Hot Water Generation

Considerations
- Structural Capacity
- Maintenance
- Costs
- Aesthetics
Energy Generation – Solar PV

- **Solar resources:**
  - Better resources outside northeast of state.

- **Exposure:**
  - Panels should face south.
  - Tilt angle equal to latitude plus 10 degrees (Illinois latitudes - 37 to 42 degrees).
Cost per watt decreases with capacity.

- Typical range: $8 to $10 per watt:
  - Can be as low as $5/watt for the collectors.
  - Thin film costs less, but is less efficient.
  - New technology may be as low as $1.70/watt.

- Total installed costs:
  - $8-12 thousand/kW
Energy Generation – Solar PV

- Increased efficiency:
  - Recent breakthroughs reach 40%
  - Current cells around 8-19%
- Building integrated PV.
- Possible decrease in manufacturing cost.
Energy Generation – Solar PV

Considerations

- Space Required:
  - For a pitched roof – about 100sf/kW
  - For a flat roof – about 200sf/kW
- A typical system should generate about 1,200-1,300 kWh/kW of installed capacity.
- Payback is 15-30 years depending on incentives and upfront costs.

Other Considerations

- Structural Capacity
- Maintenance
- Aesthetics
As opposed to using slow and expensive high-vacuum based thin-film deposition processes, a proprietary ink allows simpler and higher-yield printing for depositing the solar cell’s semiconductor.

- A highly conductive, low-cost foil as a substrate avoids the need to separately deposit an expensive bottom electrode layer (as required for a non-conductive substrate such as glass).
- Uses high-yield continuous roll-to-roll processing.
- Achieves a lower-cost, high-performance top electrode.
- Cells are assembled by individually matching electrical characteristics.
- Panels are high-power, high-current with a lower balance-of-system cost.

Nanosolar SolarPly™
Energy Generation – Solar PV
Energy Generation – Rooftop Wind
Energy Generation – Rooftop Wind

- Horizontal axis most common.
- Vertical axis:
  - Increasing in popularity, but have lower efficiencies.
  - Rooftop potential.

Windterra Rooftop

Darrieus

Savoniu
Energy Generation – Rooftop Wind

- Horizontal axis most common.
- Vertical axis:
  - Increasing in popularity, but have lower efficiencies.

Considerations
- Structural Capacity
- Actual vs. Predicted Generation Data
- Noise
- Vibration
- Cost
- Maintenance
- Aesthetics

Not Ready for Prime Time?
Energy Generation – Funding

- Grants from the Illinois Clean Energy Community Foundation.
- Grants from state renewable energy programs.
- Tax incentives for those who pay taxes.
Sustainability of Materials

A SUSTAINABLE ROOF = WELL DESIGNED AND CONSTRUCTED

To include:
- High Recycled Content
- High Recyclability or Reusability
- Low Embodied Energy
- Minimal Negative Environmental Impacts
Sustainability of Materials

Considerations

- Cradle to cradle impact of material choices
- Avoid Persistent Chemical Pollutants (e.g. PVC Vinyl)
- Consider Total Life Cycle Embodied Energy
- Durability
The world is changing:

- High performance is the expectation.
- Energy efficiency is a key ingredient in high performance buildings.
- The costs of negative environmental impacts are being born by consumers.
- Beyond code is the price of entry to green design and high performance.
- Green design is going mainstream.
- USGBC, AIA and ASHRAE/IESNA are weighing in on the issues and changing expectations.
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Conclusions

- We have entered interesting times.
- Enhancing sustainability, including energy efficiency in existing buildings and utility systems is an imperative.
- New building and utility system designs have to be profoundly more sustainable and efficient.
- This is not going to go away.
Illinois Smart Energy
Design Assistance Center

Web site: www.sedac.org
Contact: info@sedac.org
1-800-214-7954