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The Earth Institute AT COLUMBIA UNIVERSITY

COLUMBIA 250

Green Roofs in the New York Metropolitan Region

New York Ecological Infrastructure Study (NYEIS)

Study Leaders: Cynthia Rosenzweig, NASA/Goddard Institute for Space Studies and Columbia University Center for Climate Systems Research
William D. Solecki, Hunter College -- City University of New York, Colin Cheney, Earth Pledge

Introduction

A green roof is a roofing assembly that allows for the dispersion of vegetation across all or part of a roof surface. Widespread adoption of green roofs as a roofing technology can potentially address multiple environmental and human health problems in New York City including the urban heat island effect, global climate change, and stormwater runoff. The type of green roof that our research has focused on is lightweight, thin(4 – 6" growing medium), and planted with hardy, drought-resistant plants to minimize weight, cost, and maintenance. This type of green roof is generally referred to as "extensive." (Exhibits A, B, C and D)

Exhibit C. Hamilton Apts., Portland OR (Source: Env. Services City of Portland Brochure)

Exhibit B. Layers of a green roof

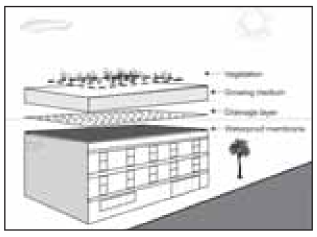

Exhibit A. Chicago City Hall (Source: Dunnett and Kingsbury, Planting Green Roofs and Living Walls, 2004)

Exhibit D. Type of vegetation generally planted on green roofs

a) Sedum Fuldaglut *b) Sedum Weihen-stephaner Gold*

c) Sedum Spurium *d) Sedum Lidekense*

Green Roof Research Station

A central component of the NYEIS work is the development of a rooftop research station to collect data about green roof performance in New York City and to validate energy and hydrology models. A research roof would also provide a range of possibilities for science and social science research in the coming years, as well as community outreach and education. (Exhibit E)

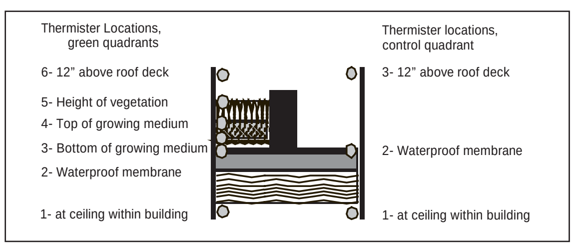

Exhibit E. Green Roof Research Station, temperature monitoring points.

Costs and Benefits

The cost-benefit analysis is divided into two tiers. Tier I includes the benefits and costs of green roofs covered by NYEIS active research and expertise. The analysis indicates that green roofs may not be cost effective at the individual building level, but green roof infrastructure is cost effective when the full range of benefits is considered. (Exhibits F and G)

Private (Building-Level)	Public (City-Level)
Tier I Benefits	
Increased service life for roof membrane	Reduced stormwater runoff expenditures
Reduced energy use for cooling	Reduced urban heat island
Tier II Benefits	
Sound insulation	Improved air quality
Food Production	Reduced greenhouse gas emissions
Aesthetic value	Improved public health
	Aesthetic Value
Costs	
Net cost of green roof	Program administration and setup
Maintenance costs	

Exhibit F. Private and public benefits and costs of green roofs

Scenario	Performance Scenario		
Tier I	Low	Medium	High
Benefit-Cost Ratio Tier I, Private	0.34	0.46	1.31
Benefit-Cost Ratio Tier I, Private & Public	0.53	0.65	1.57
Tier II	Low	Medium	High
Benefit-Cost Ratio Tier I & II, Private	0.38	0.54	1.85
Benefit-Cost Ratio Tier I & II, Private & Public	0.66	1.02	3.87

Exhibit G. Preliminary cost-benefit analysis results for 50% green roof scenario Tier I (areas of NYEIS active research and expertise) and Tier II (additional potential benefits and costs of green roofs in New York City).

Green Roof Policy for New York City

In order to evaluate the rationale and form of government support for green roofs in the New York metro region, the following strategic outline should be followed:

1. Education of policymakers and government officials on benefits of individual green roofs, including recognition of other municipal implementation and support structure;
2. Financing of demonstration project for public education and scientific testing;
3. Removal of existing barriers in building and zoning codes, and modification of stormwater laws and energy ordinances, allowing for streamlined construction of green roofs; Drafting and review of regulatory measures, subsidies, zoning bonuses, tax incentives, and sewer rate reduction appropriate to New York metro region conditions and needs, based on thorough evaluation of building and infrastructure level benefits.

Conclusion

Green roof infrastructure could be a cost-effective way to help solve some of New York City's environmental and human health problems, when multiple private and public benefits are considered together. In North America, green roofs are still a relatively new ecological infrastructure. Therefore, New York City has an opportunity to be a trend-setter in the green roof arena. The New York Ecological Infrastructure Study (NYEIS) is a multidisciplinary research project investigating the potential of green roofs to address multiple environmental and human health problems in New York City. This work was done as part of the New York Ecological Infrastructure Study (NYEIS), a multidisciplinary research project investigating the potential of green roofs to address multiple environmental and human health problems in New York City.

Key Findings

Energy

By cooling the surface of a roof, green roofs can help the region prepare to adapt to global warming, and potentially reduce energy usage, fossil fuel consumption, and greenhouse gas emissions, the cause of global warming.

On average, surface temperatures in July 2003 were 34oF (19°C) higher on the standard roofs during the day and 14°F (8°C) lower at night (Exhibit H).

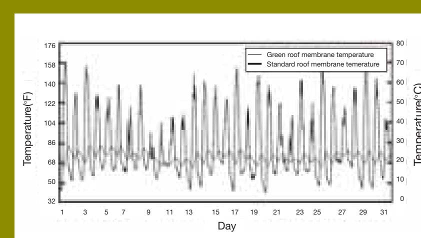

Exhibit H. Average surface temperature on green roofs and standard roofs at Penn State research roofs. (Data provided by Dr. David Beattie)

Urban Heat Island

By providing a vegetated surface, green roofs may reduce outdoor air temperature and the urban heat island effect through evapotranspiration, shading, and increased albedo.

A 50% extensive green roof scenario reduced New York City's average surface temperature by 0.1 – 1.4°F (<0.1 – 0.8°C) (Exhibit I).

Exhibit I. Thermal map of surface temperature in the New York Metropolitan Region. Landsat ETM 7, August 14 2002, 10:30 AM, Band 6

Hydrology

By retaining (and evaporating) and delaying runoff, green roofs can reduce combined stormwater-sewage overflows (CSOs).

Analysis of Penn State data showed that green roofs captured 80% of rainfall during rainstorms, compared to 24% for standard roofs

Simulation of green roof rainfall retention using a simple box model and data from LaGuardia airport showed that a runoff could be reduced by up to 10% at the sewage-shed scale, with a 50% green roof infrastructure scenario.

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