GREEN ROOFS

A Resource Manual for Municipal Policy Makers

Canada

CMHC SCHL
HOME TO CANADIANS

CMHC—HOME TO CANADIANS

Canada Mortgage and Housing Corporation (CMHC) has been Canada's national housing agency for over 60 years.

Together with other housing stakeholders, we help ensure that Canada maintains one of the best housing systems in the world. We are committed to helping Canadians access a wide choice of quality, affordable homes, while making vibrant, healthy communities and cities a reality across the country.

For more information, visit our website at www.cmhc.ca

You can also reach us by phone at 1-800-668-2642 or by fax at 1-800-245-9274.
Outside Canada call 613-748-2003 or fax to 613-748-2016.

Canada Mortgage and Housing Corporation supports the Government of Canada policy on access to information for people with disabilities. If you wish to obtain this publication in alternative formats, call 1 800 668-2642.

Green Roofs
A Resource Manual for Municipal Policy Makers

Authors

Gail Lawlor
Beth Anne Currie
Hitesh Doshi
Ireen Wieditz

May 2006

Library and Archives Canada Cataloguing in Publication
Green roofs : a resource manual for municipal policy makers / Gail Lawlor... [et al.].

(Research report)
Issued also in French under title: Toits verts.
ISBN 0-662-44084-6
Cat. no.: NH18-26/4-2006E

1. Green roofs (Gardening)—Canada. 2. Green roofs (Gardening)—United States. 3. Green roofs (Gardening). 4. City planning—Environmental aspects—Canada--Case studies. 5. City planning--Environmental aspects—United States--Case studies. 6. City planning—Environmental aspects-—Case studies. I. Lawlor, Gail II. Canada Mortgage and Housing Corporation III. Series: Research report (Canada Mortgage and Housing Corporation)

SB419.5.G73 2006 635.9'671 C2006-980224-6

Printed in Canada
Produced by CMHC

Advisory Committee

Region	Name	Contact Information
West (B.C.)	Dale Mikklesen	City of Vancouver 604-871-6168 dale.mikklesen@vancouver.ca
West (Alta.)	Kerry Ross	Studio T Design 403-220-0542 kr.st@shaw.ca
West (Man.)	Rodney McDonald	McDonald and Hardess Sustainability Group Inc. 204-478-0598 rmcdonald@mhsg.ca
Central (Ont.)	Karen Moyer	City of Waterloo 519-747-8609 kmoyer@city.waterloo.on.ca
Central (Ont.)	Jane Welsh	City of Toronto 416-392-9709 jwelsh@toronto.ca
Central (Que.)	Owen Rose	Urban Ecology Centre, Montreal 514-522-6936 owen.rose@mail.mcgill.ca
	Véronique Jampierre	Vivre en Ville vjampierre@vivreenville.org
East (N.S.)	Kendall Taylor	Kendall Taylor Architect 902-441–4329 ktaylorarchitect@eastlink.ca

EXECUTIVE SUMMARY

This *Manual* is an overview of international and Canadian green roof policies and programs. By reviewing the reasons municipalities throughout the world have set green roof policies and program, policy makers can better determine which policies suit their needs.

European jurisdictions have long used green roof technology for stormwater management, to reduce energy use in buildings and to increase amenity space. Green roofs are gaining acceptance throughout North America as knowledge of the environmental benefits and as the technology for green roofs improves.

In Europe, intensively competitive market forces are driving development of green roof technology. These forces include years of accumulated research on membrane technology, roof design and plant performance. Social ideals in Europe that value environmental protection and increasing green space in urban areas also drive development of green roof technology.

Canada does not have the same social conditions and market forces as Europe, but Europe's experience has lessons for Canadian municipalities considering green roof policies and programs. This *Manual* gives examples of North American and world green roof policies and programs. From the examples, policy makers may find a good fit for their situations.

Green roof policies and programs are most often one feature of wide-ranging policies and programs that promote more green space in dense urban areas and propose alternatives to standard stormwater infrastructure.

RESEARCH PROGRAM

This *Manual* features 12 jurisdictions that demonstrate leadership in green roof policy development. These jurisdictions have successfully established supportive programs and succeeded in significantly advancing the green roof movement in their communities.

Discussion of 13 additional jurisdictions with less-developed green roof policies also has useful insights and benchmarks to give a more complete picture of green roof development. Understanding the driving influences behind the widespread application of green roofs is the key to developing programs supporting the technology.

An advisory committee made up of representatives from across Canada guided the *Manual's* research team. The committee was essential in selecting the example jurisdictions and advised on the content of each case study.

The advisory committee and the research team picked the 12 jurisdictions because of the maturity and type of their green roof policies or programs, key motivators and their success in promoting green roofs.

<table>
<tr><th colspan="3">The Manual features the following municipalities:</th></tr>
<tr><th>Canada</th><th>United States</th><th>International</th></tr>
<tr><td>Montréal</td><td>Chicago, Ill.</td><td>Basel-City, Switzerland</td></tr>
<tr><td>Toronto</td><td>New York</td><td>Münster, Germany</td></tr>
<tr><td>Vancouver</td><td>Portland, Ore.</td><td>Singapore</td></tr>
<tr><td>Waterloo</td><td rowspan="2">Minneapolis-
St. Paul, Minn.</td><td>Stuttgart, Germany</td></tr>
<tr><td>Calgary</td><td>Tokyo, Japan</td></tr>
<tr><td>Halifax</td><td>Pittsburgh, Penn.</td><td>Berlin, Germany</td></tr>
<tr><td>Ottawa</td><td>Seattle, Wash.</td><td>London, U.K.</td></tr>
<tr><td>Winnipeg</td><td rowspan="2">Washington, D.C. and
Chesapeake Bay area</td><td rowspan="2">North-Rhine, Westphalia,
Germany</td></tr>
<tr><td>Québec City</td></tr>
</table>

Green roof policy and programs in each municipality are unique to the local climate, political position, environmental motivators and resource capacity. To capture the different approaches and diverse nature of green roof programs, the following headings highlight activities in the selected jurisdictions:

- Description of jurisdiction
- Key motivators
- Green roof policy
- Process to establish policy
- Effectiveness
- Lessons learned
- Future predictions
- Applicability to Canada of international jurisdictions

The key motivators are the need to:

- Control stormwater runoff
- Reduce urban heat-island effect
- Lower building energy consumption
- Reduce air pollution

- Increase green amenity space
- Maintain biodiversity
- Reduce escalating infrastructure costs.

The *Manual* outlines six phases in setting appropriate green roof policies and programs:

- Introductory and awareness
- Community engagement
- Action plan development and implementation
- Technical research
- Program and policy development
- Continuous improvement

Municipalities can use many tools and incentives to encourage implementation of green roofs and stimulate the local market. They include:

- Education and champions
- Indirect financial incentives
- Direct financial incentives
- Regulatory measures
- Performance rating systems
- Building codes and regulations

CONTENTS

PART 1 — INTRODUCTION TO GREEN ROOFS

This section of the *Manual* is a general description of green roof technology, key motivators, policy phases, incentive tools and building codes.

What is a green roof?

In this *Manual*, a green roof is a conventional flat or sloped roof amended with some or all of the following layers or elements:

- structural support
- vapour control
- thermal insulation
- a waterproofing membrane
- a roof drainage layer
- a root-protection layer
- synthetic planting media
- hardy, drought-resistant plants.

As Figure 1 shows, designers or building owners may adjust or enhance green roof layers based on their vision and guiding principles.

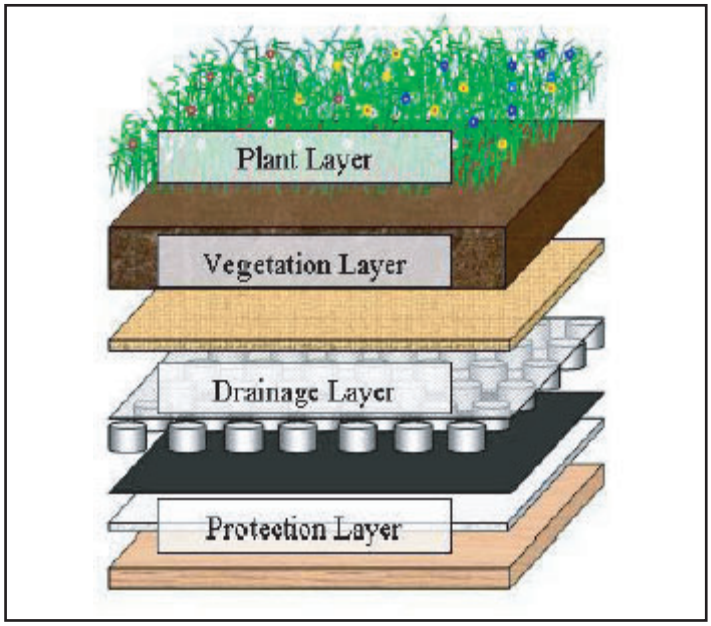


Figure 1 Green roof layers[1]

Green roof terminology

"Extensive" and "intensive" are the two main terms describing green roof design. These terms describe differences in construction, design and costs. Extensive green roofs, which have a thin growing medium, are the most typical.

Extensive green roofs use a substrate depth ranging between 5 and 15 cm (1.97 and 5.91 in.) and weigh between 72.6 and 169.4 kg/m^2 (160.06 and 373.46 lb./sq. ft.). This shallow planting media (low-weight, soil-less) helps minimize costs and the total structural load. These low-weight synthetic planting media, combined with the challenging winds, drought and high-temperature microclimates on an elevated surface, make hardy, low-height, drought-resistant plant species necessary.

Comparatively less maintenance is needed to install and maintain an extensive green roof; however, the success of any roof is measured by the survival of the plants. Ongoing plant and substrate research is contributing to green roof success across North America.

Intensive green roofs can be designed for unique and esthetic amenity or recreational space, including public access. Intensive green roofs feature deeper planting media, irrigation systems, complex landscaping features and a broad range of plant species. They can support large plant species such as trees, shrubs, ponds, waterfalls and other decorative features. Engineered roof surfaces that can accept heavier weights support the deeper growing media of intensive green roofs. Intensive green roof retrofits may require roof structure upgrades. They may also cost more for materials, labour, design features and heavy equipment, such as overhead cranes to get materials to the roof.

KEY MOTIVATORS FOR GREEN ROOFS

Key motivators are factors that lead communities to consider green roofs as an effective way to reduce pollution and to reduce the effects of dense urbanization.

Key motivators include:

- stormwater runoff affecting drinking water and habitat in local rivers and lakes
- increased impervious surface areas and urban heat island effect
- energy demand in commercial and residential buildings;
- deteriorating air quality
- lack of green space for social and recreational use
- increasing loss of biodiversity.

[1] Moran, A., Hunt, B. & Jennings, G. (2003). *A North Carolina Field Study to Evaluate Green Roof Runoff Quantity, Runoff Quality and Plant Growth*. St. Joseph, Michigan: ASAE (American Society of Agricultural Engineers) and Currie, B.A. (2005) *Air Pollution Mitigation with Green Roofs Using the UFORE Model*. Unpublished MASc. thesis, Ryerson University, Toronto

Stormwater management

Impervious surfaces—concrete sidewalks, paved parking lots, streets and highways, building walls and conventional roofs—dominate urban landscapes. These impervious surfaces direct stormwater into storm gutters, sewers and engineered channels.

Some older urban areas still have aging combined storm and sewage infrastructure. In these areas, the sewers reach maximum capacity more quickly and discharge runoff water mixed with untreated sewage directly into receiving lakes and rivers. Runoff reaches these receiving waters in uncontrolled surges that destroy natural habitats and deposit contaminants, such as suspended solids, heavy metals, chlorides, oils and grease, into local waterways.

Stormwater management is a concern for municipalities everywhere and they are looking at green roofs as an alternative to costly infrastructure. Vancouver, Toronto, Waterloo, Portland and several cities in Germany are examples of municipalities concerned about stormwater management.

Urban heat island effect

The most frequently documented climatic effect of urbanization is the difference in surface and air temperatures between urban and surrounding rural areas.

Dense urban areas can cause temperature increases as high as 10°C (50°F). This heat results from modifications to surface areas, such as increased use of asphalt and concrete, coupled with the atmospheric changes caused by motor vehicles.

The hard, heat-absorbent surfaces of cities retain more heat than areas with more vegetation and plant life. This "heat island" phenomenon is the result of ground-level air temperature being much higher than in surrounding rural areas, where the vegetation and plant life cool the air through moisture retention and subsequent evaporation and transpiration through their leaves. New York and Chicago are both particularly concerned with urban heat island effect.

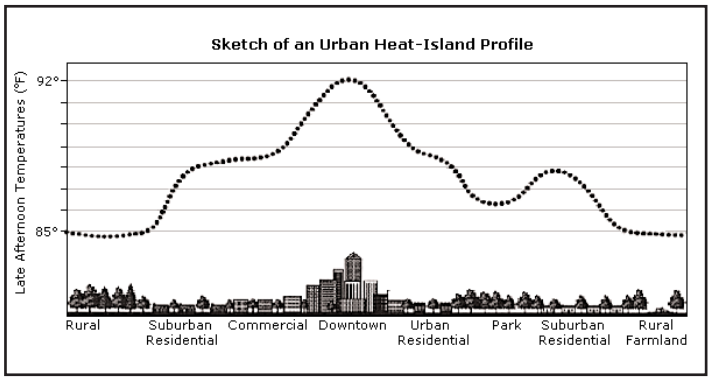


Figure 2 Rural and urban area heat characteristics
Source: http://www.epa.gov/heatisland/about/index.html

Energy demand

Recent green roof research [2] in Canada supports European findings that green roofs (coupled with insulation) reduce overall building energy demand. The insulating effect of a green roof also reduces the penetration of ultraviolet energy in summer. Together, these effects prolong the life of the roofing membrane. Green roofs, though, may be less effective at preventing the escape of heat in the winter.

Nonetheless, the greater energy savings in the summer are significant. The savings are the result of the cooling effects of evapo-transpiration within the plants and the evaporation of retained moisture from the soil. Since climatic conditions and architectural standards vary across Canada, research results must be interpreted in terms of where the study was undertaken and how relevant they are to that particular area.

Air pollution

Air pollution is a trans-boundary issue. Pollution is worse in hot summer conditions and exacerbates pre-existing health concerns for both young and the elderly. Local solutions to air quality concerns include anti-idling bylaws, smog summits, improved urban transit systems, bio-diesel for city vehicle fleets, hybrid vehicles and phasing out coal-fired electricity plants.

Among the solutions is restoration of biological systems that help reduce airborne contaminants, such as more urban trees, shrubs and green roofs. Singapore and Toronto, two of this *Manual's* example municipalities, have primary research quantifying the effect of green roofs on air pollution.

[2] Bass, B., Stull, A., Krayenhoff, S., & Martilli, R.B. (2002). Modeling the Impact of Green Roof Infra-structure on the Urban Heat Island in Toronto. The Green Roof Infrastructure Monitor. 4 (1).
Bass, B., Krayenhoff, S., Martilli, A., Stull, R.B. & Auld, H. (2003, May). The Impact of Green Roofs on Toronto's Urban Heat Island. Presented at the Greening Roofs for Sustainable Communities Conference, Chicago, Ill.
Liu, K. & Baskaran, B. (2003, May). Thermal Performance of Green Roofs through Field Evaluation. Presented at the Greening Rooftops for Sustainable Communities Conference, Chicago, Ill.
Liu, K. & Minor, J. (2005, May). Performance Evaluation of an Extensive Green Roof. Presented at the Greening Rooftops for Sustainable Communities Conference, Washington, D.C.

Amenity space

Many urban buildings stand on busy streets and transportation routes and have little access to green space. Green roofs provide a measurable psychological benefit to urban dwellers by adding tangible, accessible, natural space for social interaction, recreation and relaxation.

A green roof offers building occupants proximity to green common spaces. Residential condominium developers are starting to realize positive economic benefits from green roofs as the rate of occupancy, the index of satisfaction and the overall positive experience from green roofs become brisk sales and longer tenancies. Green roofs have been shown to provide positive amenity space in Singapore, Vancouver, Toronto and Ottawa.

Biodiversity

The expansion of urban spaces and built form has led to habitat loss and fragmentation for many animal species. Green roofs can provide suitable habitat and refuge space for many bird and invertebrate species in urban areas. Green rooftops can be designed to play two key roles: they can be a "stepping stone habitat," connecting natural isolated habitat pockets with each other, or an "island habitat" that is separate from habitats at grade for less mobile species. Because roofscapes make up 15 to 35 per cent of the urban footprint, they have great potential to mitigate lost biodiversity. Basel, Switzerland and London, England have successfully used green roofs for beneficial habitat for bird and invertebrate species.

Phases become successively more time- and resource-intensive. Phase 6 involves improving current programs, usually because new challenges arise or current programs are not successful. This typically involves revisiting Phase 4 to conduct further research or revisiting Phase 5 to develop new programs better suited to current challenges.

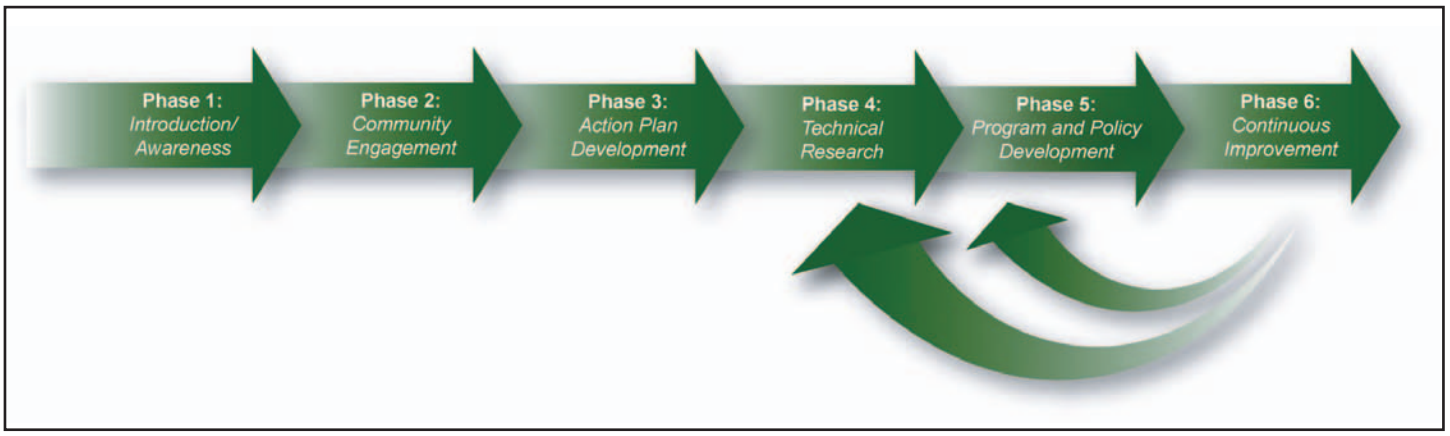


Figure 3 The six phases in developing green roof policies and programs

GREEN ROOF POLICY DEVELOPMENT

There are six phases in establishing a green roof policy. This *Manual* discusses jurisdictions that represent each phase in more detail in later sections. The policy phases this *Manual* describes are not rigid classifications. Jurisdictions may be at different phases at the same time and they may return to an earlier phase if they need to.

Phase 1: Introductory and awareness

In this phase, a jurisdiction looks at the merits and environmental benefits of green roofs. The municipality may hold a green roof workshop, send delegates to a green roof conference or visit a jurisdiction with existing green roofs or a green roof policy.

Green Roofs for Healthy Cities (greenroofs.org[3]) has been key in helping North American municipalities organize green roof workshops to bring local stakeholders together. In this phase, a local champion is usually declared who may act as a spokesperson for the jurisdiction. Winnipeg and Ottawa are examples of municipalities in this phase. (www.Greenroofs.com[4] has a comprehensive overview of green roof technology).

Phase 2: Community engagement

A local champion or a green roof committee may seek any number of creative methods to raise the profile of green roofs. There may be meetings with community leaders, mayors, architects, landscaping professionals, building owners and environmental groups to gain support for green roofs. Funding sources, such as government programs, utilities or green roof manufacturers, will be explored and negotiated.

The champion or committee will outline the opportunities, threats, strengths and weaknesses of green roof development in the municipality. An extremely harsh climate is a potential threat; a large number of flat roofs are an opportunity. Halifax and Calgary are in phase 2 and are nearing phase 3, with plans for green roof demonstration sites and research.

Phase 3: Action plan development and implementation

The municipality or the community may establish a green roof advisory or working committee made up of key community leaders. A green roof demonstration project may be launched with or without scientific monitoring equipment, depending on the need for local research data. Green roof tours and ongoing planning meetings often include site visits to buildings with different types and designs of green roofs, leading to the establishment of a green roof database or inventory. A review of existing policy options and tools may be explored in this phase and various programs and policy opportunities identified. Minneapolis-St.Paul, in Minnesota, is an example of a municipality in this phase.

Phase 4: Technical research

The local green roof advisory committee or the local champion(s), or both, along with a possible consortium of public-private partnerships set up a research site. In some cases, the technical research is demonstration projects or green roof installations on prominent site, such as the green roofs on the Toronto and Chicago city halls. A jurisdiction exploring green roofs as a step in setting green roof policy needs local research data with outcomes that can be applied to any or all of the key motivators prioritized in the jurisdiction. The National Research Council of Canada (NRC) has provided technical assistance to many research projects.

In the technical phase, researchers investigate and quantify the benefits of green roofs, which will become part of green roof policy and design guidelines. Research typically involves assessing the ability of green roofs to manage stormwater, mitigate the urban heat island, or provide other necessary environmental benefits. Typically, jurisdictions with monitored demonstration sites collect and prepare findings for conference proceedings, which are shared at international green roof conferences. Sharing data and research findings is an important part of the technical research phase. Toronto, Waterloo, Vancouver, Montréal and New York are examples of municipalities in this phase.

Phase 5: Program and policy development

The green roof advisory committee may expand to include more professionals, such as landscape designers, horticulturalists, designers and municipal urban planners. This phase translates local and regional research into policy options and tools. This involves establishing ways of offering incentives to contractors, developers and building owners to retrofit or plan new buildings with green roofs. This can include financial incentives, tax credits or density bonuses. Chicago, Portland and Singapore are in this phase.

Phase 6: Continuous improvement

At this phase, a jurisdiction has achieved maturity and familiarity with green roof technology. Now, the jurisdiction assesses the effectiveness of policies and programs and decides whether to continue on the same path or explore other policy options.

To gather information and assess program success, there must be a mechanism to collect and analyze constructive feedback from users, professionals and the building community. Phase 6 typically involves exploring other policy options or further research to fine-tune existing programs.

One German jurisdiction had to include policy language requiring maintenance of green roofs for a specified period, as some owners neglected their green roofs and the roofs did not achieve their expected environmental goals. The German cities of Stuttgart, Münster and Berlin and the state of North Rhine Westphalia are in this phase.

[3] Retrieved November, 2005. English only.
[4] Retrieved November, 2005. English only.

Jurisdiction	Phase 1 Introductory	Phase 2 Community engagement	Phase 3 Action plan and implementation	Phase 4 Technical research	Phase 5 Program and policy development	Phase 6 Continuous improvement
Montréal	Done	Started in the last year	Demonstration roofs	Ongoing for several years at university level. Field monitoring starting soon	Very initial stages	Not there yet
Toronto	Done	Started in 2001	Demonstration and research projects (university and community) and a proliferation of green roofs across city	Technical data supporting conference papers/ proceedings since 2003; partnerships with Environment Canada/NRC ongoing; Cost-benefit analysis 2005	Predicted for 2005	Not there yet
Vancouver	Done	Started in 2001	Stormwater management planning for GVRD includes green roofs	B.C. Institute of Technology launched the first Canadian green roof research centre in 2004	Each municipality considering program/policy options for 2006	Not there yet
Waterloo	Done	Well underway for a few years	Green Roof Feasibility Study complete	Demonstration project with research component has begun	Initial stages	Not there yet
Chicago	Done	Started in 2001	Demonstration project on Chicago City Hall and the Centre for Technology	Proliferation of green roofs across the city; technical data supporting conference proceedings; mayor is local champion; proliferation of green roof technology in the State	Programs support stormwater mitigation, public education and municipal incentives offered at the building permit level	Not there yet
New York	Done	Well underway for few years	Demonstration roofs	Significant primary research completed including cost-benefit analysis	Very initial stages	Not there yet
Portland	Well past	Well past	Many plans implemented	Significant technical research related to stormwater benefits done	Well underway	Started

continued on next page

Jurisdiction	Phase 1 Introductory	Phase 2 Community engagement	Phase 3 Action plan and implementation	Phase 4 Technical research	Phase 5 Program and policy development	Phase 6 Continuous improvement
Basel	Well past	Well past	Well past	Significant amount of research on biodiversity	Incentive program in 1996–97. Another program planned for 2005–06. Required for all flat roofs	Looking into quality control measures
Münster	Well past	Well past	Well past	No evidence	Had various incentive programs (now defunct). Stormwater fee. State-level incentive program	Not mentioned
Singapore	Well past	No evidence found	Well into it	Significant technical research related to life cycle costing and energy benefits done	In place	Underway
Stuttgart	Well past	Well past	Well past	No evidence	Financial incentive program. Regulated in local development plans	Looking into quality control and inspection measures
Tokyo	No evidence	Not much evidence	Well into it	Some research completed and no evidence anything ongoing	In place and being extended to beyond Tokyo and at country level	Started

Table 1 Policy phases of selected jurisdictions

TOOLS TO ENCOURAGE GREEN ROOFS

There are a number of incentives and tools to encourage implementation of green roofs. These vary in financial, time and administrative commitment.

Indirect financial incentives

Indirect incentives recognize green roofs as one environmental tool among many. The tools range from improving the energy efficiency of a building to Münster's tax for stormwater disposal. In Munster, installing a green roof along with other stormwater source controls reduces the amount of tax paid, which gives building owners an indirect financial incentive to install a green roof. The Ontario municipality of Waterloo is considering a reduced stormwater utility fee for buildings with green roofs.

Direct financial incentives

Direct financial incentive programs cover some building costs for green roofs. There are usually specific conditions, verified in an application process, to qualify for the funding. The conditions can include minimum water-retention capacity, growing-medium thickness and a contract binding the building owner to regular maintenance of the green roof.

Cities in Germany, Belgium and the province of Quebec have direct financial incentive programs running from three to 20 years.

Other financial incentives, such as tax credits, fee waivers and density bonuses, do not require substantial financial investment.

For example, a municipality can waive all or part of the development charges for buildings designed with green roofs. Municipalities can also waive fees for official plan and zoning bylaw amendments, consents, development agreements, minor variances and building permits for buildings designed with green roofs.

Density bonuses are another tool. The municipality allows floor space or building height beyond zoning bylaw regulations if there are resulting community benefits.

In Portland the "ecoroof" (or green roof), floor area ratio (FAR) bonus is expected to provide additional development potential. This additional potential can be anywhere from one square foot to three square feet of additional development for one square foot of green roof. Portland now applies the bonus to targeted areas, mainly in the city's central district.

Regulatory measures

Compulsory green roof installation can ensure that a specific geographic area or urban space roofscape is greened. Regulatory measures can achieve specific and sustainable urban goals such as improvements in air quality, urban heat island effect, stormwater management and amenity space.

Regulatory measures can also set minimum properties for the green roof, such as growing medium thickness or types of plants used. This approach has been widely used in Germany. The following is a regulation from a German municipality:

> All buildings with flat and sloping roofs up to an incline of 15 degrees are to be permanently greened with ground-covering plants. Areas of vegetative decline greater than and equal to five m^2 are to be replanted. Roofs with a total area less than 10 m^2 are exempt from this rule, however, must be kept in good state. Growing medium depths must be at least eight to 10 cm in depth and plants, seeds, or sprouts must be indigenous to the area. [5]

Municipalities can also mandate compulsory roof greening for public buildings. Stuttgart sets aside funds every year to green the roofs of public buildings. These roofs are usually greened when they are retrofitted.

Tokyo requires at least 20 per cent of a roof to be greened in new developments or extensions to existing developments larger than 1,000 m^2 (10,764 sq, ft.) for private developments and 250 m^2 (2,691 sq. ft.) for public developments. Failure results in a penalty of approximately 200,000 yen ($2,000 US).

Other tools and incentives

Green Roofs for Healthy Cities (GRHC), led by Steven Peck, is a major force in green roof education, research and policy in North America. GRHC initiated Green Roof workshops that have been catalysts in awakening professionals and municipalities to the many benefits of green roofs. This organization also launched the North American Green Roof Conferences, which have been a focus of the North American green roof industry for several years. These conferences publicize research on technology advances, implementation case studies and policy. Most recently, GRHC initiated green roof training workshops and has linked with the 2005 World Green Roof Congress in Europe.

[5] Ackermann, A. (1995), "Dachbegrünung aus der Sicht des Stadtplaners," Das Gartenamt, 44(2), 73–80, and Dürr, A. (1993), "Dachbegrünung im Bauplanungsrecht," Landschaft Architektur, 23(3), 48–51.

LEED™

Throughout North America, Leadership in Energy and Environmental Design (LEED™) is raising the profile of green roofs and other sustainable or green building practices that are more typical in Europe.

LEED is a U.S.A.-based, non-governmental, rating system, which the U. S. Green Building Council (USGBC) administers. It is a voluntary system for rating new and existing commercial and institutional buildings. Developers and building designers who want accreditation for a project use LEED. Portland, Atlanta and Chicago promote LEED certification for all new and retrofitted buildings that meet specific dimensions, particularly for city-owned projects.

LEED evaluates environmental performance based on a "whole building design" perspective over a building's life cycle. This provides a standard to measure against the proposed components of a new building. For more information about life-cycle analysis, see the Athena website at www.athenasmi.ca/index.html.[6] LEED criteria guide consideration of several environmental design features, including water and energy conservation, innovative design, indoor air quality improvements, reduced urban heat island impacts, reduced impacts on wildlife and several other criteria that green roofs may support to a greater or lesser degree.

LEED provides ratings in credits or points: LEED Certified (26–32 points), LEED Silver (33–38 points), LEED Gold (39–51 points) and LEED Platinum (52–69 points).

LEED™ Canada — Canada Green Building Council

The Canada Green Building Council (CaGBC) promotes the design and construction of green buildings. The Council is a coalition of representatives from different segments of the design and building industry. The Council works to change industry standards and develop best design practices and guidelines. See http://www.cagbc.org/[7] for more information.

LEED Canada for New Construction and Major Renovations version 1.0 is an adaptation of the USGBC LEED Green Building Rating System, tailored specifically for Canadian climates, construction practices and regulations. The LEED Canada 1.0 Rating System recognizes buildings that incorporate design, construction and operational practices that combine healthy, high-quality and high-performance advantages with reduced environmental impacts. It is promoted by the CaGBC.

LEED Canada's rating system is voluntary, consensus-based, market-responsive criteria that evaluate a project's performance from a whole-building, whole-life perspective and provides a common understanding for what constitutes a "green building" in the Canadian context.

Some of the benefits of adopting LEED for Canada include:

- defines "green" within a common North American framework
- prevents "green-washing" as LEED is based on an external certification process
- relatively simple to implement
- flexibility, based on individual building specifications
- can be modified for local climate and building standards
- has legitimacy and consistency around the world
- provides credit for the installation of green roofs.

LEED Canada organizes its prerequisites and credits into the five principal LEED categories:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere
4. Materials and Resources
5. Indoor Environmental Quality.

"Innovation and Design Process" is an additional category for Canada. This category addresses sustainable building expertise and design measures not covered under the five principal categories

A unique aspect of LEED Canada is the credit for Durable Building (Envelope), which is credit MR 8 (Materials and Resources credit 8). It is based on CSA credit (CSA S478-96 (R2001) – *Guideline on Durability in Buildings*. This credit is relevant for Canada. While this credit does not deal directly with green roofs, it applies to green roofs as they are purported to considerably extend the lifespan of roof membranes. Currently, there is one LEED product approved for Canada—LEED NC 1.0 (NC=New Construction).

See http://www.cagbc.org/[8] for more information about LEED Canada.

Earning LEED™ Canada credits with green roofs

Green roofs are a recognized technology that can help designers and developers achieve LEED credits. Green roofs may contribute up to 11 LEED building credits by providing stormwater retention, energy savings through shading, heat island reduction by evaporative cooling, acoustical insulation, improved air quality and airflow, water conservation, wildlife habitat and other environmental benefits.

[6] Retrieved November, 2005. English only.
[7] Retrieved November, 2005. English only.
[8] Retrieved November, 2005. English only.

The following are some ways to earn LEED credits:

- Two LEED credits under the roofing credit by installing green roofs to reduce urban heat island effect.
- One LEED credit under the non-roof credit for a green roof on the top deck of a parking structure for reducing urban heat island effect.
- Two LEED credits for stormwater management as green roofs reduce runoff rates, peak flow and suspended solids.
- One LEED credit for green roofs, as they mitigate site disturbance
- One LEED credit for redeveloping a green space.
- Two LEED credits if the plants used on the green roof are drought-tolerant and require no irrigation, which improves the building water efficiency.

Additional LEED credits can be sought by demonstrating that a green roof (of a specified planting medium thickness and canopy coverage) may reduce the HVAC (Heat Ventilation Air Conditioning) load required by a building, particularly in summer peak-demand. LEED credits may also be earned by optimizing energy performance.

British Columbia shows the most leadership in using LEED certification. In Winnipeg, the new Mountain Equipment Co-op building, which includes a green roof, has earned LEED Gold certification.

Green Globes

Green Globes is an online environmental auditing tool for designers, property owners and managers to assess and rate their existing buildings against best practices and standards in areas such as energy use, water use, pollution management, hazardous waste, waste management and the health of the indoor environment.

Similarly, Green Globes integrates principles of green architecture at every stage of a project delivery for retrofits and the design of new buildings. The Green Globes program produces a detailed online report based on a confidential questionnaire that can be filled out by building managers. Green Globes may also certify third-party verified projects.

There are several versions of Green Globes for different types of projects including: Green Globes U.S.A., GEM (Global Environmental Method) U.K. and Green Globes Canada, which includes a section for existing office buildings, existing light industrial buildings and MURB's (multi-unit residential buildings), design, fit-up and building emergency management.

Green Globes is the newest addition to the Building Research Establishment Environmental Assessment Method (BREEAM)/Green Leaf suite of environmental assessment tools for buildings. Green Globes audit criteria are based on the internationally accepted BREEAM assessment method. The Canadian Standards Association (CSA) publishes BREEAM Canada as *Plus 1132/BREEAM Canada*.

The core premise of Green Globes is that environmental leadership and responsibility make business sense. The following Canadian organizations use BREEAM/Green Leaf tools:

- Public Works and Government Services Canada (PWGSC) for all federally owned buildings.
- The Department of National Defence for the design of new buildings
- The Federation of Canadian Municipalities for its Municipal Building Retrofit Program
- The Hotel Association of Canada
- The City of Toronto Better Building Partnership
- Major property management firms

For more information about Green Globes go to www2.energyefficiency.org[9]

Local improvement charges

The Pembina Institute, an independent, not-for-profit environmental policy research and education organization, promoted local improvement charges (LICs) as a way to encourage energy efficient building design and a tool that can be applied to green roof implementation.[10]

This approach associates the additional cost of a measure with the building property, rather than with the current building owner. In other words, all owners, not just the current owner, share the additional costs.

LICs are now used to help cover of infrastructure improvement costs on public property, such as roads and sidewalks, which benefit a specific neighbourhood. The municipality pays for the improvements (usually from its annual capital budget). The municipality assesses the LIC on the property taxes of the benefiting property owners until their share of the improvements is paid. There must be an approval process, which includes obtaining agreement from a certain percentage of the property owners who benefit, before the municipality can levy LICs.

[9] Retrieved November, 2005. English only.

[10] Pembina Institute. (2004). Using Local Improvement Charges to Finance Building Energy Efficiency Im-provements: A Concept Report. Drayton Valley, Alberta: Climate Change Control and BC Hydro.

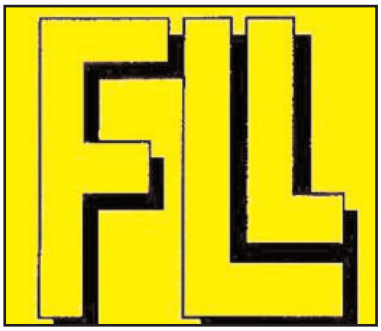
For new construction, the additional cost of a green roof is included in the LIC. This, for instance, would remove the capital cost of building a green roof from the sale price of a new home. The LIC allows a homeowner to pay the additional cost in annual installments.

A major benefit of LICs is that by allowing the additional cost of the building to be shared by all owners over time they deal with barriers such as long payback periods and higher up-front costs,. According to Pembina, the Regional Municipality of Waterloo and Oshawa in Ontario have LIC bylaws.

Ottawa is exploring LICs for capital projects, including green roofs.

The Pembina Institute web address is www.pembina.org[11]

FLL GUIDELINES FOR GREEN ROOF DESIGN, CONSTRUCTION AND MAINTENANCE



A key player in the development of the green roof movement in Germany is the FLL (Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V. [The Research Society for Landscape Development and Construction]). Eight professional organizations established the FLL in 1975 to research plants and for their use for environmental improvement. The FLL is a not-for-profit, membership-based organization with about 20,000 members that coordinates research, holds seminars and symposiums and produces publications about landscaping and plants.

The FLL is widely known for its technical guidelines on green roof design, construction and maintenance. The guidelines set standards for the individual components of the system, construction techniques and outline the maintenance for different types of roofs.

The FLL guidelines have been highly successful in setting quality standards for green roof systems throughout Germany. When the green roof construction boom first took off, many unqualified green roof companies surfaced, leaving behind a legacy of poorly constructed green roofs.

The guidelines, now used by various sectors of the green roof industry, achieve several goals, such as:

- green roof manufacturers will design their products according to the FLL guidelines, thereby producing a more marketable product;
- jurisdictions that provide financial incentives require that all applicants follow the FLL guidelines
- home and building owners are guaranteed a sound product when purchasing green roof systems and products designed according to the guidelines.

FLL performance rating system

A key part of green roof policy is ensuring that a green roof achieves its performance goals or performs its ecological function. To do this, the FLL developed a performance rating system for green roofs to aid with regulatory measures to ensure compliance.

The points-based system assesses the components and functions of the green roof. To obtain the base value, it takes the depth of the green roof system that can be penetrated by the plant roots and assigns 10 points for each centimetre of penetration. For example, if the depth is 10 cm, the system's base value is 100 points. From here, the system sets performance criteria for four further categories:

1. water retention capacity of the drainage layer
2. water retention capacity of the growing medium
3. the number of plant species on an extensive green roof
4. the amount of green volume (m^2/m^3) for intensive green roofs.

Each category must meet certain criteria (for example, water retention capacity must be at least 25 per cent). If the criteria are not met, points are subtracted from the base value and will have to be compensated for, either in the area where the deficit occurs, or in one of the other categories.

Municipalities can use this tool to ensure that a green roof meets the desired ecological functions. For instance, a municipality can designate a certain point value it wants to achieve for new development projects and use the point system to ascertain what type of green roof (water retention capacity, number of plants and so on) will achieve the desired value.[12]

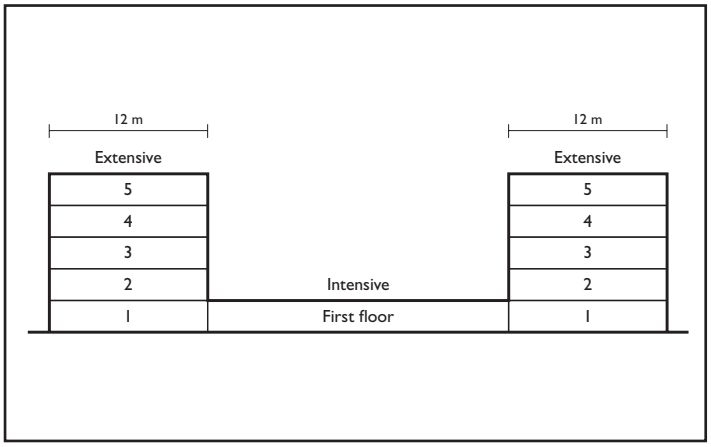
[11] Retrieved November, 2005. English only

[12] Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V. (FLL). (1998). Bewertung von Dachbegrünungen: Empfehlungen zur Bewertung in der Bauleitplanung, bei der Baugenehmigung und bei der Bauabnahme. Bonn, Germany.

Sample calculation using FLL point system

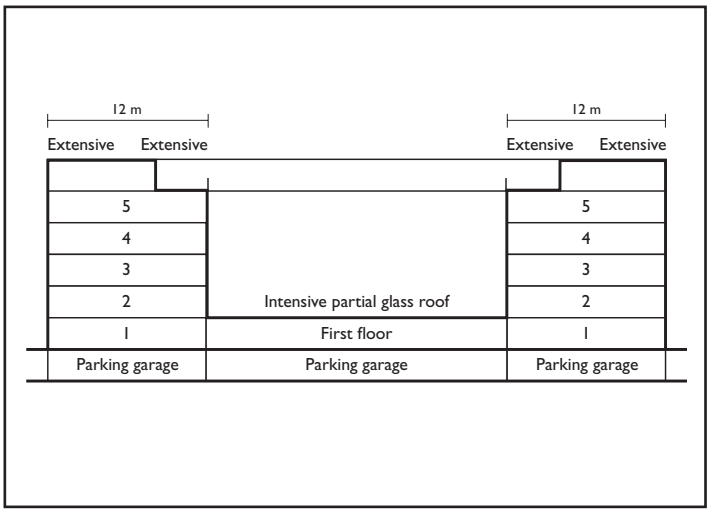
The following illustrates application of the point system. The project is a shopping centre, Markt Brandenburg, in Berlin.

The following diagrams depict the extent of roof greening in the local development plan (Figure 4) and the extent of roof greening the developer intended (Figure 5). A few adjustments to the design of the building, such as extra storage space on top of the fifth floor and extra glass light covers on the roof of the first floor, reduced the roof area available for greening. The point system is applied to determine how to compensate for the reduced area.



Adapted from: FLL 1998

Figure 4 Extent of roof greening instituted in local development plan



Adapted from: FLL 1998

Figure 5 Extent of roof greening the developer intended

Extensive green roof		**Intensive green roof**	
Area of building's roof	2,420 m^2	Area of the first floor roof	800 m^2
Area after reduction of non-greenable areas, due to light covers, vents, etc. (10%)	2,178 m^2	Area after reduction of non-greenable areas, due to light covers (10%)	720 m^2
1. Combined depth of drainage layer and grow-ing medium 10 cm=100 pts/m^2 **=217,800 points** 2. Maximum water-retention capacity of growing medium **=at least 48%** 3. Maximum water-retention capacity of drainage layer **=at least 15%** 4. Number of plant species **=10**		1. Combined depth of drainage layer and growing medium 20 cm=200 pts/m^2 **=144,000 points** 2. Maximum water-retention capacity of growing medium **=at least 53%** 3. Maximum water-retention capacity of drainage layer **=no value** 4. Green volume **=0.50 m^2/m^3**	
Total (217,800+144,000) =361,800 points			
Adapted from: FLL 1998			

Table 2 Roof greening design requirements in local development plan

Extensive green roof		**Intensive green roof**	
Area of building's roof	2,420 m^2	Area of the first floor roof	800 m^2
Area after reduction of non-greenable areas, due to light covers, vents, etc. (20%)	1,938 m^2	Area after reduction of non-greenable areas, due to light covers (15%)	680 m^2
1. Combined depth of drainage layer and growing medium 10 cm =100 pts/m^2 **=193,800 points** 2. Maximum water-retention capacity of growing medium **=at least 48%** 3. Maximum water retention capacity of drainage layer **=at least 15%** 4. Number of plant species **=10**		1. Combined depth of drainage layer and growing medium 20 cm =200 pts/m^2 **=136,000 points** 2. Maximum water-retention capacity of growing medium **=at least 53%** 3. Maximum water retention capacity of drainage layer **=no value** 4. Green volume **=0.50 m^2/m^3**	
Total (193, 800+136,000)=329,800 points			
Adapted from: FLL 1998			

Table 3 Roof area available for greening on modified building

Table 3 shows the amount of space available for greening on the modified building and its associated point value.

A comparison of the extent of roof greening instituted in the local development plan (361,800 points) and the reduced roof greening because of the modified building design (329,800 points) shows a deficit of 32,000 points (assuming that all other factors remain constant), obliging the building owner to provide compensation.

There can be compensation for the quantitative deficit by increasing the growing medium thickness on the intensive green roof from 20 to 30 cm (8 to 12 in.) on the outer section of the first floor roof, an area of 558 m^2 (6,006 sq. ft.). Table 4 shows the calculations.

Extensive green roof		**Intensive green roof**	
Area of building's roof	2,420 m^2	Area of the first floor roof	800 m^2
Area after reduction of non-greenable areas, due to light covers, vents, etc. (20%)	1,938 m^2	Area after reduction of non-greenable areas, due to light covers (15%) Outer (558 m^2) + Centre (122 m^2)=	680 m^2
1. Combined depth of drainage layer and growing medium 10 cm=100 pts/m^2 **=193,800 points** 2. Maximum water-retention capacity of growing medium **=at least 48%** 3. Maximum water retention capacity of drainage layer **=at least 15%** 4. No. of plant species **=10**		1. Combined depth of drainage layer and growing medium Outer (30 cm)=300 pts/m^2+Centre (20 cm) **=200 pts/m^2=191,800 points** 2. Maximum water-retention capacity of growing medium **=at least 53%** 3. Maximum water-retention capacity of drainage layer **=no value** 4. Green volume **=0.50 m^2/m^3**	
Total (193, 800+191, 800)=385,600 points			
Adapted from: FLL 1998			

Table 4 Compensating for a point deficit

Increasing the growing-medium depth of the outer area of the green roof fulfils the requirements of the local development plan. The increased growing-medium thickness also allows planting of larger shrubs and trees, which have greater ecological benefits and thus compensate for possible qualitative losses from the changes. In this case, the point system ensures that the building owner complies with the development plan greening regulations and that the green roof can adequately mitigate the environmental damage.[13]

The advantage of this rating system is that it ensures ecological function and compliance with regulations, while allowing for flexibility in the design. It also allows policy makers to clearly define the type of green roof desired in policy documents, thus preventing ambiguous wording.[14]

[13] Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V. (FLL). (1998). "Bewertung von Dachbegrünungen: Empfehlungen zur Bewertung" in der Bauleitplanung, bei der Baugenehmigung und bei der Bauabnahme. Bonn, Germany.

[14] Krupka, B. (1994). "Ein Bewertungssystem für Dachbegrünung nach Punkten," Das Gartenamt, 43(7), 448–450.

Figure 6 NRC Institute for Research in Construction, field research green roof facility, Ottawa summer and winter, 2003

Building codes and green roofs in North America

Consumers throughout North America look for general contractors who not only follow local building codes, but also demonstrate eco-efficiency and environmental sustainability in building practices. For example, consumers are demanding competitively priced roofing systems that satisfy the human need for comfort and energy efficiency, but which also incorporate improved quality of life and are ecologically sensitive. Consumers are now able to choose from a suite of construction materials that reduce the environmental impact and resource use. The profusion of "green" roofing products and practices throughout North America attests to the predominance of environmental and social concerns within the industry.

Canada recently ratified its Kyoto Treaty commitment to reduce greenhouse gas emissions. Because Canadian buildings account for 30 per cent of Canada's energy use and 27 per cent of Canada's greenhouse gas emissions, ways to incorporate energy efficiency into building design are being promoted to help meet Canada's greenhouse gas reduction target. In addition, with the increased interest in LEED and other environmental rating systems, the roofing industry is becoming more aware that cool roofs and green roof technology are useful in the Canadian context.

With much of Canada subjected to below-freezing temperatures and snow; snow load, planting depths, plant choices and vegetation performance bring unique challenges to our green roof technology.

Building codes and standards in Canada

With the exception of small wood-frame buildings, building codes in Canada do not support specific building technologies. Independent bodies, such as the Canadian Standards Association (CSA), Canadian General Standards Board (CGSB) or the American Society for Testing and Materials (ASTM) International develop standards when there is a need for specific building technology standards. An ASTM Green Roof Task Force is now working on performance standards for green roof systems. Municipalities may also choose to adapt the standards developed by FLL in Germany. In North America, the ASTM, which is developing standards for green roof technology, has already approved standards for load determination and growing medium selection.

Most Canadian provinces, territories and municipalities use the National Building Code of Canada (NBC), researched and developed by the NRC and its Institute for Research in Construction. Municipalities and provinces can make changes to the NBC, but they require significant development investment. Ontario bases its building code on the NBC for the most part and adds specific requirements related to accessibility and retrofitting.

Since the fall of 2005, the NBC has been using objective-based code requirements. The NBC now bases each requirement on its ability to meet stipulated national performance objectives. Building professionals can meet or exceed these requirements in several ways, using new technologies that have been evaluated as equivalent to the stated performance requirements.

When considering green roof technology the current NBC demands assessment of structural loading, roof drainage capacity, waterproofing and warranties, wind protection, fire safety, public accessibility and exit planning. However, it does not otherwise regulate the use of green roofs.

Municipalities must consider other regulations. For instance, fire codes generally require firefighting or fire prevention capabilities and mitigation to decrease fire risk. Provinces may also have code requirements for occupational health and safety for workers accessing a roof surface or a building's vertical surfaces (walls that might support a "living wall of plants"). Municipalities may also have bylaws affecting green roof technology, such as privacy, esthetics, biodiversity, amenity space, green space and so on.

Municipalities may need to consider changing building regulations related to green roof technology. This may require assessment at the National Building Code level and a long cycle of evaluation. It may be simpler for municipalities to adopt new standards through their own bylaws. For instance, municipalities may require a building permit before green roofs can be installed on existing buildings or they may have recommended standards for planting media, depth of media, vegetation cover and maintenance that applicants must follow.

BACKGROUND — THE GREEN ROOF MOVEMENT IN GERMANY

Germany is the world leader in documenting the benefits of green roofs, advancing the technology and program and developing policy. The *Manual* discusses the green roof movement in Germany because the German experience has significant lessons for Canadian policy makers.

The widespread use of green roofs in Germany can be traced back to two simultaneous movements in the 1970s — a flurry of technical research to evaluate the ecological benefits of green roofs, and citizen movements arising from concern for the environment and political dissatisfaction.

In the late 70s, researchers started evaluating the ecological benefits of green roofs, inspired by the accidental establishment of plant life on "rental barracks" in Berlin. These working class apartment blocks were built with tar, sand and gravel roofs to prevent the risk of fire. Over time, plant life established itself, leading to the study of the roof's ecological value.

In 1975 the FLL (*Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V.* —The Research Society for Landscape Development and Construction) was established and began to assess construction methods for green roofs. Through research, practical evidence and project implementation the FLL established a set of guidelines to standardize green roof construction at a high level of quality.[15] (See "FLL guidelines for green roof design, construction and maintenance," page 18.)

At the same time, citizen initiatives (*Bürgerinitiativen*) drew attention to environmental issues in urban areas. Concerns about increasing urbanization, a lack of green space and a sense of inadequate government interest spurred the initiatives. This gave rise to many grassroots initiatives to bring nature back into the city, such as courtyard and facade greening and reduction of paved areas. This populist movement gained considerable momentum and gave birth to a powerful political party, the Greens (*Die Grünen*), in the 1980s. [16]

The 1980s saw a number of municipal and state incentive programs aimed at bringing nature and green space back into the city. These programs encouraged a variety of urban initiatives, including green roofs, by subsidizing 50 to 100 per cent of the costs. At least 24 German cities offered some type of urban greening subsidy by 1983. These financial incentives were important, as they offset the higher costs of green roof technology. However, as green roofs were more widely implemented, technology costs fell.[17]

Germany amended its Federal Building Code (*Baugesetzbuch*) and Federal Nature Protection Law (*Bundesnaturschutzgesetz*) in the mid-1980s to include the Ecological Compensation and Replacement Measure. This requires that environmental disturbances first be avoided, then minimized and, as a last resort, mitigated. The Measure gives municipalities the authority to determine the nature of the compensation and enforce it through legally binding local development plans. Green roofs have become a popular mitigation measure, as they allow developers to meet their green space requirements.[18]

[15] Köhler, M. & Keeley, M. (2005). The Green Roof Tradition in Germany: the Example of Ber-lin. In Earth Pledge, Green Roofs: Ecological Design and Construction. New York, New York: Schiffer Publishing Ltd.

[16] Haan, G. de & Kuckartz, U. (1996). Umweltbewußtsein. Opladen: Westdeutscher Verlag. Köhler, M. & Keeley, M. (2005). The Green Roof Tradition in Germany

[17] Keeley, M. (2004, June). Green Roof Incentives: Tried and True Techniques from Europe. Presented at the Greening Rooftops for Sustainable Communities Conference, Portland, Ore.

[18] Dürr, A. (1994). Dachbegrünung: ein ökologischer Ausgleich. Wiesbaden: Bauverlag GmbH. Köhler, M. & Keeley, M. (2005). The Green Roof Tradition in Germany

A 1984 federal court ruling requiring transparency in fees for water was another other development in green roof acceptance. Until the ruling, usage was the sole basis for all water fees for supplying and disposing of water. In response to the ruling, several municipalities split their waste water fees, separately charging property owners for the stormwater directed to sewers from their property. The fee can range from €0.2/m² (30 cents Cdn) to €2/m² ($3 Cdn), depending on a property's impervious surface area — including rooftops. To encourage stormwater source control, municipalities offer a discount for measures, such as de-paving, stormwater retention ponds and green roofs that keep stormwater out of sewers. Discounts for green roofs range from 30 to 50 per cent.

The split waste water fee, which follows the "polluter pays" principle, is a successful and well-accepted tool. An estimated half of German cities with populations of 100,000 or more use split waste water fees.[19] The fees are also effective in decreasing the load on sewer systems.

Municipalities are downsizing and eliminating subsidies for urban greening projects and replacing them with regulations or combinations of taxes and fees as they deal with tight budgets.

Soka Bau, Germany

Table 5 shows the rate of green roof growth in Germany from 1994 to 2003.

Year	1994	1997	2001	2002	2003
Flat roofs greened (millions of m²)	9	11	13.5	13.5	13.5
Hämmerle, F. (2005). Der Gründachmarkt leidet unter Wachstumshemmern. (pre-press)					

Table 5 Growth of green roofs, 1994–2003

With green roof implementation levelling off, green roof proponents are looking for new ways to stimulate the market. Two ideas are a quality control system for completed green roofs and a green roof "seal of approval." Inspecting green roofs after installation is an important way to ensure that green roofs meet FLL guidelines and their ecological requirements.

[19] Hämmerle, F. (2004). Personal communication; Keeley, M. (2004, June). Green Roof Incentives

PART 2 — GREEN ROOF POLICIES WORLDWIDE

Introduction

The *Manual's* national advisory committee selected the jurisdictions in this section because they illustrate unique, successful green roof initiatives from different geographic areas, different climates and different phases in the evolution toward green roof policy development.

Policy and programming will be the next step in green roof development across Canada. Much can be learned from other countries. However, Canada's topography, regionalism and often-harsh winters make green roof technology particularly challenging compared to the European experience. Research, experience, policy tools, incentives and capacity within the private and public domain are coming together with specific, regional and tailor-made green roof policies.

Canada	United States	International
Montréal	Chicago	Basel-City, Switzerland
Toronto	New York	Münster, Germany
Vancouver	Portland	Singapore
Waterloo, Ont.		Stuttgart
		Tokyo

Canada	United States	International
Calgary	Minneapolis-St. Paul, Minn.	Tokyo, Japan
Halifax	Pittsburgh, Penn.	Berlin, Germany
Ottawa	Seattle, Wash.	London, U.K.
Québec City	Washington, D.C. and Chesapeake Bay area	North Rhine, North-West Phalia, Germany
Winnipeg		

Exchange rates

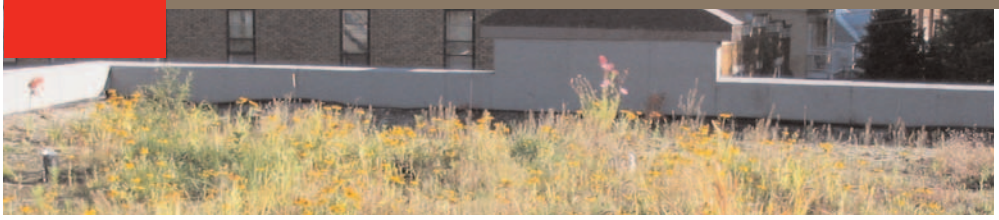
These are the currency exchange rates as of December, 2005.

Currency	Canadian $
British pound — £	$2.03
Euro — €	$1.36
Japanese yen — ¥	$0.009
Singapore dollar — $	$0.69
Swiss franc — CHF	$0.88
U.S. dollar — $	$1.15

Canada

GREEN ROOFS POLICIES WORLDWIDE

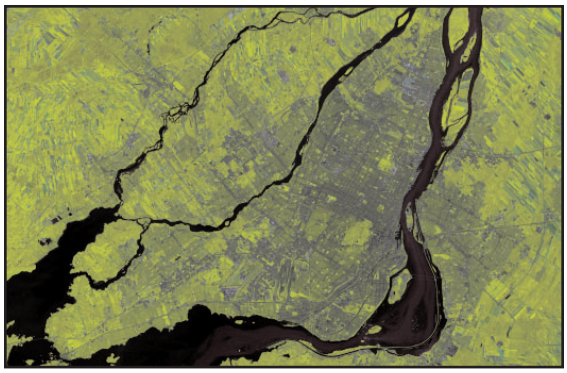
Case studies



Montréal, Quebec

Key motivators	Energy efficiency, urban agriculture		
Policy phase	5 — Program and policy development		
Champion	Multi-sectoral		
Longitude	46°N	**Latitude**	74°W
Average summer temperature	21°C (70°F)	**Average winter temperature**	-10°C (14°F)
Average annual rainfall	760 mm (30 in.)	**Average annual snowfall**	2,142 mm (84 in.)*

*The depth of snowfall does not necessarily provide a good indicator of the amount of equivalent rain, as snow compacts over time. For example, in Montréal the total annual precipitation including rainfall and snowfall is 967 mm (38 in.)



Heat Island Effect
Infrared scan of the Island of Montréal - lighter colours represent cooler areas, such as the Mount Royal Park in the centre of the island.

Description

Montréal, in southern Quebec, is Canada's second largest city. It has very cold winters, hot summer periods and a fair amount of rainfall throughout the year and heavy snowfall in the winter months. Geographically, it is on an archipelago where the Ottawa and St. Lawrence Rivers meet.

One of the oldest cities in North America, Montréal is one of Canada's leading commercial, industrial and service centres. The metropolitan area has a population of over 3.5 million.

Montréal has a northern climate, with temperatures that range from -40°C (-40°F) to 40°C (104°F).

Harmonization of the built environment with the low-rise, multi-family character of the low-lying areas around the city's Mount Royal that seems to be driving the current interest in green roofs. In some ways, this esthetic consideration is similar to the drive for green roofs in Singapore, although in Montréal the buildings are predominantly low-rise wood construction.

Montréal has also considered green roofs for agriculture. Universities in Montréal and Québec City have initiated research related to plants on green roofs and urban agriculture.

Elements of policy phases 2 to 5 are evident in Montréal. So far, implementation of green roofs in Montréal has been sporadic. However recently the work done by the Urban Ecology Centre, a non-profit organization, is succeeding in bringing many stakeholders, including municipal officials, together. The official City Master Plan now contains specific language related to green roofs.

There is a direct incentive program, of $5 a square foot towards green roof installation, offered by The Quebec Energy Efficiency Fund. Gaz Métropolitan (the gas utility), provides the funding. Green roofs are considered to have the potential to reduce energy consumption in buildings. There was apparently no calculated basis for the $5/ sq. ft. (about $54/m^2) incentive. The subsidy is the first of its kind in Canada.

Gaz Métropolitan has also supported a research project by NRC and Environment Canada to model energy savings from green roofs.

Key motivators

The key motivators for green roof implementation are an interest in the benefits of energy efficiency, because of the climate extremes and the use of green roofs to provide urban agriculture opportunities. Other identified motivators include stormwater runoff, urban heat island effects and air quality.

An incentive for Montréal is the desire to green the asphalt roofs of the city's typical low-rise, multi-family housing.

Description of policy

Montréal has undertaken policy work related to phases 1 to 4 and is considered to be in the preliminary stages of phase 5. However, more work is needed for community engagement and technical research before fully embarking on program and policy development in phase 5.

There are currently no stated municipal policies relating to green roofs although The Plateau (a borough of Montréal) is considering requiring new municipal buildings to have green roofs.

The Montréal Master Plan identifies two areas where green roofs can meet the stated objectives:

- Objective 17: ensure the optimal management of resources in an urban context, which is part of the goal for healthy environment. This objective can be achieved by developing and implementing incentives to improve energy efficiency standards and by applying innovative techniques, such as green roofs for new construction and existing buildings.
- Objective 12: promote quality architecture and consolidate the built environment in harmony with the surrounding character. This objective can be achieved by developing and implementing incentives to encourage the integration of energy-efficient methods and environmentally sensitive architectural innovations, such as green roofs, in new construction or renovation projects.

Additionally, the municipal government supports initiatives related to green roofs such as partial funding of a demonstration roof by the Urban Ecology Centre (UEC) and the funding of a symposium on green roofs organized by Green Roofs for Healthy Cities.

Demonstration project and grass roots movement

In the summer of 2005, the Urban Ecology Centre (UEC) built a demonstration project on the roof of the Coopérative la petite cité at 3518, rue Jeanne-Mance, a flat-roofed duplex in the Milton-Parc neighbourhood.

In early 2006, UEC also initiated a second and larger green roof conference to increase awareness of green roof benefits among policy makers, industry and the public. [20]

In February 2005, the UEC published its Green Roof Report, with information about green roofs in the context of Montréal.

[20] For information about this project see http://www.ecosensual.net/drm/portfolio/projetpilote1.html. Retrieved November, 2005. French.

Green roof awareness

The City of Montréal was co-host of a green roof symposium with Green Roofs for Healthy Cities in November 2004, with 100 participants. Following the symposium, Montréal established a Green Roof Committee to investigate ways to promote green roofs.

In other green roof activities, two local suppliers of green roof systems, Hydrotech and Soprema, have researched green roof systems in Quebec through work by local universities. In addition, Marie Anne Boivin, through Soprema, has done extensive work on growing medium and plant selections for the Canadian climate.

The impact of green roofs on firefighting is a unique issue in Montréal. Currently, Montréal firefighters cut an opening in the roof of a wood-frame building to vent smoke. The fire department was concerned that green roofs will slow their efforts in a fire. This concern has been resolved through the development of the UEC demonstration roof and discussion among stakeholders.

Effectiveness

The language in the Montréal Master Plan suggests that green roof awareness is growing in Montréal. It is becoming recognized at the political level as well.

Under the incentive offered by the Energy Efficiency Fund, there were three projects approved in the first three years of the program. As more people become aware of the program, more projects may take advantage of the incentive.

As awareness of green roofs increases, more projects are expected. The headquarters of Cirque du Soleil is an example of one recent large local development with a green roof. There have been others, mostly institutional projects, such as the new addition to the École Polytechnique (U de M engineering school), the retrofit at the Faculté d'aménagement (U de M landscape architecture school), the Québec headquarters of the RCMP in St-Henri, and the Châteauguay library. McGill University is planning two projects that will have green roofs.

UEC is helping to solve issues related to green roofs as retrofit measures on residential buildings. The UEC has been effective in bringing the City of Montréal, the roofing supply industry, the roofing industry, fire services, media, Environment Canada, Environnement Québec, the NRC and local residents together. The Association des maîtres couvreurs du Québec (AMCQ), the Québec Roofers Association, documented construction of the UEC demonstration project to publish a technical bulletin.

Predictions

In Québec, the Agence d'efficacité énergétique has recently increased the incentive for green roofs to $5/sq. ft. Along with the information products and recent activities of the Urban Ecology Centre discussion, action on green roofs will continue to increase in Montréal.

The UEC believes that the new demonstration roof, along with grass roots movements, will result in:

- Completion of research on green roofs on wood-frame construction to understand the necessary fire, structural and architectural interventions that may be needed and benefits that may accrue for buildings in Montréal.
- Organization of education programs to publicize the benefits of green roofs.
- Identification of costs and benefits related to green roofs.
- Collaboration amongst stakeholders in furthering green roofing.
- Encouragement by the City of Montréal and other levels of government to implement a green roof subsidy program and green roof requirements in building regulations.

Contact information

Marie-Anne Boivin
Soprema
450-655-6676
maboivin@soprema.ca

Manon Lacharité
Quebec Energy Efficiency Fund
514-598-3344
www.eefund.gc.ca

Lucia Kowaluk
Urban Ecology Centre
514-282-8378

Owen Rose
Montréal
514-522-6936
owen.rose@mail.mcgill.ca

Key literature

Fotopulos, H. (2005, May 19). Protecting our Trees. *Montréal Mirror* 20 (27). Retrieved June 2005, from http://www.montrealmirror.com/2005/051905/letters.html

Lamey, M. (2004). Going Green on Top. *Montréal Gazette* (Dec. 18, 2004). Retrieved from http://www.urbanecology.net/GRED/Archive/going_green_on_top.htm

Lamey, M. (2005). It's not easy being green. *Montréal Gazette*, page E1 (Aug. 27, 2005).

Landreville, M. & Rose, O. (2005). Tortures vertes à la montréalaise: Rapport de recherche sur l'implantation des toits verts à Montréal. Montréal: Urban Ecology Centre-Sodec.

Laroche, D., Mitchell , A.-M. & Peloquin, S. (2004). *Les toits verts aujourd'hui; c'est construire le Montréal de demain - Mémoire présenté a l'office de consultation publique de Montréal dans le cadre du nouveau plan d'urbanisme 2004*. Retrieved from http://www2.ville.montreal.qc.ca/ocpm/pdf/41/8aa.pdf

Léger, Marie-France. (2005). Se mettre au vert en ville. *La Presse*, page I3. (July 16, 2005). *Opt for a Green Roof! Financial incentive program to encourage urban green roof installation.* (n.d.). Montréal, Quebec: Energy Efficiency Fund Office. Retrieved from http://www.fondsee.qc.ca/en/pdf/Programmes_commercial/CII%20Toiture%20vegetale%20Ang.pdf

Rabinowicz, J. & Hautecouer, I. (2004). *Rooftop gardening, liberating spaces for healthier cities.* Montréal, Quebec: Alternatives & Santropol Roulant. Retrieved from http://www.santropolroulant.org/images/4pp-EN-2004-5.pdf

Urban Ecology Centre. (2004). *Green roofs a la montrealaise - A demonstration project.* Retrieved from http://www.urbanecology.net/GRED/Archive/Green%20Roof%20project%205-10-04.doc

Ville de Montréal. (n.d.). *Master Plan, Action* 17.1. Retrieved from http://www2.ville.montreal.qc.ca/plan-urbanisme/en/plan_urbanisme/2_3/chap2/2_7/obj17/page3.shtm

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Toronto, Ontario

Key motivators	Stormwater management and air pollution		
Policy phase	5 - Program and policy development		
Champion	Multi-sectoral		
Longitude	79°24' W	**Latitude**	43°40' N
Average summer temperature	26°C (79°F)	**Average winter temperature**	-2°C (28°F)
Average annual rainfall	68.9 cm (27 in.)	**Average annual snowfall**	135 cm (53 in.)

Green roof Toronto City Hall

Description

Toronto is the fifth largest city in North America, with a population of 2.54 million. It is part of the Greater Toronto Area (GTA), the largest metropolitan area in Canada, with a population of 5,203,686 people. The GTA includes four regional municipalities with 15.9 per cent of Canada's and 41.8 per cent of Ontario's population. Major transportation routes and rail lines connect Toronto to other economic centres and the city is a short drive from other densely populated urban areas to both the east and west. Toronto is an economic hub within Ontario.

Toronto's climate is among the mildest in Canada and is comparable to that of New York or Chicago. Toronto receives less snowfall than other cities in Canada but winter temperatures can stay below freezing for extended periods.

With little or no protective snow cover, plant choices for green roofs can be a challenge. Over the last five years, Toronto has shown significant leadership in research that supports the environmental benefits of green roofs. Currently, there are two fully instrumented green roofs (and a third one planned) that contribute to the compilation of local data on the stormwater and energy benefits of green roofs. These attributes, as well as strong multi-sectoral support for green roof policy development, position Toronto in phase 5 in the evolution of policy development. In 2005–2006, Toronto will start developing programs and policies supporting the implementation of green roofs.

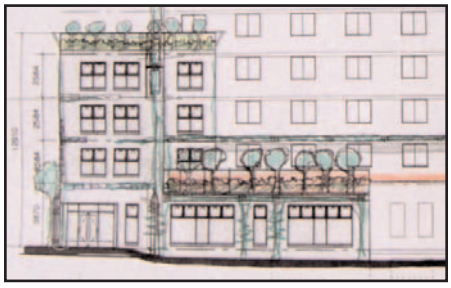
Canada

CMHC SCHL
HOME TO CANADIANS

Figure 7 Views from extensive green roof (planted in June, 2004) at The Robertson Building, 215 Spadina Ave, Toronto. Urbanspace Property Group of Toronto owns and manages the Robertson Building.

Toronto has a unique ecosystem, bounded by Lake Ontario in the south, the Niagara Escarpment in the west and the Oak Ridges Moraine in the north. The GTA is part of the Greater Toronto Bioregion, a larger, natural ecosystem. Several watersheds drain into Lake Ontario and provide important biodiversity and aquatic habitats within the city limits. Toronto is the northern extent of the Carolinian forest zone in Ontario.

Lake Ontario moderates Toronto's climate, which is among the mildest in Canada. Toronto receives significantly less snowfall during the winter than most other Canadian cities and winters tend to be mild. However, in recent years winter temperatures have been more variable, with daytime high temperatures averaging just a few degrees below freezing (there are often two or three cold snaps each year). A typical snowfall is no more than 10 cm (4 in.).Toronto does have heat waves, usually coupled with high humidity and smog alerts, with temperatures above 32°C (90°F), but they generally last no more than a couple of days.



Charrette design showing proposed green roof as part of supportive housing extension in Toronto

Key motivators

The key motivators for the City of Toronto are reduction of stormwater runoff, especially in areas overflow of combined sewers; reduction of urban heat island effect and replace-ment of displaced green spaces.

Description of the policy

Toronto has demonstrated solid leadership in green roof technology and green roof re-search over the past five years. Toronto is developing programs and policies to support implementation of green roof technology throughout the GTA. A cost-benefit analysis completed in 2005 will contribute to the formation of new policy.

Process to establish policy

The city's involvement in green roofs goes back to the recommendations of the 2001 environmental plan, which first identified the need for a strategy to encourage green roofs and rooftop gardens. The natural environment policy within the city's new official plan supports "the development of innovative green spaces such as green roofs and designs that will reduce the urban heat island effect."

The *Wet Weather Flow Management Master Plan* for Toronto, completed in 2000, examined ways to improve the water quality of local rivers and Lake Ontario by strengthening mechanisms to prevent and reduce stormwater runoff. Green roofs may appear in future stormwater-planning policies.

A *Toronto Green Roof Feasibility Study,* completed in 2000, provided support for a team to move forward with two green roof demonstration projects—one of 557 m^2 (6,000 sq. ft.) on Toronto City Hall Podium Roof and the other, 650 m^2 (7,000 sq. ft.), on Eastview Community Centre roof at 86 Blake St. Launched Nov. 2, 2000, the Toronto City Hall Green Roof Infrastructure Demonstration Project is a private-public partnership of the City of Toronto, the Toronto Atmospheric Fund, Green Roofs for Healthy Cities, the NRC's Institute for Research in Construction and Environment Canada. The cost, which included re-roofing, was about $260,000.

The investment in the Eastview Community Centre re-roofing and green roof was $274,000. The federal government's Technology Earthly Action Measures (TEAM), the City of Toronto, NRC, Environment Canada, the Toronto Atmospheric Fund and Green Roofs for Healthy Cities supported the project.

The objective was monitoring and evaluating thermal performance and other environmental benefits.

The First International Green Roof Workshop on Establishing Common Protocols for Building and Aggregate Level Green Roof Benefits Research took place in Toronto in 2000.

Toronto Public Health, the Toronto Atmospheric Fund and the Climate Change Action Fund sponsor "Cool Toronto." The objective is to protect Torontonians from the negative impacts of extreme summer heat and to develop programs to reduce summer temperatures. Cool Toronto and the United States Environmental Protection Agency (EPA) were co-hosts for a North American summit May 2–4, 2002, to examine ideas to manage urban heat island. At the June, 2004 Smog Summit, Toronto—in partnership with the Centre for Research in Earth and Space Technology (CRESTech)—announced a $40,000 grant from the Federation of Canadian Municipalities (FCM) Green Municipal. Enabling Fund to study municipal cost savings benefits of green roofs completed in 2005. The study provided measurable costs and benefits of green roofs within the city, quantify potential money savings, identified the projected time for cost recovery; and identified minimum threshold points for providing incentives.

CRESTech conducts multidisciplinary collaborative research and development in space and earth sciences. A consortium of university-based researchers, industry leaders and government, CRESTech is committed to bridging the gap between pure science and the successful application of science and technology in profitable new businesses.

In 2005, Toronto was also the host for a rainwater harvesting workshop and charette supported by CMHC, in which green roofs played a prominent role.

Following the 2005 cost-benefit study, the City's planning department presented a discussion paper Making Green Roofs Happen to its advisory Roundtable on the Environment. This paper was based on the findings of Stakeholder Workshops, the City's study The Environmental Benefits and Costs of Green Roof Technology and informed by an early draft of this *Manual*.

The options that were put forward for consideration by the Roundtable include:

- Subsidies or grants
- Green loans
- Pilot retrofit grant program
- Regulations requiring that a new building not increase stormwater flow from a site
- Rebate in water or energy rates to offset ongoing costs
- Introduction of a stormwater management charge with forgiveness according to stormwater management measures achieved on site
- Encourage developers to install green roofs by
- Offering density bonuses
- Qualifying green roofs as parkland dedication
- Improving approval procedures
- Training of city permits staff
- Encouragement of the province to amend the Ontario Building Code to facilitate "green technologies"
- Integrate green roofs into the City's new Green Development Standards
- Include green roofs as stormwater best management practice in City Guidelines
- Educate different audiences about the benefits of green roofs.

As of March 2006, the City has adopted the criteria for a Green Roof Incentive Pilot Program, which offers a grant of $10 Cdn per square metre ($ 0.93/sf) of eligible green roof area, up to a maximum of $20,000. The eligible green roofs must:

- Cover any size or type of heated building space, with the roof above grade
- Be intensive or extensive
- If new, have a minimum growing medium depth of 15 cm (6")
- If retrofitted roofs, have a minimum growing medium depth of 7.5 cm (3")
- Have a maximum slope of 10%.

Applicants are required to show:

- At least 50% coverage of the building's roof footprint
- Mixed vegetation rather than monoculture
- Maximum runoff coefficient of 50%.

Effectiveness

Some of the green roofs in the GTA:

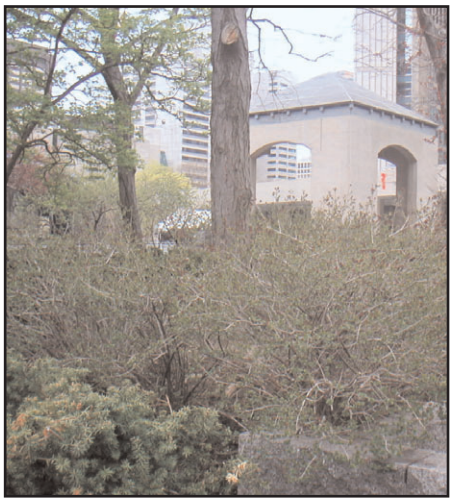
- York University, Toronto, installed a 2,787 m² (30,000 sq. ft.) green roof on the Computer Sciences Building as part of York's Greening Initiative.
- Ryerson University's engineering building set up a 743 m² (8,000 sq. ft.) green roof in 2004.
- In 2000, the Merchandise Building, a condominium unit in downtown Toronto, built a 929 m² (10,000 sq. ft.) intensive green roof with accessible public pathways, decks and eight garden beds. The building is a former department store.
- One of the oldest green roofs in Toronto belongs to Mountain Equipment Co-op. Built in 1998, the roof is about 604 m² (6,500 sq. ft.).
- Earth Rangers Centre, in Woodbridge (north of Toronto) is a leading education, wildlife rehabilitation and research centre. It has a 1,394 m² (15,000 sq. ft.) green roof that is expected to reduce energy costs, reduce stormwater runoff and improve air quality.
- The University of Ontario (formerly Durham College) in Oshawa, about 40 km (25 mi.) east of Toronto, installed a 836 m² (9,000 sq. ft.) green roof in 2004.

Lessons learned

The City of Toronto has gained valuable insight into the environmental costs and benefits attributed to green roofs through the *Municipal Cost Savings Benefits Study on Green Roofs* and from well-established partnerships with green roof researchers across Ontario. The Eastview and York University green roof demonstrations have provided valuable local sources of information on the effectiveness of green roofs in Toronto for managing stormwater and thermal and energy savings.

Predictions

Based on the findings of the *Municipal Cost Benefits Study on Green Roofs*, the City of Toronto's Round Table on the Environment will recommend ways to promote green roofs that will go to Council in early 2006. Toronto has also started preparing green development standards to guide private developers and construction of city-owned buildings. The standards will focus on the city's objectives for reducing energy and water consumption, stormwater runoff, urban heat island effects and promote the restoration and conservation of the natural heritage system. [22]



Ryerson University green roof

[22] For more information, see www.toronto.ca/greenroofs Retrieved Novermber, 2005. English.

Literature

Akbari, H.,& Konopacki, S. (2004). Energy effects of heat-island reduction strategies in Toronto, Canada. *Energy*, 29, 191-210.

Bass, B., Stull, A., Krayenhoff, S.,& Martilli, R.B. (2002). Modeling the Impact of Green Roof Infrastructure on the Urban Heat Island in Toronto. *The Green Roof Infrastructure Monitor*. 4 (1).

Bass, B., Krayenhoff, S., Martilli, A., Stull, R.B. & Auld, H. (2003, May). The Impact of Green Roofs on Toronto's Urban Heat Island. Presented at the *Greening Roofs for Sustainable Communities Conference*, Chicago .

Currie, B.A. (2005). *Air Pollution Mitigation with Green Roofs Using the UFORE Model*. Unpublished MASc. thesis, Ryerson University, Toronto, Ont.

Liu, K. & Baskaran, B. (2003, May). *Thermal Performance of Green Roofs through Field Evaluation*. Presented at the Greening Rooftops for Sustainable Communities Conference, Chicago.

Liu, K. & Minor, J. (2005, May). *Performance Evaluation of an Extensive Green Roof*. Presented at the Greening Rooftops for Sustainable Communities Conference, Washington, D.C.

Ryerson Quad green roof over library

Contact information

Joe D'Abramo
City of Toronto
(416) 397-0251
jdabramo@toronto.ca

John Minor
City of Toronto
(416) 449-2668
jminor@toronto.ca

Jane Welsh
City of Toronto
(416) 392-9709
jwelsh@toronto.ca

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Vancouver, B.C.

Key motivators	Stormwater runoff, urban heat island reduction, public amenity space		
Policy phase	5 - Program and policy development		
Champion	Multi-sectoral		
Longitude	123°07’ W	**Latitude**	49°17’ N
Average summer temperature	18°C (64°F)	**Average winter temperature**	3°C (37°F)
Average annual rainfall	121.9 cm	**Average annual snowfall**	—

Description

Vancouver is in a temperate rainforest influenced by the Pacific Ocean on its western border. Water surrounds the city on three sides and the Coast Mountain Range, with peaks above 1,500 m (4,920 ft.), on the fourth side. High-rise dwellings dominate Vancouver’s densely packed city core.

Local governments in B.C. have recognized that stormwater-related problems can be avoided by designing and building communities that capture rainfall at source and restore it to natural hydrologic pathways.

As the key objective in Vancouver is to reduce the total impervious area within the city limits, green roofs fall under a broad and sustainable stormwater management plan in the Greater Vancouver Regional District (GVRD). The recent *Stormwater Source Controls Design Guidelines* highlights green roofs as a tool for stormwater control. Vancouver is expected to be a strong contributor to Canadian green roof leadership. The British Columbia Institute of Technology (BCIT) opened a Green Roof Research Facility in 2004. The City and the GVRD are embarking on programs and policies that support awareness and use of green roofs, which places Vancouver at phase 5 in policy development.

The population of downtown Vancouver is approximately 560,000 and the GVRD about two million. Covering about 113 km^2 (43 sq. mi.),Vancouver is the largest port on the west coast of North America, the largest city in B.C. and the third largest city in Canada.

CMHC SCHL
HOME TO CANADIANS

Key motivators

Many local governments in B.C. have recognized that they can avoid stormwater-related problems by designing and building communities that capture rainfall at source and restore it to natural hydrologic pathways. Stormwater issues are a particular problem where buildings are built on steep slopes that have difficulty retaining soil from water runoff.

Description of policy

There is no direct policy supporting green roof development in Vancouver, but the city is exploring ways of implementing green roofs.

In the Southeast False Creek (SEFC) area, a brownfield site, the city is pursuing development of about 60 acres of mixed-use development as a model, sustainable community. The City has required that all buildings obtain LEED certification. Part of this site will be home to the 2010 Olympic Village and construction completed for that event. Intensive and extensive green roofs will be part of the green building elements and will help to implement the City's targets with respect to pervious land area of 60 per cent and amenities in this new neighbourhood.

In July, 2004 Council approved a green building program report that asked staff to work on the development of a city-wide green roof strategy. As the first phase of this strategy, Council adopted a green building strategy as a baseline for all development in SEFC. The official development plan for SEFC (March, 2005) ensures that all buildings will have a minimum of 50 per cent green roofs, with the roof built to a structure and capacity (including health and safety and access-egress) to support intensive green roofs.

Downtown Vancouver

While these may be planted as extensive roofs, they will have the capacity to support transformation to intensive spaces at the discretion of future owners. An IDP workshop was held in April 2006 to align the City and the Olympic Village developer in support of their green building agenda.

Additionally, Vancouver is embarking upon a city-wide green building strategy that will change bylaws and code requirements for all development, making the city baseline a "green" baseline. Green roofs will play a role in this strategy.

The city wants to make green buildings and green roofs a provision of new best practices for development and does not foresee incentives or bonuses as a tool for implementation. The city may use secondary tools to encourage green roofs, such as negotiations for amenity through rezoning or through development cost charges, if water and sewerage moves to a metered basis. It is not considering bonuses for height or density, following extensive studies on view corridors, urban design and the public realm. Additional height and density would have adverse affects on many of these key issues.

Other policy considerations in Vancouver include building management elements, such as:

- a commitment to maintain the green roof for the life of the building
- a fire prevention program
- a green roof data inventory
- some monitoring for environmental performance
- a commitment to sharing lessons learned.

Because of Vancouver's temperate climate, property owners have used green roofs to provide additional urban amenity space. The adequate supply of rainwater and the enhanced humidity have helped intensive and extensive green roofs thrive over the years. Many visitors notice the spontaneous appearance of moss (nature's own extensive green roof) on the surfaces of many sheds and garages.

Process to establish policy

BCIT launched the Green Roof Research Facility (GRRF) in 2004. The 100 m^2 (1,076 sq. ft.) building is dedicated to research on stormwater source control and thermal performance of green roofs. This information will be used to create and support installation and design guidelines and for policies and programs supporting the broad implementation of green roofs in the GVRD.

Over the past two years, the *Stormwater Source Control Design Guidelines* have helped the GVRD examine the costs and benefits of different regulatory options to manage stormwater. The *Guidelines* feature the major landscape design guidelines to improve stormwater runoff quantity and quality, such as absorbent landscapes, bio-

retention facilities, vegetated swales, pervious paving, infiltration trenches and extensive green roofs. The *Guidelines* devote several pages to green roofs, including a description, rationale, applications, limitations, types, guidelines and recommended design criteria to maximize the environmental benefits of green roofs.

This report is part of the Region's Liquid Waste Management Plan (LWMP) to implement integrated stormwater management planning for all developing watersheds. A LWMP approved by the provincial minister of water, land and air protection under the *Waste Management Act* may replace the more prescriptive regulations contained in the municipal sewage regulation. A stormwater interagency liaison group (a commitment in the LWMP) helps develop tools, such as the *Guidelines*.

Given the unique objectives, needs and priorities of each GVRD municipality, these stormwater guidelines neither recommend nor prescribe one particular stormwater management option. Instead, municipalities contemplating bylaw changes can use the *Guidelines* as a reference for more detailed, site-specific technical and legal investigations of possible changes to their bylaws.

Effectiveness

In 2002, the GVRD commissioned the first green roof inventory for the region. The inventory proved challenging and beneficial as a tool for professionals and municipalities in developing green roof policy, planning and education. It not only illustrated the types, numbers and distribution of green roofs in the region, but it also helped to determine their impact on development.

The inventory focused on all types of large buildings in the urban core and municipal centres. Aerial photographs, contacting local professionals and visits to local sites identified nearly 550 buildings, with 278 recognized as garden roof decks, over 30 categorized as extensive green roofs and three as semi-intensive green roof systems.

Significant buildings with green roofs include the Vancouver Public Library, the Vancouver Court House, the Waterfall Building, the White Rock Public Works Building and the Fairmont Waterfront Hotel (urban agriculture). Other current projects include the Seymour-Capilano Filtration plant and the Vancouver Convention Centre. The convention centre, when completed in 2008, will be the largest green roof in Canada with 2.4 hectares (6 acres) of flowers and grasses. The centre will be the media and broadcast centre for the 2010 Winter Olympics and its design and green roof are a response to the sustainable goals for the Games.

Lessons learned

One benefit of the green roof inventory was the recognition of perceptions and barriers affecting the region's green roof industry.

Historically, garden roofs were included for esthetics and recreational purposes; however, green roofs are now installed for economic and environmental purposes. While stormwater management was a key motivator for municipal governments in the region, the adoption and pursuit of a Silver or Gold LEED certification has been cited as the impetus for many new and prospective green roofs.

Some general misconceptions discovered during the inventory have helped to define the need for the next phase of green roof education and awareness in the GVRD. For example, respondents indicated that they believed that green roofs tend to leak, that they hold water on the roof, which causes membrane failure, that they are associated with Vancouver's leaky condominium problem and that both the upfront and maintenance costs are prohibitively expensive.

For more information see:
http://www.betterbuildings.ca[23]

Predictions

Local performance data and a commitment to ongoing research in the GVRD are contributing to an expansion of trained professionals with specific knowledge of green roofs. They are helping to build and distribute design guidelines for municipalities to use as development occurs. Green roofs are part of the GVRD's overall commitment to sustainable development and green building. The pursuit of LEED certification has been the impetus for many green roof projects in the region and is expected to spur further implementation of green roofs.

[23] Retrieved November, 2005. English.

Key literature

Connelly, M. & Liu, K. (2005, May). *Green Roof Research in B.C. - An Overview*. Presented at the Greening Rooftops for Sustainable Communities Conference, Washington, D.C.

Davis, K. & Kim, M. (2003, May). *Vancouver's Green Roof Inventory and Next Steps*. Presented at the Greening Rooftops for Sustainable Communities Conference, Chicago .

Greater Vancouver Regional District. (2004). Stormwater Reports. Retrieved April 20, 2005, from http://www.gvrd.bc.ca/sewerage/stormwater_reports.htm

Johnston, C., McCreary, K. & Nelms, C. (2004, June). *Continuous Flow and Temperature Runoff Monitoring of a Green Roof in the Pacific Northwest*. Presented at the Greening Rooftops for Sustainable Communities Conference, Portland.

Oberlander, C., & Whitelaw, E. (2005, May). *Aesthetic Design and Green Roofs*. Presented at the Greening Rooftops for Sustainable Communities Conference, Washington, D.C.

Vancouver library inaccessible green roof viewed from surrounding buildings.

Contact information

Maureen Connolly
Director of Green Roof Research
BCIT
Maureen_Connelly@bcit.ca

Marian Kim, P. Eng.
Senior Project Engineer
Policy and Planning Department
GVRD
(604) 436-6828
Marian.kim@gvrd.bc.ca

Dale Mikkelsen
Project Planner
City of Vancouver
(604) 871-6168
dale.mikkelsen@vancouver.ca

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Waterloo, Ont.

Key motivators	Stormwater control and air quality		
Policy phase	4 — Technical research		
Champion	Municipality		
Longitude	80°30'W	**Latitude**	43°30'N
Average summer temperature	80°30'W	**Average winter temperature**	-11.4°C (52°F)
Average annual rainfall	917 mm (36 in.)	**Average annual snowfall**	158 cm (62 in .)

Description

An "Environment First" philosophy gives the City of Waterloo a direction that will naturally lead to the promotion of green roofs and most likely to the creation of a green roof policy. This philosophy evolved from a city-wide visioning exercise called Imagine! Waterloo and has resulted, among many other projects, in a Green Roofs Feasibility Study and the construction of a demonstration green roof. These actions place the city in phase 4—Technical Research, of green roof policy development.

Stormwater control is the key driver for the city and it is considering innovative ways to manage the runoff, such as impervious surfaces and a stormwater utility fee. The citizens of Waterloo have identified improved air quality as their key driver to encourage green roofs. The city recently convened a steering committee of surrounding communities to work together to consider the development of a green roof policy. Waterloo is an example of the importance and benefit of engaging the entire community in planning. Political will and community support, combined with the City's moderate climate in southwestern Ontario, will advance the development of green roof policy.

Situated on the banks of the Grand River in the heart of southwestern Ontario, the City of Waterloo, population 110,800, is surrounded by agricultural land with fragmented forest systems (13 per cent forest cover). Three-quarters of the city's water supply is drawn from groundwater; the remainder from the Grand River. Waterloo has a moderate climate with similar temperatures and precipitation as Toronto. It has two major universities — the University of Waterloo and Wilfrid Laurier University.

Key motivators

Stormwater control is the key driver for the city, but Waterloo residents identified air as the main concern in the Imagine! Waterloo visioning exercise.

Description of the policy

There is no specific policy encouraging green roof construction, but the city is considering several ideas, such as a stormwater utility charge on the industrial, commercial and institutional sector for stormwater treatment. Neighbouring jurisdictions are interested in joining Waterloo on this initiative. Buildings with a green roof will pay a reduced fee. This idea is several years from reality but appears to be feasible and there is the political will to make it happen.

There are also restrictions on impervious surfaces in some residential areas, providing another way to reduce stormwater runoff.

Process to establish policy

Waterloo adopted its Environment First strategy and philosophy in 1989 to ensure that environmental matters are assessed at the forefront of all its business activities .

The results of the community-wide visioning exercise Imagine! Waterloo, served, among many things, to reconfirm the City's high priority for preserving the natural environment. Air quality, water quality and access to natural areas are key quality-of-life indicators for the future.

In 2001, building on existing environmental management capabilities, the City of Waterloo then identified the need for an environmental strategic plan and formed the Mayor's Environmental

Waterloo City Centre

Task Force. The task force developed 24 strategic actions linked to Imagine! Waterloo and included ways to work towards environmental improvements for air and water quality, green spaces, planning and growth, energy and natural resources, and stakeholder awareness. Each action provides high-level direction on environmental protection and enhancement goals.

The Task Force identified six key environmental areas and defined strategic actions. The six areas are:

1. planning and growth
2. water resources
3. air quality
4. energy and resources
5. environmental awareness
6. green space.

Green roofs fit into the environmental strategic plan in most of these areas, most notably under planning and growth, air quality and water resources.

There are four strategic actions in planning and growth

1. enhance existing policy
2. consider new policy and regulations
3. establish a development forum
4. enhance technical considerations in planning and urban design.

Green roofs fall under the last action. The Environmental Strategic Plan states that "urban design needs to consider opportunities for new environmental technology" and includes green rooftops in the list of examples. Green roof initiatives could also be incorporated under the strategic action of considering new policy and regulations. For example, in the future, the City of Waterloo may consider adding a requirement to all new developments that green roofs be a part of new buildings, or at least considered.

Strategic actions considered under air quality include reducing external pollution, such as trans-boundary pollution; reducing local pollutants, primarily vehicle emissions; identifying sources of air pollution; and, reducing the urban heat island effect.

Green roofs can play a significant role in reducing the urban heat island effect because they reduce the area that absorbs solar radiation as heat. They also cool the surrounding air through evapo-transpiration.

Phase II of the Environmental Strategic Plan implementation directly incorporates both actions that consider green roofs. Phase II is expected to take place from 2005 to 2008 in three phases. The first phase includes actions that can be easily implemented or that amplify existing City initiatives and show immediate environmental benefits. Items designated for Phase II may require additional resources to what currently exists, including additional lead-time for planning and implementation. Other areas where green roofs could fit into the Environmental Strategic Plan include water resources and energy and resources; the first because of the stormwater

management benefits that green roofs provide and the second because of the energy-efficiency benefits. Waterloo's Environmental Strategic Plan is a useful document in providing guidance and helping to set priorities for action on environmental health and protection in Waterloo in the future. Given the strategies and goals in the Environmental Strategic Plan, green roofs can play a role in improving the overall environmental health of the City of Waterloo.

As a result of the Environmental Strategic Plans and the identified potential of green roofs to meet many of the identified goals, the city applied to the Federation of Canadian Municipalities (FCM) for $25,000 through its federally-funded Green Municipal Funds for a green roofs feasibility study and green roof demonstration site on a city-owned building.

With matching dollars from the city, the feasibility study was conducted to identify which of their municipal buildings would be most suitable for green roofs. The study also discussed the types of green roof and their advantages, the costs of installation and maintenance as well as the long-term planning required.

The intent of this feasibility study was to identify the municipal buildings most suitable for a green roof. The analysis determined the advantage of a green roof and construction and maintenance costs. The study also determined the potential for green roof systems in Waterloo and identified existing opportunities.

The report is intended as a tool to guide decision-making for the city's building roof maintenance or new building and facility projects. More specifically, this report tells the City the best places to apply green roof technology and outlines the benefits.

Waterloo City Centre

The study consolidated relevant information already available from Europe and North America, supplemented the information with additional data yet to be collected, then produced a Waterloo-oriented analysis. It provides an accurate picture of green roof applications in Waterloo, including the required long-and short-term planning.

Construction of an accessible demonstration green roof began in the fall of 2005 on City Hall , which also raises awareness of green rooftops and their benefits. The demonstration project has the potential to affect the municipality's sustainable development plan, community energy plan, water and stormwater management plans as well as its long-term infrastructure plan. Monitoring equipment will be installed to quantify the benefits.

Waterloo won the Canadian Administration Municipal Award (CAMA) for its Environmental Strategic Plan, which took over a year to complete. The Mayor's Environmental Task Force is identified as the local champion for the green roof feasibility study and demonstration site. In addition, Karen Moyer, Waterloo's Environmental Coordinator, was awarded the Green Roof Civic Award of Excellence at the 2005 Green Roofs for Healthy Cities' Conference in Washington D.C. This award recognizes a public servant for outstanding contribution to the community and the development of the green roof industry.

July 12, 2005, was the inaugural meeting of a regional steering committee for development of a green roof policy. At this meeting representatives from the City of Waterloo, the Region of Waterloo and the cities of Kitchener and Cambridge discussed the purpose and benefits of creating a steering committee and how best to move forward on creating green roof policy. The committee is considering incentives, such as density bonuses and reducing stormwater charges, marketing and educational initiatives, developing specifications for common requirements to ensure the installation of proven green roof systems.

Effectiveness

Waterloo's work so far has been in planning, but it appears that through the City's involvement of all departments in the demonstration project and the Environment First philosophy that the demonstration project will be successful and result in opportunities to retrofit other City-owned buildings. Though local developers are not yet fully engaged, Ms. Moyer feels that this will come as awareness of the demonstration project increases.

The proposed stormwater utility is expected to play a major role in furthering the development of green roofs on new and retrofit buildings because is it one way a business can reduce its stormwater fees.

Lessons learned

One of the initial barriers the City has overcome is defining a green roof. It is expected that the accessible demonstration garden and results of monitoring will overcome doubts about the capability of green roofs of mitigating stormwater runoff and improving air quality.

Ms. Moyer notes the importance of involving all city departments, council and the community in planning process. She credits the Environment First philosophy and the Imagine! Waterloo visioning exercise as critical steps.

Local, national and international recognition for the City's efforts has also proven to be essential for obtaining community and council support.

Predictions

Waterloo's past planning, visioning activities and reports have set the stage for moving to the point where new development will automatically consider a green roof as part of an integrated green building design and existing buildings will investigate the possibility of a green roof when re-roofing.

Ms. Moyer expects that once the public fully supports green roofs it will ask council to create policy to ensure that green roofs become the standard, not the exception, in Waterloo.

Contact information

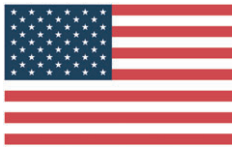
Karen Moyer
Environmental Coordinator
City of Waterloo
519-747-8609
kmoyer@city.waterloo.on.ca

Key literature

City of Waterloo website (n.d .). Retrieved from http://www.city.waterloo.on.ca/DesktopDefault.aspx
City of Waterloo. (2004). Green Roof Feasibility Study and City Wide Implementation Plan.
City of Waterloo. (2002). Environmental Strategic Plan.

12-10-06

United States of America



GREEN ROOFS POLICIES WORLDWIDE

Case studies

Chicago

Key motivators	Urban heat island and air quality		
Policy phase	6 - Continuous improvement		
Champion	Municipality		
Longitude	87°54' W	**Latitude**	41°59' N
Average summer temperature	27°C (80°F)	**Average winter temperature**	-6°C (21°F)
Average annual rainfall	72 cm (28 in.)	**Average annual snowfall**	24 cm (9 in.)

Description

In 2002 Chicago Mayor Richard Daley proclaimed that Chicago would become "America's greenest city" and should live up to its motto, *Urbs in horto* (City in a garden).

Despite some challenges with high summer temperature and damp, cold winters, green roofs are being built and declared an acceptable means to support higher solar reflectivity (that is, applications that lower the absorption of solar energy), mitigate urban heat island effects and improve Chicago's air quality.

The Chicago Department of Planning and Development has been actively encouraging the installation of green roofs on Chicago's buildings since early 2003. Currently, the City of Chicago has developed a Building Green/Green Roof policy that applies to construction projects that receive public assistance or are subject to review by the Department of Planning and Development as a Planned Development or a Lakefront Protection Ordinance Development. These measures place Chicago at phase 6 in policy development. Chicago is now in a position to examine continuous quality improvements in its green roof programs.

Chicago is located at the southwestern tip of Lake Michigan. The city has a population of 2.87 million and occupies a total area of 606.1 km^2 (234.0 sq. mi.) of which about three per cent is branches of the Chicago River. Weather can be extreme in summer, with high heat and humidity (Chicago has had many heat-related deaths) while in winter it can be damp and cold. The city's location on

Lake Michigan, coupled with the flat, Midwestern terrain, combine to make sometimes unpredictable and occasionally extreme weather.

The largest portion of Chicago's urban fabric is vegetative land cover (ground and canopy cover) at almost 40 per cent, followed by paved surfaces (31 per cent) and total roofed area (27 per cent). Chicago boasts having five of the 10 tallest buildings in the United States. From 1991 to 1998, Chicago planted more than 500,000 trees for a new over 4.1 million trees. Chicago's Bureau of Forestry plants a minimum of 5,000 new trees per year.

In paved surfaces, transportation has the highest percentage (69 per cent).

Commercial suburban has 61 per cent; commercial urban, 51 per cent and industrial, 48 per cent.

Key motivators

The City of Chicago is concerned about the effect of urban heat islands and poor air quality on human health and quality of life. Ordinances such as the Energy Conservation Code, passed in 2001, have helped to promote green roofs by requiring that all new and retrofit roofs should meet a minimum standard for solar reflectance (.25 reflectance is code requirement). The city shaped the ordinance in response to a severe heat wave that hit the area in 1996, which contributed to a significant number of deaths, particularly among senior citizens. The city's Bureau of the Environment deemed that green roofs were an acceptable means to lower roof reflectivity, mitigate urban heat island and improve Chicago's air quality.

In 2003 at the inaugural Green Roofs for Sustaining Healthy Cities Conference in Chicago, Mayor Daley received the 2003 Civic Award of Excellence for his leadership in promoting green roofs. The Peggy Notebaert Nature Museum, at the Chicago Academy of Sciences, received the 2003 Green Roof Award of Excellence. The Museum, on the shore of Lake Michigan, is a green roof demonstration project that educates visitors about green roofs as they tour the museum.

	Public assistance RFPs, Negotiated Sales with land writedown, TIF, Empowerment Zone Grants, DOH	**Public assistance** Bond Issues, Class 6b, SBIF, Enterprise Zone Facility Bonds, Bank Participation Loans	**No public assistance** Planned Developments, Lakefront Protection Ordinance Developments
Residential			
Market Rate SF and TH Multi-units<4 units	Energy Star or LEED certification		
Market Rate=>4 units	50% Green Roof and Energy Star Certification or LEED Certification*	50% Green Roof and Energy Star Certification*	25% Green Roof*
>20% Affordable Units or CPAN	DOH Green Criteria		
Institutional			
Hospitals	50% Green Roof or 25% Green Roof and LEED Certification*	>25% Green Roof or 10% Green Roof and LEED Certification*	25% Green Roof or 10% Green Roof and LEED Certification*
Community centres and schools†			25% Green Roof or 10% Green Roof and LEED Certification*
Industrial			
	10% Green Roof or Energy Star Roof and LEED Certification	>10% Green Roof and Energy Star Roof	
Commercial			
Retail>10,000 sq. ft.‡	75% Green Roof or 50% Green Roof and LEED Certification*	50% Green Roof or 25% Green Roof and LEED Certification*	50% Green Roof*
Retail<10,000 sq. ft.	25% Green Roof or LEED Certification*	Energy Star Roof	Energy Star Roof
Office>80 ft.	100% Green Roof	75% Green Roof*	50% Green Roof*
Office<80 ft.	50% Green Roof or Energy Star Roof and LEED Certification	Energy Star Roof	

Legend

SF=Single family

TH=Townhouse	DOH=Department of Housing
RFP=Request for Proposals	CPAN=Chicago Partnership for Affordable Neighborhoods
TIF=Tax Increment Financing	* Remainder of roof must meet Energy Star levels
SBIF=Small Business Improvement Fund	

for reflectivity.
† Church buildings serving multiple purposes will be considered a community center.
‡ Run-off coefficient value reduction will be required for big-box retail projects more than 100,000 sq. ft.

NOTE: All projects reviewed by the Department of Planning and Development are encouraged to use stormwater best management practices, LEED and Energy Star building standards and residential green building standards where applicable.
A 50% green roof and LEED certification are required for all public projects except community centers and schools.

LEED certification plus a 10 per cent green roof or a 25 per cent green roof will be required for Public Community Centers and School Community Centers. Schools will also focus on indoor air quality and day lighting.

Links
Green Roof Information—www.greenroofs.com
Energy Star Roof—www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products
Energy Star Certification—/www.energystar.gov/index.cfm?c=home.index
LEED Certification—www.usgbc.org/DisplayPage.aspx?CategoryID=19

Table 6 Chicago's Building Green Roof Matrix

Description of policy

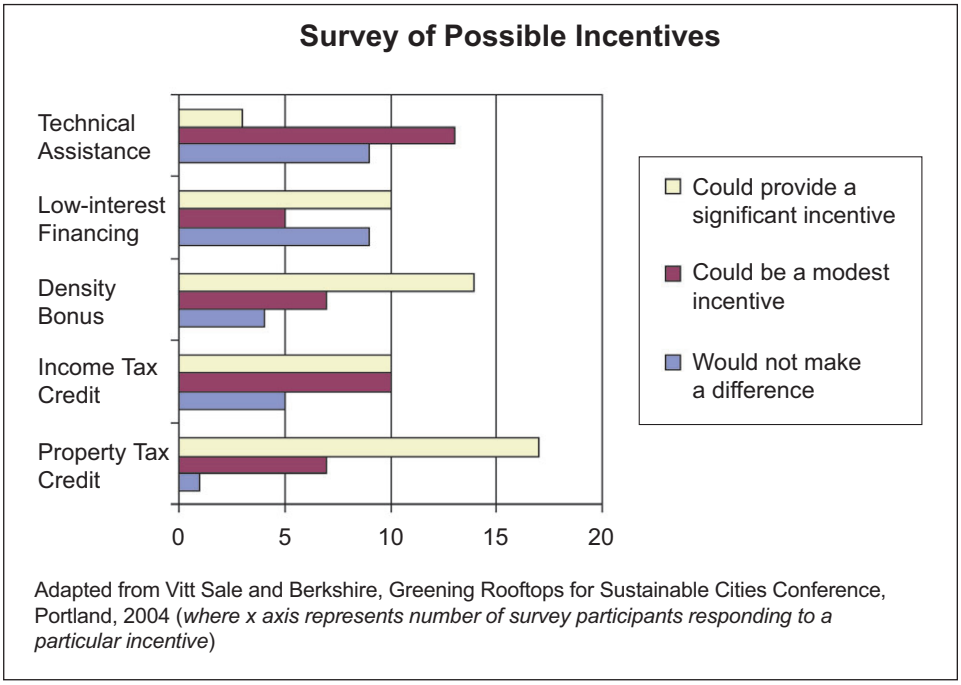
The Chicago Department of Planning and Development has been actively encouraging the installation of green roofs on Chicago's buildings since early 2003. The matrix summarizes the City's Building Green/Green Roof policy, showing what projects are subject to the policy and what green strategies are promoted through the policy.

Basically, the City of Chicago grants a density bonus option to developers in the form of a floor area premium. To qualify for more intense development or more floors in a new building project, at least 50 per cent of the roof surface area or a minimum of 185.8 m² (2,000 sq. ft.)—whichever is greater—must be covered by vegetation—Typically in the form of a green roof.

Process to establish the policy

Interest in green roofs in Chicago began when Mayor Daley visited Europe in 1998 and noticed the large number of green roofs. In 2003, the city Department of Environment designed and installed a 1,886 m² (20,300 sq. ft.) demonstration project on the roof of City Hall. Other city-sponsored green roof projects that year were the Chicago Center for Green Technology and the Chicago Transit Authority Substation as well as a few city fire stations.

In 2003, to encourage the private sector to play a leadership role in establishing green roofs, the Department of Planning and Development engaged the Chicago Urban Land Institute (ULI) a non-profit organization of real estate professionals, to hold seminars on green roofs to dispel fears and misconceptions about green roofs.



Adapted from Vitt Sale and Berkshire, Greening Rooftops for Sustainable Cities Conference, Portland, 2004 (*where x axis represents number of survey participants responding to a particular incentive*)

Table 7 Most attractive incentives for green roof installation

The Department of Planning and Development partnered with green roof providers to build and compare green roof test plots using different kinds of plants and materials. The Mayor's Water Agenda in 2003 recognized the benefits of improved stormwater management with a proclamation that "green infrastructure and design would be encouraged in City projects" including the use of green roofs. The Department of Water Management (DWM) re-calculated detention requirements to include green roofs as equal to vegetated areas at grade level. The DWM uses a "C" factor to calculate runoff values and determined that green roofs were equal to grass. Nonetheless, not all jurisdictions in Chicago rate green roofs equally. For example, the Metropolitan Water Reclamation District does not recognize the benefits associated with a six-inch green roof system for runoff control.

Similarly, professionals were surveyed to determine what incentives would be most attractive for them to install green roofs. Table 2 shows the results.

Effectiveness

According the Michael Berkshire, Green Projects Administrator with Chicago's Department of Planning and Development, there is more that 92,903 m² (one million sq. ft.) of green roofs in Chicago. (See figure 2) The City of Chicago has a website that supports green roof installation, information and technical assistance. Documents available on the website include:

- A guide to rooftop gardening
- Design guidelines for green roofs
- Extensive green roofs—what are the benefits of green roofs?
- Green roof basics (structural building related information)
- Green building projects including those with green roofs

- A guide to stormwater best management practices (green roofs are noted under best management practices (BMPs).

Lessons learned

While Chicago offers a stormwater retention credit for green roofs because of their ability to reduce and delay stormwater runoff, there is no stormwater impact fee. Similarly, parts of Chicago, such as the Central Plan Area, do not require on-grade detention of stormwater, but instead, require that stormwater be released at a desired rate to the underground stormwater system. While the Department of Planning and Development has created the Building Green/Green Roof Matrix to guide city development, there is no requirement to use green roofs or green building strategies in the private sector.

Predictions

The number of green roofs in Chicago is growing each year, as there is strong support for green infrastructure in city's top administration. Despite the lack of formal regulation supporting green roof installations on new and retrofit roofs in Chicago and the upfront costs that are perceived to prohibit their use by developers, green roofs are predicted to grow in the Chicago marketplace. According to Lois Vitt Sale, a design and construction consultant with the Department of Planning and Development, local green roof performance data, competitive pricing for green roof infrastructure and higher energy costs will spur the Chicago green roof market in years to come.

Contact information

Mike Berkshire
Green Projects Administrator
Department of Planning and Development
City of Chicago
(312) 744-8280
mberkshire@cityofchicago.org

Lois Vitt Sale
Corporate Vice President
Wight and Company
(312) 261-5704
lvittsale@wightco.com

Key literature

City of Chicago. (n.d.). Building Green/Green Roof Matrix. Retrieved from http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/Green_Roof_Policy_Matrix_revised.pdf

City of Chicago. (2004). The Chicago Standard. Retrieved from http://egov.cityofchicago.org/webportal/COCWebPortal/COC_ATTACH/ChicagoStandard.pdf

Sale, L., & Berkshire, M. (2004, June). Creating a Marketplace for Green Roofs in Chicago. Presented at the Greening Rooftops for Sustainable Communities, Portland .

10-10-06

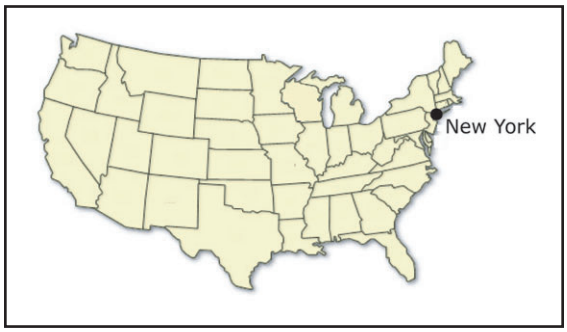
GREEN ROOFS POLICIES WORLDWIDE

Case studies

New York, New York

Key motivators	Urban heat island, stormwater runoff		
Policy phase	4 — Technical Research		
Champion	Non-profit sector		
Longitude	41°N	**Latitude**	74°W
Average summer temperature	25°C (77°F)	**Average winter temperature**	0°C (32°F)
Average annual rainfall	1,200 mm (47 in.)	**Average annual snowfall**	700 mm (27 in.)*

*Snowfall in New York contributes very little to precipitation



Description

New York's population of about 8.1 million lives on a land area of about 834 km² (322 sq. mi.). Located at the mouth of the Hudson River on the eastern Atlantic coast of the U. S., New York has a temperate maritime climate.

New York faces challenges related to the quality of its natural waterways from stormwater and sewage and challenges related to urban heat island effect.

These challenges present opportunities for consideration of green roofs. New York is behind Portland, Chicago and Washington D.C. in developing green roof policies. It appears that similar to Toronto, New York intends to develop policies after completing more detailed studies of the benefits of green roofs.

Earth Pledge, a non-profit organization, is bringing the various stakeholders together to document the costs and benefits of green roofs.

Intensive activity that falls within policy phases 3 and 4 is taking place in New York. The activity showcases Earth Pledge's unique approach.

Key motivators

New York has several environmental challenges. Urban heat island has existed since the early 20th century and it is believed to increase city temperatures by two to three degrees Celsius compared to the surrounding areas. Pollution from stormwater runoff is a concern because it compromises the health of New York's water. Every year, half the rainstorms in New York overflow the combined sewage system, pouring an estimated 40 billion gallons of untreated wastewater into city waterways.

Description of the policy

The Earth Pledge Foundation is a non-profit organization that identifies and promotes innovative techniques and technologies that restore the balance between human and natural systems. In New York, the promotion of green roofs has been primarily through the efforts of Earth Pledge, which has undertaken several green roof initiatives. Earth Pledge hopes the initiatives will lead to private and municipal government support for green roofs in New York.

Process to establish policy

To support government evaluation of locally appropriate green roof infrastructure and policy support structures, Earth Pledge has:

- done research to quantify the costs and benefits of green roofs for New York;
- educated the stakeholders whose participation is crucial to achieving widespread green roof development in New York; and
- implemented green roof projects.

This information is not yet publicly available but is expected to be available soon through the Earth Pledge website.

The Earth Pledge projects are the New York Green Roof Policy Task Force, Green Roof Symposia and Workshops, Green Roof Toolbox, Green Roof Infrastructure Study, Green Roof Stormwater Model (GRSM), the New York Ecological Infrastructure Study (NYEIS), Greening Gotham.org, the Viridian Project and the recently published book *Green Roofs: Ecological Design and Construction.*

New York Green Roof Policy Task Force

This is a group of public officials and representatives from government agencies convened by Earth Pledge to explore policy options in support of green roof development. Agencies represented include New York's Department of Environmental Protection, Mayor's Office of Environmental Coordination, the Department of Housing Preservation and Development; Housing Authority; the Battery Park City Authority, Department of City Planning; Department of Parks; U.S. Environmental Protection Agency, Region 2; and the United States Forest Service.

Members of the task force engage with their parent agencies to help determine needs for evaluating how each agency can best engage in green roof development, through pilot projects, specifications development, incentive creation or policy support.

Green roof symposia and workshops

Earth Pledge holds green roof events that engage and educate a range of stakeholder groups, including technical workshops and green roof symposia for design and building professionals that bring together a diverse group of designers, builders, developers, educators and community and environmental groups. Well over 1,000 professionals have participated.

Green Roof Toolbox

The *Green Roof Toolbox* is an online resource for design and building professionals, policymakers and the public. It provides detailed information to facilitate green roof project development.

Green roof infrastructure study

Under contract with the New York State Energy Research and Development Authority and the Clean Air Communities Fund, Earth Pledge's research team is monitoring in-situ two green roofs in Long Island City, Queens.

Green roof stormwater model

Under contract from the New York Water Board, Earth Pledge is building a theoretical stormwater-modelling tool to evaluate green roof runoff reduction at the building and drainage basin scale in Lower Manhattan.

The New York Ecological Infrastructure (NYEI) Study

This project investigates the form and function of an "ecological infrastructure" for New York's built environment and landscape. The study emerged from a desire to develop a cost-benefit analysis of city-wide green roof implementation.

Development of a New York "ecological infrastructure" can restore lost ecosystem function, address current environmental, health and economic concerns and establish a vision for a sustainable urban

future. The study is intended to provide policy-makers with a set of scientific analyses and balanced benefits and costs to determine the rationale for and the proper means of supporting green roofs and other measures.

Greening Gotham.org

This web-based project presents Earth Pledge's vision for improving the urban environment by bringing to life a barren and abandoned landscape — New York's rooftops. Greening Gotham.org enables New Yorkers to share in that vision, learn about the urgent environmental problems that face the city and how green roofs can solve them. A regularly updated news section lets New Yorkers track the progress of green roof work in the city — new green roof projects, public events and public policy developments. It is supported by New York Mayor Michael Bloomberg, Senator Hillary Clinton (D-N.Y.), actor Ed Norton and many others.

The Viridian Project

The Viridian Project brings the environmental, health and social benefits of green roofs to low- and moderate-income communities. Through Viridian, Earth Pledge is providing technical and financial support to non-profit organizations that serve these groups, in order to help them develop green roofs and related programming at affordable housing and other community facilities.

Green roofs: Ecological design and construction

Published by Schiffer Design, Earth Pledge's most recent publication includes hundreds of photographs, 40 case studies of exemplary green roof projects, seven municipal case studies and design details.

Effectiveness

The approach in New York has been effective on various fronts. The Green Roofs Task Force has detailed the type of information government agencies need and highlighted areas for further studies.

The U.S. EPA Region 2 supported the task force by funding the Greening Gotham.org. website.

The NYEI study undertook a comprehensive analysis, from 2002 to 2004, of the impacts, costs and benefits of citywide green roofing.

Earth Pledge has an ongoing relationship with the New York Department of Environmental Protection (DEP), which has funded the development of two computer models of green roof performance for Lower Manhattan. The models will provide the first significant green roof stormwater analysis using New York climate and sewage data.

In Queens, the Pratt Institute Centre for Community and Environmental Development is developing a green roof on a metal fabrication plant as part of a planned neighbourhood-wide test site for green technologies and green industries. The roof will be monitored for energy use and will be financed in part by the New York State Energy Research and Development Authority.

The Earth Pledge Viridian Project has partnered with a number of community groups and housing organizations, who have installed green roofs as a way to add greenery in limited space. Six projects have been completed. Viridian also has several partnerships with schools.

Green roofs offer a unique solution for the South Bronx sewer shed, whose land area is densely built, with 75 per cent covered by roof space. Funding has been granted to form the Bronx River Alliance, which will consider incorporating green roofs into the borough's environmental strategies. In addition, a Bronx Initiative for Energy and funded by a one-time appropriation of $1 million. BIEE funds energy-efficient projects — including green buildings — with solar panels and green roofs.

In Lower Manhattan, the Battery Park City Authority (BPCA) has taken steps towards the creation of green infrastructure. The BPCA has mandated stringent environmental requirements for all new buildings. The 27-storey Solaire residential high-rise in the first built to these specifications and it includes two green roofs — one accessible and another inaccessible.

A number of private companies have also built green roofs in New York, including the Nassau Brewery Icehouse in Brooklyn with one inaccessible green roof and Helena, a luxury high-rise with five extensive green roofs.

Municipally funded green roofs are planned for the St. George Ferry Terminal on Staten Island and at the Queens Botanical Gardens. New York City Council is also examining green building policies, including legislation that would require all publicly funded buildings to be LEED Silver certified. The Building Department is also seeking to incorporate building technologies — including green roofs — into the International Building Code, which is the building code used by New York.

Lessons learned

Earth Pledge endeavoured to frame city-wide green roof development and subsequently policy support, in terms of its potential to meet a wide spectrum of needs. It has succeeded in laying the groundwork for this type of approach.

By allowing government representatives to articulate the challenges facing the city — whether relating to stormwater pollution, affordable housing or open space equity — green roof development in New York has taken on its proper quality: one of many potential solutions to complex problems arising from numerous interrelated factors. It has become more likely that future green roof development will interdisciplinary to maximize benefit to the city.

Through Earth Pledge's experience it seems that the evaluation of green roof potential in New York cannot be solely the purview of government. No matter the mandate, government is not able to represent all the interests of a community, its culture or its environment. In serving as the convening and coordinating entity, Earth Pledge has been able to draw upon the range of its other activities to illuminate and inform the political process to make certain that other scientific, environmental, social and economic needs are brought to the table and integrated into the agenda.

For other cities considering city-wide green roof development, New York can provide a model for framing the political process to effectively respond to local needs by incorporating green roofs. As presented throughout this *Manual*, cities in Europe, Asia and other parts of North America provide important examples of how green roofs were developed and the types of support structures implemented to encourage their construction. The approach in New York, however, can demonstrate how green roofs are a fascinating ecological building technique full of potential to positively affect a range of challenges facing the urban landscape.

Predictions

Green roof support in New York is expected to grow and be encouraged by private sector efforts through the development of policies and programs by governmental organizations.

Contact information

Leslie Hoffman
Earth Pledge
212-725-6611
lhoffman@earthpledge.org

Key literature

Cheney, C. (2004, June). *The New York Green Roof Policy Task Force: A Model for Context-Appropriate Urban Green Roof Development*. Presented at the Greening Rooftops for Sustainable Communities Conference, Portland.

Cheney, C. (2005). *Greening Gorham's Rooftops*. In Earth Pledge, Green Roofs: Ecological Design and Construction (pp. 130-134). New York, New York: Schiffer Publishing Ltd.

12-10-06

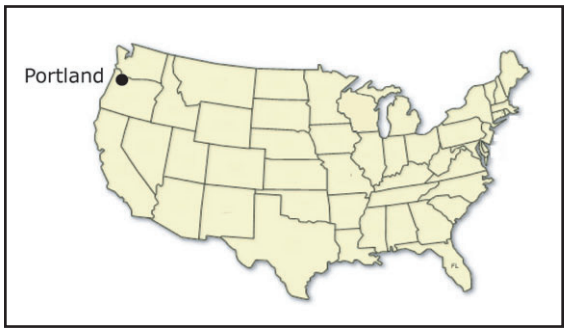
GREEN ROOFS POLICIES WORLDWIDE

Case studies

Portland, Oregon

Key motivators	Pollution from stormwater runoff		
Policy phase	5 — Program and policy development		
Champion	Municipal		
Longitude	46°N	**Latitude**	123°W
Average summer temperature	20°C (68°F)	**Average winter temperature**	4°C (39°F)
Average annual rainfall	900 mm (35 in.)	**Average annual snowfall**	50 mm (1.9 in.)*

*Snowfall in Portland contributes insignificantly to total precipitation



Map showing City of Portland, Oregon
Scale 1:4,000,000

Description

Portland is considered the North American leader in green roofs. Oregon's largest city, with a population of about 2 million, covers 13,022 km² (5,027 sq. mi.). It is located ap-proximately 112 km (70 mi.) inland from the Pacific Coast on the Willamette River and is bordered by the Coastal and Cascade Mountain ranges. The city has a temperate climate with mild spring and summer weather. It receives heavy rains in the late fall and winter with a three month dry season (drought) in the summer. Its climate is similar to that of Vancouver.

There is very little specific data available about inventory of land use inventory. However, Portland is known for its smart growth policies. Current development around Portland is held within the Urban Growth Boundary.

The main motivator for green roofs is stormwater management, in particular the reduction in combined sewage overflow.

Portland moved very quickly through the first three phases of policy development. It has conducted significant technical research and phase 5 is well underway. Portland shows that where there is political will, things happen.

Unlike New York, which is studying the costs and benefits of green roofs before moving forward, Portland was able to quickly fund many demonstration and experimental projects based on their success in Germany. Today, new municipal buildings are required to consider green roof installation. Portland's municipal

website promotes green roofs and provides helpful advice to those in the private sector considering green roofs.

Portland quickly included green roof technology as an acceptable option in its existing development bonus schemes, such as floor area ratio (FAR) bonus and as an acceptable measure to reduce stormwater management charges.

As of the summer of 2005, the City was looking at details of the municipal level costs and benefits to further evolve policies. The success in Portland is attributed by many to one municipal employee: Tom Liptan, although non-profit organizations such as Ecoroofs Everywhere now promote green roofs.

With the success at the civic level, Portland is now reaching out to fully engage the community to ensure the success of green roofs.

Key motivators

While many benefits are attributed to green roofs, or ecoroofs as they are called in Portland, the main motivator has been the issue of combined sewer overflow. This issue became critical when a 1994 state mandate required that Portland comply with the *Clean Water Act* and clean up the Willamette River — a significant stretch of which is now a designated Superfund site — the Environmental Protection Agency (EPA) program to clean up hazardous waste sites.

Portland is currently building a pipeline on the west side of the Willamette River and a large pump station to deal with combined sewer overflow. It is also designing an east-side pipeline to reduce combined sewer overflow volume to the river by 94 per cent. The price tag for compliance, based on these structural changes to reduce combined sewer overflow, is estimated at $1 billion.

This strategy, however, will need to be supplemented with additional inflow and management strategies after 2011, when it is anticipated that the new infrastructure will reach full capacity.

The City of Portland Bureau of Environmental Services (BES) began to investigate alternatives to structural changes such as decentralized stormwater management techniques, including green roofs/ecoroofs.

Description of policy

The City promotes ecoroofs but does not require them, except for its own facilities.

Ecoroof requirements for public buildings

All new, city-owned facilities are required to be designed and constructed with an ecoroof that covers at least 70 per cent of the roof. The remaining roof area must be covered with Energy Star-rated roofing material. All roof replacements are required to include an ecoroof when practical.

Ecoroof requirements for private buildings

There are no requirements for ecoroofs for private developments. The City has stringent stormwater management requirements, outlined in its *Stormwater Management Manual*, which directs all development and by which the City retains its federal stormwater permit.

In areas of the city, such as the Central City District, developments must comply with design guidelines that are intended to protect the architectural and cultural integrity of the area. Each project in these areas goes through design review. Ecoroofs, also called "rooftop stormwater facility" in the guidelines, are considered for their contribution towards improving the esthetics around the site in addition to managing stormwater onsite.

Since 2001, the city's zoning code has also offered developers zoning bonuses when they implement stipulated options, such as ecoroofs. The floor area bonus is calculated at three thresholds:

1. A 10–30 per cent ecoroof coverage results in floor area ratio bonus of 1:1;
2. A 30–60 per cent ecoroof coverage results in a bonus of 2:1;
3. A coverage greater than 60 per cent ecoroof results in a bonus of 3:1.

The owner must sign an agreement that ensures roof proper maintenance in compliance with the zoning code. The details and period of such agreements were not clear in the summer of 2005. However, the city perceives maintenance to be a problem.

Another financial incentive being considered is the reduction in charges for stormwater retention by soft landscaping as opposed to impervious area on the site. Buildings with ecoroofs would qualify for such a reduction. This anticipated stormwater fee will offer a 35 per cent reduction in stormwater rates for owners who install ecoroofs with at least 70 per cent of the roof area covered with an ecoroof. Now, the stormwater management charge for commercial, industrial and institutional ratepayers is $6.06 US per 1,000 sq. ft. (93 m^2) of impervious area a month. The current stormwater management charge for single-family residences is $13.30 US a month. The charge appears on the city's water/sewer utility bill and is pro-rated at a rate of $0.43721 US a day.

Policy application

On public projects, all municipal project managers are required to consult the city's

inter-bureau Green Building Advisory Team (GBAT). The GBAT provides upfront assistance and guidance by outlining strategies to meet the Green Building Policy objectives (LEED Gold and Ecoroof). GBAT is, in effect, the City's internal green building consultant.

On private projects there are no additional requirements since the mechanisms to promote ecoroofs all fall with the city's existing framework. For example, the city offers floor area ratio (FAR) bonuses for a variety of development practices that meet the City's objectives, such as providing public art, housing and child care facilities. There are other technical strategies to comply with the *Stormwater Manual and Design Guidelines* similar to low impact development (LID) techniques.

Public outreach and education

The City of Portland's Ecoroof Program has educational and outreach components. Through this program, the city provides technical assistance to building owners considering applying an ecoroof, provides grants for ecoroof demonstration projects, conducts ecoroof tours and monitors ecoroofs.

Process to establish policy

Portland is the first city in the U.S. to pass legislation promoting green roofs, the result of the requirement to conform with the *Clean Water Act*. One response was to develop strategies that would increase surface water absorption and reduce imperviousness around developments.

Portland began to research ecoroofs as a stormwater management tool in the mid 1990s. Encouraged by the results of the research, which showed that an ecoroof was able to retain rainfall, the city funded an ecoroof demonstration exhibit at the Portland Home and Garden Show. City officials surveyed public opinion at the show and found that 75 per cent of the responses were favourable. Based on these results, the City funded, from stormwater fees, two green roof test sites: the 10-storey Hamilton Apartments and five-storey Buckman Terrace.

The successful outcomes from the two test sites encouraged the city to promote ecoroofs as a stormwater management tool.

The city has used a variety of policy structures to support green roof construction. The City provides technical assistance to developers and architects. In addition, the City set up an ecoroof demonstration grant program. Technical data from grant projects is documented and publicly available.

Most public ecoroof projects have been financed by stormwater fees. Portland has a split fee system, with separate charges for water consumption, sanitary discharge and treatment and stormwater management. In 2001, the City split the stormwater fee in two—35 per cent based on drainage on the property and 65 per cent of the fee based on drainage onto public streets, calculated according to the amount of impermeable surface area on the property.

Ecoroofs have been formally recognized as a best management practice in the City's stormwater manual since 1999. The City is considering a discount on the stormwater runoff fee for properties using certain best management practices. Installing a green roof will earn one of the highest discounts.

Since the early 1980s, Portland has recognized green roofs as an asset to the urban environment and created a FAR zoning code bonus that included green roofs. This applies to the dense downtown district, a priority stormwater management area, where zoning limits height-to-floor-area ratio. This original roof garden bonus was not widely used. In 2001, the City added extensive ecoroofs, which use shallower growing media, to the program.

In recent years, a citizen group called Ecoroofs Everywhere has taken the lead in encouraging equitable distribution of green roofs across all income levels. The group creates affordable demonstration projects, secures grants for small-scale developments and negotiates lower prices with vendors.

Portland gained international recognition for its green roof efforts by co-sponsoring the Greening Rooftops for Sustainable Communities Conference in 2004.

Effectiveness

By January, 2004, over 30 new green roofs were built or being built in Portland, including five on government buildings. It is estimated that there are two acres of ecoroofs in Portland with another two acres committed to be built.

By the end of 2004, four developments had benefited from the FAR bonus to implement green roofs.

Portland has raised awareness of the benefits of ecoroofs so effectively that the private sector has begun to construct them on its own initiative. Many people are installing ecoroofs on their houses.

Lessons learned

Portland's support for green roofs is a phased approach, similar to the German model, which has used research to buttress public investment in green roof projects and policies. The City has used subsidies and incentives to encourage private investments in green roofs. Public education and civic consciousness has also been integral to the success of green roofs.

The incentives and subsidies do not seem to have encouraged ecoroofs on industrial buildings, which generally have larger impermeable surface areas.

Predictions

The successful continuation of green roof construction in Portland will likely depend on the success of current programs and policies. Evaluation of Central City Design Guidelines policies is expected. Some parts of the evaluation were presented at the 2005 Greening Rooftops for Sustainable Communities Conference, which the City of Portland and Green Roofs for Healthy Cities co-sponsored. This analysis will become increasingly relevant in determining the effectiveness of ecoroofs in decentralized stormwater management.

It is also expected that a geographical information system (GIS) will be used to identify priority areas for ecoroofs. For these priority areas, it is expected that the city may consider an upfront incentive to partially offset the capital cost of a green roof.

Contact information

Marie Johnson
Senior Planner
Bureau of Planning
City of Portland
(503) 823 5771
mjohnson@ci.portland.or.us

Tom Liptan
Bureau of Environmental Services
City of Portland
(503) 823 7267
toml@bes.ci.portland.or.us

Terry Miller
Office of Sustainable Development
City of Portland
(503) 823.7418
tmiller@ci.portland.or.us

Key literature

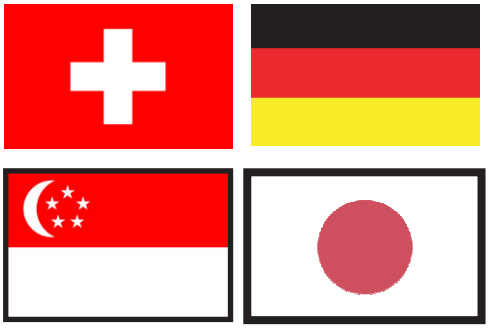
Johnson, M. (2004, June). The Role of Land Use Tools in Portland's Toolbox for Pro-moting Eco-Roofs. Presented at the Greening Rooftops for Sustainable Communities, Portland.

Liptan, T. (2003, May). Planning, Zoning and Financial Incentives for Ecoroofs in Portland. Presented at the Greening Rooftops for Sustainable Communities, Chicago.

Liptan, T. (2005). Portland: A New Kind of Stormwater Management. In Earth Pledge, Green Roofs Ecological Design and Construction (pp. 130-134). New York, New York: Schiffer Publishing Ltd.

12-10-06

International

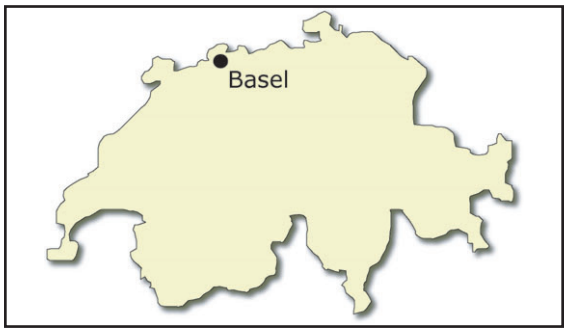


GREEN ROOFS POLICIES WORLDWIDE

Case studies

Basel-City, Switzerland

Key motivators	Energy savings and biodiversity		
Policy phase	6 — Continuous Improvement		
Champion	Multi-sectoral		
Longitude	7°36' E	**Latitude**	47°34' N
Average summer temperature	24°C (75°F)	**Average winter temperature**	-2°C (28°F)
Average annual rainfall	784 mm (31 in.)		



Map showing City of Basel, Switzerland
Scale 1:4,000,000

Description

Located in northwestern Switzerland on the Rhine River and bordering Germany and France, Basel has a population of about 187,000. It is in the most successful economic region of Switzerland, with the pharmaceutical and chemical industries forming the backbone of its economy. Many major Swiss banks have central offices in Basel, giving finance a pivotal role in the local economy. Basel-City is one of 26 cantons (states) of Switzerland with its own constitution, legislature, government and courts.

Basel has a mild climate due to its location in the Rhine valley at an elevation of 277 m (909 ft). It receives Mediterranean air currents and lots of sunshine throughout the year. Winters are characterized by short, cold periods, with longer moderate ones (rain and temperatures between 0 and 5°C [32 and 41°F]). Basel typically has a light snow cover for about 25–30 days, which does not stay on the ground for more than two weeks at a time.

The city is interested in green roofs for energy saving and biodiversity protection. The municipality first explored green roofs as an energy-saving measure for buildings. An electricity tax generated funds. The municipality was quick to involve a variety of stakeholders, such as business associations and environmental organizations, in developing an incentive program.

Green roofs were funded for a two-year period in the mid-1990s to stimulate interest and awareness. Encouraged by the success of this project, funds were allocated for a study documenting the biodiversity benefits of green roofs. The

incentive program, in combination with the outcomes of the research, led to including green roofs in building regulations. Another incentive program is planned for 2005–2006. Basel has reached policy phase 6 as it is exploring means to improve its second incentive program by incorporating quality control measures into the guidelines.

The biodiversity research conducted in Basel has produced convincing evidence that a green roof's can protect endangered invertebrate species. London, England is exploring a similar approach to green roof development as a result of this research.

Use	Percentage
Forest	17%
Agricultural	17%
Building	23%
Recreational	13%
Traffic	25%
Water	6%

Table 8 Land use, Basel-City

Key motivators

Reducing energy consumption of buildings and protection of biodiversity are the key motivators for green roofs in Basel. Research by Dr. Stephan Brenneisen championed green roofs. The research documents and details how green roofs can protect endangered invertebrate species.

Description of the policy

In 1996 and 1997 Basel invested 1 million CHF (Swiss francs) ($670,000 Cdn) in a green roof incentive program. Funding for the program came from electricity fees, a portion of which must be used for energy-saving measures. Another 1 million CHF green roof incentive program is planned for 2005–2006. The Department of Environment and Energy administers the program.

With the success of the first incentive program, in 2002 green roofs were included in building regulations. The regulation states that all new and renovated flat roofs must be greened to provide valuable habitat.

The green roof regulation says:

- The growing medium should be native regional soils — the regulation recommends consulting a horticulturalist.
- The growing medium should be at least 10 cm (4 in.) deep.
- Mounds 30 cm (11 ½ in.) high and 3 m (10 ft.) diameter should be built at random to foster insect life.
- Vegetation should be "Basel mix" — a mix of native plant species.
- Builders of green roofs on flat roofs 1,000 m^2 (10,764 sq. ft.) or more must consult Dr. Brenneisen during design and construction.

Basel has reached policy phase 6. It has implemented incentive and regulatory tools to promote green roofs in its jurisdiction and is now exploring ways to enforce compliance with design specifications.

Process to establish policy

The Department of Environment and Energy conducted a poll to determine the level of support for an electricity tax to pay for energy-saving measures. The results favoured a tax and the city explored energy-saving ideas, including green roofs. The city consulted various stakeholders when considering green roofs and in establishing the first incentive program. Stakeholders included the local business association, the horticultural association, the green roof association, the Pro Natura Basel environmental organization, the department of parks and cemeteries and the National Department of Environment, Forest and Landscapes.

The Department of Environment and Energy decided to pursue and promote green roofs and launched the first incentive program.

The incentive program spurred interest in research on the biodiversity protection benefits of green roofs. Dr. Brenneisen received 40,000 CHF to carry out the research, which discovered that green roofs have great potential as valuable habitat for invertebrate species and birds and could be designed to maximize biodiversity by using native plants and soils, varying topography, bare patches and using wood and rocks.

This research, in combination with the success of the incentive program, led the City to institute green roofs in building regulations. Dr. Brenneisen's study was a key part in setting green roof design specifications.

Effectiveness

In 1996–97, 135 people applied for a green roof subsidy, which led to 85,000 m^2 (915,000 sq. ft.) of roofscape being greened. The program led to a further investment of 13 million CHF. Energy savings totalled 4 GW/year.

Media interest in the program was high, which played a large part in its success and gained nation-wide profile for Basel. To aid with the promotion of the program, the city held a contest for the best looking green roof.

Since 2002, when the city mandated green roofs for all new and renovated flat roofs, about 15 per cent of flat roofs in Basel have been greened.

Lessons learned

It is important to involve all stakeholders from the beginning to address questions and concerns and ensure that everyone's goals are being met.

The incentive program succeeded in part because all stakeholders benefited. Local business profited from sales of materials and supplies, building owners realized energy savings and Basel gained nation-wide profile.

Predictions

Estimates are that through the green roof regulation, 30 per cent of all flat roofs in Basel will be greened within the next 10 years.

Basel is now exploring ways to enforce quality of green roofs. The incentive program planned for 2005–06 will give subsidies to applicants who show that the city's conditions will be met.

Applicability to Canada

Basel's incentive program is an interesting approach in that it concentrated efforts in a two-year program, which significantly raised the profile of green roofs. The large financial investment may be difficult for Canadian municipalities to equal. However, there may be an opportunity to partner with electrical or water utilities to raise revenue.

The establishment of the regulation was met no resistance, largely because all parties were involved in the process from the beginning. It was also accepted because of the success of the incentive program. Canadian municipalities interested in creating momentum and acceptance for green roofs could consider a Green Roof Task Force that includes a wide variety of stakeholders.

Basel's regulation is used to specify the type of green roof required, in this case the purpose being biodiversity protection. Given that the regulation in Basel is fairly new, there was no mention of required green roofs not being properly maintained. However, ensuring design and construction quality is the next step in the green roof development.

Contact information

Dr. Stephan Brenneisen
Research Fellow and Green Roof Director
University of Wädenswil
s.brenneisen@hswzfh.ch

Key literature

Brenneisen, S. (2004, June). *Biodiversity Strategies to Agricultural Productivity*. Presented at the Greening Rooftops for Sustainable Communities Conference, Portland.

Brenneisen, S. (2003, May). *The Benefits of Biodiveristy from Green Roofs*. Presented at the Greening Rooftops for Sustainable Communities Conference, Chicago.

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Münster, Germany

Key motivators	Stormwater management		
Policy phase	6 — Continuous improvement		
Champion	Municipality		
Longitude	52°13 N’	**Latitude**	7°70 E’
Average summer temperature	23°C (73°F)	**Average winter temperature**	0°C(32°F)
Average annual rainfall	756 mm (30 in.)		

Description

Münster is a low-lying, flat area with a temperate climate. The city has been concerned with the effects of increasing urbanization since the 1970s and, more recently, stormwater management. Its sewer system is primarily separate for storm and waste water, with a few combined system areas on the city outskirts. Münster has 605 km (376 mi.) of waterways that it is working to restore and protect.

The municipality promotes green roofs through tools and incentives. In 1991, Münster applied a stormwater fee, based on the amount of impervious surface on a property. Installing a green roof reduces the fee by 80 to 90 per cent, based on its water retention capacity. Residents can also apply for a state-funded incentive of €15 /m^2 for a green roof. The city administers the incentive.

Münster has reached policy phase 6, evident through its implementation of various incentives and efforts to revise these to meet current environmental concerns.

Use	Percentage
Building	11.4%
Traffic	6%
Agricultural	64.3%
Forest	15.1%
Recreational	1.1%
Water	1.9%
Other	0.5%

Table 9 Land use, Munster

Key motivators

The effects of increasing urbanization, such as a lack of green space, have concerned Münster since the late 1970s. Early incentive programs were aimed at increasing green space and improving the quality of life in the downtown core.

In the early 1990s, stormwater management was added to the list of program goals, to decrease the load on the sewer system and to protect the city’s extensive waterways. The city’s fee system encourages stormwater source control measures.

Description of the policy

Münster has a history of financial incentive programs dating back to the late 1970s. The programs provided subsidies for a variety of ecological initiatives to encourage green development and offset the effects of increasing urbanization. These programs have since ended, with the most recent City-run incentive program finishing in 2002.

There are two tools used to provide green roof incentives: a state-level stormwater man-agement program of North Rhine-Westphalia (NRW) and a stormwater fee.

The stormwater fee is €0.44/m² per year. If stormwater runoff is directed into ponds, rivers, creeks, or seeps into the ground, no stormwater fee is levied. If a green roof is installed, the stormwater fee is reduced by 80 per cent to €0.09/m² of green roof per year. A green roof with high retention incurs a charge of only €0.04 m². There are also fee reductions for retention ponds, infiltration systems and removal of impervious surfaces.

Property owners receive a water bill that states the amount of pervious and impervious surface area on their property. The public work department oversees the program and the municipal tax services department administers the fees — used for maintenance of the sewer system — and discounts.

The table below outlines the savings from greening a garage roof 50 m² (538 sq. ft.).

The roof greening benefits are even greater for large developments. An industrial area with 17,000 m² (183,000 sq. ft.) of conventional roof pays up to €7,480 a year in stormwater fees. Greening this area reduces the annual fee to €1,496 a year.

Münster has reached policy phase 6, having implemented incentive programs to encourage green roofs and now using a fee system to promote their use. The periodic revision of the financial incentive program for greening initiatives demonstrates the "continuous improvement" aspect of this phase.

Process to establish the policy

In the late 1970s, Münster established a financial incentive program to subsidize environmentally friendly initiatives. The aim of the program, Improving the Quality of Living in the Downtown Core, was to offset the increasing amount of asphalt and concrete within the city and to improve the local climate. This program ran successfully for a number of years and led to increased environmental awareness and knowledge within the community. Building on this momentum, Münster implemented a stormwater fee in 1991 and established a rainwater management program.[24]

The incentive program was merged with the rainwater management program in 1993, which gave rise to a new program, Depaving and Greening. This program combined aspects of both the downtown improvement and rainwater programs. [25] In 1994, the city modified the program again, simplifying the guidelines and expanding the area for the incentive. Measures to improve rainwater retention and re-use rainwater were also included. This program, Green vs. Gray, was allotted €25,000 a year and subsidized green roofs in the amount of €15 per square meter. [26] Program goals included stormwater source control and improving the visual landscape, primarily in the densely built downtown core. [27] Initiatives carried out downtown (see figure 9 for outline of area) received an additional 20 per cent funding. Guidelines for this program are included at the end of this case study. This program ended in 2002 because of financial constraints.

The stormwater fee is still in effect today. According to Gräser [28] this fee was established in order to provide home and property owners with an incentive to deal with rainwater at its source, while consequently reducing stormwater loads on the municipal sewer system. Moreover, it would create a just means of levying stormwater taxes, forcing developers to pay for the stormwater their properties generate, while simultaneously reducing waste water charges for apartment dwellers and other owners of small properties.

	Stormwater fee — m²/yr	Annual cost	Yearly savings	Savings after 40 years
Conventional garage roof	€0.44	€22	—	—
Extensively greened	€0.09	€4.50	€17.50	€700

Table 10 Stormwater fee reductions, garage roof 50 m² (538 sq. ft.)

[24] City of Münster. (2001). Grün gegen Grau. Entsiegelungs- und Begrünungsprogramm. Münster, Germany: Tiefbauamt.
[25] Ibid
[26] Gräser, B. (2002). Interview on May 6, 2002. Münster, Germany: Tiefbauamt.
[27] Ibid
[28] Ibid

Figure 9 Münster's downtown core.

Effectiveness

The Green vs. Gray program greened about 1,000 m² (10,700 sq. ft.) of roofscape each year. Funds for the program were fully spent every year because of the high demand. Applications were mainly from homeowners wanting to extensively green their garages or carports. By 2002, approximately 12,000 m² (130,000 sq. ft.) of green roofs had been planted through the incentive program.

The stormwater fee has also been successful, particularly evident by its acceptance among residents. According to von Trümbach, seeing the amount of impervious surface area on a water bill has been a motivating factor in getting property owners to implement stormwater source-control measures. It is difficult to determine how many green roofs were installed as a result of the stormwater fee alone, as the NRW incentive program is a major motivator.

Lessons learned

Establishing and managing a stormwater fee is a substantial administrative task. The amount of impervious surface on each property is first assessed from information submitted by property owners and verified by city staff. Impervious surface area can also be determined through maps and aerial photographs.

When a green roof has been installed, public works visit the site to verify project completion and then inform the municipal tax department.

Predictions

The installation of new green roofs is expected to decrease in 2006, when the NRW incentive program expires. The stormwater fee will still provide an incentive to install green roofs; however, coupling the fee with the incentive program has proven to be a key combination.

Applicability to Canada

A stormwater fee holds potential as an indirect financial incentive for green roofs in Canada, especially where stormwater management is a key motivator. This approach is gaining considerable momentum in Germany as more municipalities have implemented this structure to increase transparency in water billing by using the "polluter pays" principle.

Benefits of a stormwater fee include revenue generation for municipalities, or at least offsetting the cost of administration. Such fees can be implemented in new and existing areas and would be especially beneficial in areas with combined sewer systems subject to overflow. Similar to direct financial incentives, green roofs installed as a result of the fee are done so voluntarily and longterm maintenance of the green roof is more likely.

A drawback to this approach is its administrative requirements. Municipalities with a large area will find it time consuming to determine the amount of impervious surface area in their jurisdiction, whereas smaller municipalities may find the time and cost associated with administration to be exhausting.

Green vs. Gray program guidelines

1. General

A) Measures listed under heading three are eligible for funding. These measures must be within the area serviced by Münster's combined and storm sewer systems.

B) Measures carried out within Münster's downtown core will receive supplemental funding.

C) No one who receives funding from the NRW state program is eligible for funding from the Green vs. Gray program.

D) The funding will be paid in a one-time amount.

E) Regulations set out in local development plans, building ordinances, the water bylaw and the monument bylaw must be heeded.

F) Applicants cannot make any legal claims on the subsidy.

2. Individuals or Parties Eligible for Funding include:

A) Home or property owners

B) Tenants or lessees with the approval of landlords.

C) Housing associations or other legal entities

D) Business owners (including legal entities)

3. Measures Eligible for Funding

A) The conversion of impervious surfaces (i.e. concrete, asphalt, pavement) into surfaces that promote the natural seepage of rainwater.

B) The establishment of playgrounds, as long as no impervious surfaces are created. Exempt from funding are those playgrounds required under existing law.

C) The planting of tall-stemmed, indigenous, deciduous trees appropriate to the location.

D) The greening of facades.

E) The filtering and retention of relatively clean rainwater collected from rooftops on one's own property (calculated according to the area of the roof).

1. For the retroactive redirection of rainwater into:

   - the ground

   - basins, or ponds without waterproof liners

   - infiltration ditches

   - basin-infiltration ditches

2. For the construction of:

   - water retention ponds, cisterns that hold at least 30 L of water per m^2

F) Green roof retrofits, or the roof greening of a new building.

G) The construction of systems/units that collect, filter and reuse rainwater in flush toilets or for watering plants.

4. Conditions for Funding

A) Municipal funding will only be awarded if funding from federal or state (NRW) programs is not available.

B) Any systems constructed for the management or reuse of rainwater must be tech-nically sound and meet the required standards.

C) Subsidies will only be granted if:

   - measures have not yet been initiated. The city can, however, make exceptions for measures that have already been begun, if adequate funds are available,

   - the ability of ponds or grounds to facilitate natural seepage has been approved by the public water authorities,

   - the system for the collection and reuse of rainwater will not be connected to a washing machine.

D) Subsidies will not be granted for:

   - measures that qualify as tax write-offs,

   - additions to existing gardens (i.e. plantings),

   - measures that costs less than €€153.39.

5. Amount of Funding

A) Removal of impervious surfaces: €15.34 per square metre of permeable surface.

B) Private playgrounds: €12.78 per square metre of permeable surface

C) Deciduous trees: the city will cover 50 per cent of the costs, but no more than €11.29 per property.

D) Façade greening: the city will cover 50 per cent of the costs for plants, labour and climbing aids.

E) Natural seepage and retention: €3.07 per square metre of roof area drained.

F) Green roofs: €15.34 per square metre of greened area.

G) Systems that collect, filter and reuse rainwater: €1,533.88 per unit.

H) Any of the above-mentioned measures that are carried out within the downtown core will receive an extra 20 per cent funding.

6. Application Process

A) Applications must be handed in before begin of the initiative.

B) The following must be included with the application:

   - Site plan at a scale of 1:500

   - Site plan at a scale of 1:100, outlining proposed initiative

   - Cost estimate

   - Additional information required for:

   - Systems that collect, filter and reuse rainwater: questionnaire re methodology

   - Natural seepage: documents supporting the permeability of the ground and if applicable, the allowance for this type of project.

7. Award of Grant, Payment

A) The municipality will judge the application based on its compliance with the program regulations. In certain cases, the approval of the application may only be given if certain conditions are met.

B) The payment of the subsidy will be made once proof of payment has been submitted and the project has been inspected and approved.

C) Should the costs of the project turn out to be less than stated on the cost estimate, the appropriate reductions will be made or the subsidy will be withdrawn.

D) The subsidy amount granted cannot be increased at a later date.

E) The subsidy may be withdrawn if the initiative is not completed within one year after receiving approval of the grant. The time period may be extended to two years if special circumstances exist and a written request is submitted.

8. Failure to Comply with Regulations

The municipality reserves the right to withdraw the subsidy, should the applicant fail to comply with the regulations of this program, or with the conditions necessary for approval of the application.

9. Effective Date: July 1, 1994

City of Münster

Application for a Municipal Subsidy from the Green vs. Gray Program

1. Property owner (name, address, telephone number)_____

2. Applicant (name, address, telephone number)_____

3. Address (address at which the project will be carried out)_____

Proposed Measure	Total Area (m^2)	Costs (€)
Removal of impervious surface		
Playground		
Planting of deciduous trees	N/A	
Façade greening	N/A	
Natural seepage		
Roof greening		
System to collect, filter and reuse rainwater		
Total costs		

The building is a:

____ single-family home ____ multiple-family home

____ commercial building ____ garage/carport

Declaration:

1. I am personally capable of financing the portion of the project not covered by the subsidy.

2. I am aware that the municipal subsidy may be withdrawn if:

- I fail to comply with the program guidelines
- I begin with the project before my application is approved, or if I do not com-plete the project within one year of receiving approval.

3. I am aware that I may not receive tax deductions for this project.

4. For green roofs: I declare that the loading weight of the roof to be greened is capable of supporting the proposed green roof system.

5. Included in this application is:

- A site plan
- A site plan at the scale of 1:100 outlining the proposed measures
- Cost estimate
- For systems to collect and reuse rainwater: completed questionnaire
- For seepage: documents supporting the permeability of the ground
- I agree to voluntarily provide my personal information, which is necessary to process this application.

Signature, Date _____

Contact information

Frank von Trümbach
Tiefbauamt
Public Works Department
City of Münster
0251/492-6975
frank.von-truembach@stadt-muenster.de

Key literature

City of Münster. (2001). Grün gegen Grau. Entsiegelungs- und Begrünungsprogramm. Münster, Germany: Tiefbauamt.
Gräser, B. (2002). Interview on May 6, 2002. Münster, Germany: Tiefbauamt.

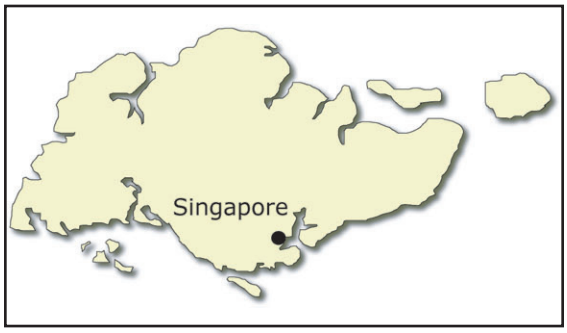
12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Singapore

Key motivators	Urban esthetics – "Skyrise Greening"		
Policy phase	5 — Program and policy development		
Champion	Municipal		
Longitude	1°N	**Latitude**	104°E
Average summer temperature	27°C (80°F)	**Average winter temperature**	26°C (78°F)
Average annual rainfall	2,250 mm (88 in.)		



Map showing Singapore
Scale 1:4,000,000

Summary

Singapore's green roofs fit in the government's overall agenda of promoting the city as the "Garden City." Singapore is a small island with tropical temperatures and heavy rain. Because of the scarcity of land, high-density developments are common. Green roofs are seen to fit within the overall strategy to green such developments. Singapore officially calls this part of "Skyrise Greening."

The driving force for Skyrise Greening and green roofs comes from the public sector. Various departments within the government have worked to make this a success. Representatives of Singapore's government have taken time to travel worldwide and have visited Germany and Canada to study green roofs.

The Singapore government did significant technical research related to life cycle costing and energy benefits and has moved to phase 5 to include green roofs as an acceptable measure for density bonuses. Part of phase 5 is education and outreach; Singapore's National Parks Board has produced a very detailed guide to green roofs.

Description

Singapore, located on one main island and about 60 small adjacent islands off the southern tip of the Malay Peninsula, has a population estimated at 4,240,000. The main island is densely populated, especially in its south-central portion, the location of the central business district and the main port. The scarcity of undeveloped land and green space creates a natural appreciation for greenery.

Singapore's total area is 699 sq km (270 sq mi). Singapore has a wet, tropical climate with an average annual rainfall of 2,250 mm (89 in.). Most rainfall is during the northeast monsoon, from November to March. During the southwest monsoon season, from June to September, much of the rain falls in short, intense showers that alternate with sunshine. Thunderstorms are frequent in April and October. The average daily humidity is 84 per cent and at night, it is often more than 90 per cent.

There are no distinct seasons in Singapore. The temperature is much the same year round. May and June are usually the sunniest months, while December and January are slightly cooler and receive the greatest amount of rain.

More than 60 per cent of Singapore Island is residential, commercial and industrial. Jungles and swamps once covered it, but today only a small area of the central hills retains its natural jungle cover. One of the island's largest remaining tracts of undisturbed (primary) rain forest is protected in the 163-hectare (405-acre) Bikut Timah Nature Reserve. Since the early 1960s, land reclamation projects have been replacing Singapore's once expansive coastal mangrove forests with developed areas. The reclamation projects have increased the nation's total area by 20 per cent.

Although Singapore has many short streams and several reservoirs, the country lacks sufficient fresh water. About half its water is imported from Malaysia by pipelines. Closely regulated government controls on emissions, effluents and other wastes alleviate the effects of rapid economic and industrial growth.

Key motivators

Singapore is a clean and green city. The continuous efforts to make Singapore a "Garden City" have resulted in lush greenery throughout the island.

With Skyrise Greening, even the concrete structures of Singapore are expected to form the fabric of the Garden City in creating a total garden environment. The main driver is to market Singapore as a "City in a Garden."

The appreciation of multiple benefits of skyrise greenery include reduction of urban heat island effect and reduction of energy use for cooling.

Description of policy

In general, rooftop greenery is promoted by not including certain portions of the areas used for greenery in the calculation of a building's gross floor area. These policies are part of a regulatory framework implemented the Urban Redevelopment Authority. Some of the specific measures are outlined below:

Gross floor area (GFA) exemption for sky terraces

Sky terraces at intermediate levels of a building that are shaded by an overhang, floor or structure with open-sided areas available for communal activities or landscaping with constant public accessibility are excluded from the calculation of GFA. Sky terraces provide communal spaces and greenery for medium or high-rise developments. They also add visual interest to the building architecture and design.

Guidelines encouraging balconies in residential developments

Encouraging balconies in residential developments supports "Garden City Ambiance." The GFA of balconies in residential developments can equal more than the master plan (MP) allowable gross plot ratio (GPR) by up to 10 per cent. To make sure balconies are suitable for sky rise gardening, at least two sides must be open. Service balconies used for drying clothes are not accepted for GFA. This policy applies to existing and new residential buildings. An amendment to this policy includes mixed use and hotel developments.

GFA exception for covered roof top areas, public thoroughfares and public spaces

To encourage more interesting roof design and better use of rooftops, GFA calculations exlcude:

- Rooftop pavilions
- Sky terraces at intermediate levels of a building that are shaded by an overhang, floor or structure with open-sided areas available for communal activities or landscaping with constant public accessibility.

GFA exemption for covered communal areas and shadow areas for the developments

To encourage more covered landscaped communal areas and greenery, certain areas are exempt from GFA computation subject to conditions:

- Communal landscaped areas on the first storey.
- 50 per cent must be enclosed and accessible for community activities.
- Must be landscaped with a variety of vegetation and add substantially to the greenery of the environment.
- Communal sky bridges linking blocks within single development.
- Covered leftover landscaped communal space at the first storey created by driveways or drop off points.
- Must be a communal area and landscaped.

Guidelines for rooftop pavilions

To promote activities on rooftops, a GFA exemption can be granted to buildings that are not landed housing developments. Several requirements must be met in order to obtain this exemption:

- Applies to single storey (under 6 m [20 ft.] high) with a non-bearing roof cover and pavilions with a maximum of 50 per cent of perimeter enclosed.
- The pavilion can be partially attached to the main building with 50 per cent of its perimeter attached.
- Pavilions coverage must be at least 50 per cent landscaped and must only be accessed from common areas and used for communal activities or as part of landscape features.
- The pavilion will not be counted as GFA if it is used for commercial purposes.
- Does not apply to landed housing developments since there is no communal use of pavilions there.

Research and educational programs

The National Parks Board organizes a series of skyrise garden exhibitions to encourage gardening in high-rise environments, including on rooftops. The Housing Development Board and the National Parks Board are working on research projects on applying green roof technology on public residential buildings.

The National Parks Board publishes a series of publications on Skyrise Greening to promote the benefits of greening the high-rise environment. More information on these publications is available on its website at http://www.nparks.gov.sg

Process to establish policy

The relaxation of GFA regulations result from a desire to improve skyrise greenery in Singapore.

The research and educational programs have been directed through demonstration projects and the development of two handbooks. Information from the research has been made available to the public through the downloadable handbook at the National Parks Board website and seminars targeted at industry players.

Effectiveness

There is no available measure of effectiveness. Informal observations indicate that there is a trend for rooftop gardens in new commercial and residential developments. One measure of increased green roof construction is the presence of green roof technology suppliers in Singapore.

Applicability to Canada

From a geographic and climate perspective, Singapore does not have many similarities to Canadian jurisdictions. Nonetheless, Canadian jurisdictions could adapt the approach in areas with high-density development or where green roofs might increase real estate value. Providing incentives through relaxed development requirements to promote green roofs would work where green roofs can provide amenity space or where green roofs can improve the esthetics of the development.

Relaxing the development requirements and a strong educational and promotion program — key features of Singapore's success in green roofs — could apply to many Canadian jurisdictions.

Contact information

Mr. Seow Kah Ping
Deputy Director
Physical Planning/Policy
Urban Redevelopment Authority
Singapore
6321 8055
seow_kah_ping@ura.gov.sg

Dr. Tan Puay Yok
Assistant Director
Research Division
National Parks Board
Singapore
6471 7834
tan_puay_yok@nparks.gov.sg

Key literature

National Parks Board, Singapore. (2002). *Handbook on Skyrise Greening in Singapore.* National Parks Board & Centre for Total Building Performance, University of Singapore. Retrieved March 2005, from http://www.nparks.gov.sg/publications/handbook_sg.shtml

National Parks Board, Singapore. (2005). *Skyrise Greenery.* Retrieved March 2005, from http://www.nparks.gov.sg/gardencity/skyrise.shtml

Urban Redevelopment Authority (URA), Government of Singapore. (2005). *Handbook on Gross Floor Area.* 2005 Edition. Retrieved March 2005, from http://www.ura.gov.sg/circulars/text/dcdgfahb_d0e4.htm

Weng, H.W. (2004). *Green Roofs in Singapore* (171-176). Presented at the International Green Roof Congress, Nurtingen, Germany.

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Stuttgart, Germany

Key motivators	Air quality		
Policy phase	6 — Continuous improvement		
Champion	Municipal		
Longitude	48°68' N	**Latitude**	9°21' E
Average summer temperature	18°C (64°F)	**Average winter temperature**	-1°C (30°F)
Average annual rainfall	731 mm (28.78 in.)		

Summary

Green roofs have a long tradition in Stuttgart. The first green roof was built in the 1920s and still exists today.

Stuttgart's location in a valley basin, its mild climate, low winds and surrounding industrial activity made it susceptible to poor air quality as early as the 1970s. Built forms on the valley slopes have made the situation worse by preventing air from moving through the city, which contributes to the urban heat island effect.

City officials set out new zoning and building regulations to improve air quality, including increasing the amount of green space. Green roofs, championed by the head of the planning department, were recognized as a way to improve air quality.

In 1985, Stuttgart became the first German city to include green roofs in its local development plans. In 1986. the city set up a financial incentive program that is still in effect . Stuttgart also greens publicly owned buildings as a demonstration of its commitment to green roofs. Stuttgart has reached policy phase 6 as the City is working on improved quality control and inspection.

Stuttgart's incentive program is successful. Funds are exhausted each year.

Description

Stuttgart is the capital of the state of Baden-Würtemburg and has a population of approximately 600,000 . The city is located in the centre of an industrial region of more than two million and is well-known for its high-tech industry

Geographically, Stuttgart is extends through two valleys (ringed with vineyards and forests) lying at right angles to each other. The main part of the city is surrounded by steep slopes on three sides, with the rest of the city located along the open valley of the Neckar River.

Stuttgart has a mild, temperate climate with warm summers, moderate enough to allow wine production on its valley slopes. Wind speeds throughout the city are generally low, which along with the urban heat island effect, contributes to poor air quality (at times) and mild climatic conditions. Stuttgart's climate is mostly affected by altitude. The downtown core, at an elevation of 207 m (679 ft.), can have winters with no snow coverage, while higher regions at 549 m (1,800 ft.) can have up to 54 days of coverage. On average, temperatures dip below zero degrees Celsius 77 days a year.

Use	Percentage
Buildings	29.3%
Traffic	14.3%
Agricultural	24%
Forest	23.8%
Recreational	5.3%
Other	3.1%

Table 11 Land use, Stuttgart

Key motivators

Stuttgart's industrial activities and location in a valley basin make it especially susceptible to poor air quality. A study in the early 1990s examining how landforms and structures affect the movement of air through the city identified the surrounding slopes, forests and agricultural areas as major sources of fresh air for the city. The pollution problem resulted from increased urban growth onto valley slopes, which replaced vineyards and trees with built form.

These findings had a significant impact on city planning. The city established an environmental department to assess proposed developments and their effect on the local climate. The city's zoning plans identified areas that are key to the health of the local climate or that lacked sufficient plant life. Planners were challenged to improve the urban climate, which meant preventing development in areas vital for fresh airflow and prohibiting new buildings where they would hinder the movement of air. Planners were also called upon to create new green spaces to improve the climate.

Description of the policy

The City of Stuttgart promotes green roof development by:

- greening public buildings,
- offering a financial incentive for building/homeowners and
- regulating green roofs in local development plans.

Its long green roof tradition places Stuttgart in phase 6 of policy development as the city continues to improve its current programs with quality control and inspection measures.

Public buildings

To demonstrate its commitment to green roof development and environmental improvements, Stuttgart has been greening the roofs of public buildings since 1986. It sets aside €90,000 annually, with most green roofs being installed when the roof is due to be replaced.

Figure 10 Extensive green roof on publicly owned parking garage in Stuttgart.

Direct financial incentive

Stuttgart's established it financial incentive program for green roofs in 1986. It is administered by the city's planning department. The program, which has €51,000 available a year, pays for 50 per cent of the costs, or up to a maximum of €17.90 per square metre.

To apply for the grant, an application must be accompanied by a site plan, green roof design plan and estimated costs. Free consultations are available from the city parks and cemeteries department. (See page 82 for the program guidelines.)

The city also produces a "how to" brochure about roof greening. It covers topics such as: benefits, extensive and intensive, weight and waterproofing, green roof systems, choosing plants (with lists)

and maintenance. The brochure outlines specific criteria and functions a green roof should have, such as 30 per cent water retention capacity, and gives the FLL as the design standard.

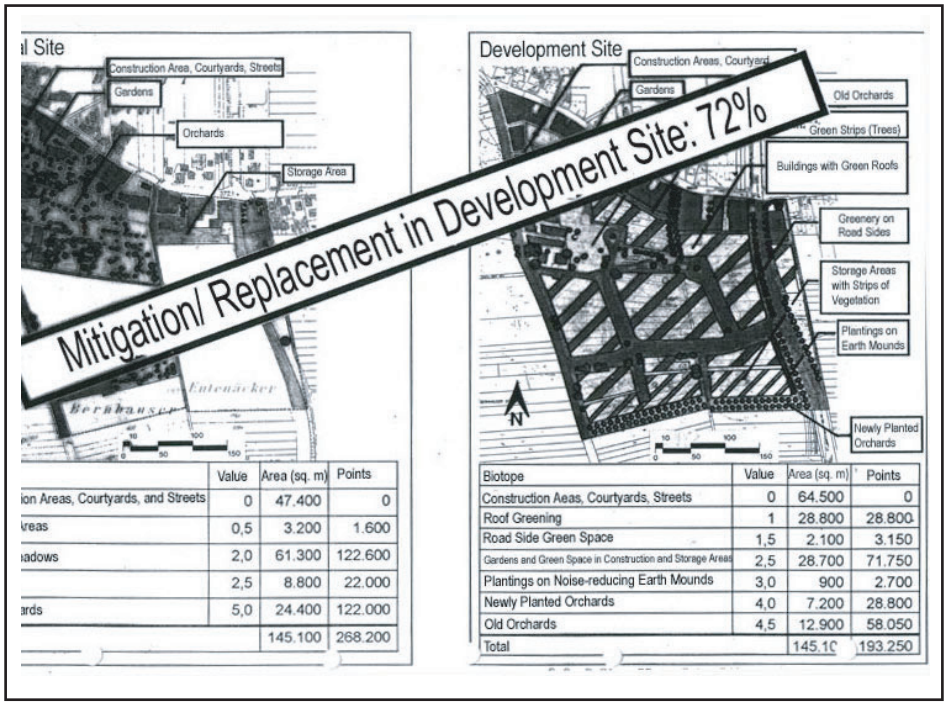
Green roof regulation

Local development plans first regulated green roofs in 1985, in an industrial area called Weiler Park. The regulation states that all flat roofs and roofs sloped eight to 12 degrees must be extensively greened with a minimum growing-medium depth of 12 cm (4.7 in.) Specifying growing-medium depth is an important component of the regulation, as it is a way to ensure compliance later.

Green roofs can also be regulated through the federal Ecological Compensation and Replacement Measure, which states that environmental disturbances must be avoided, minimized or mitigated.

Figure 11 shows an ecological compensation and replacement analysis conducted in Stuttgart-Plieningen. This analysis assigns values to various ecological features of a site before and after development. The difference between the two numbers determines the extent of mitigation required.

The area before the construction had a value of 268,000 points; after the proposed development it would have been 193,250 points — even after mitigation measures — because of the increase in impermeable surfaces. According to this assessment, the developed area will contain only 72 per cent of the originally occurring biological features, requiring that a replacement measure be carried out at another location. This may be achieved through greening or



	Value	Area (sq. m)	Points
ion Areas, Courtyards, and Streets	0	47.400	0
reas	0,5	3.200	1.600
adows	2,0	61.300	122.600
	2,5	8.800	22.000
rds	5,0	24.400	122.000
		145.100	268.200

Biotope	Value	Area (sq. m)	Points
Construction Aeas, Courtyards, Streets	0	64.500	0
Roof Greening	1	28.800	28.800
Road Side Green Space	1,5	2.100	3.150
Gardens and Green Space in Construction and Storage Areas	2,5	28.700	71.750
Plantings on Noise-reducing Earth Mounds	3,0	900	2.700
Newly Planted Orchards	4,0	7.200	28.800
Old Orchards	4,5	12.900	58.050
Total		145.10	193.250

Courtesy of the City of Stuttgart

Figure 11 Intervention-mitigation analysis conducted in Stuttgart-Plieningen (translations by author)

naturalization measures in another area in the city.

Note that green roofs are assigned a value of 1, whereas conventional roofs are allocated a value of zero. If the green roofs had not been included in this development project, the developed area would only have had a value of 164,450 points, resulting in only 61 per cent of the original biological features being accounted for, a difference of 11 per cent . Green roofs present a unique compensation opportunity by allowing mitigation and replacement measures to be conducted on site.

Trade-offs or compromises with developers are a common element of the roof greening process. For instance, exceptions can be made for architectural reasons, such as arched roofs, which although technically can be greened, are exempted from the regulation for esthetics. Compensation typically involves installing vegetation elsewhere such as planting trees at grade.

Process to establish policy

In Stuttgart, the notion of greening rooftops was first met with skepticism. Common arguments against green roofs were the higher upfront capital costs and the fear of water leakage. This was evident in the case of Weiler Park, the first area where green roofs were regulated for all flat roofs.

The development of Weiler Park was a controversial issue because of its proposed location on prime agricultural land. It was thought to be too expensive and incapable of attracting companies due to the additional capital costs. Through a series of compromises, which included extensively greening all rooftops, the development

received approval. The green roofs were to improve the microclimate, manage stormwater runoff and improve the esthetics of the development. The industrial park is situated in a small hollow at the crossroads of two major highways and a railway line that render its roofs entirely visible.

The now-retired head of the planning department, Albert Ackermann, championed the green roof movement in its early days, attending all public, board and developer meetings to address questions and concerns. His persuasive powers, persistence and political support are responsible for Stuttgart's green roof success.

Effectiveness

All approaches promoting green roofs in Stuttgart, have proven successful. To date, 105,000 m^2 (1,130,210 sq. ft.) of public roofscapes have been greened.

The financial incentive program has greened 55,000 m^2 (592,000 sq. ft.) to date. The demand for funding is high and often applications have to be declined because of insufficient funds.

There is no data on the amount of roofscape greened as a result of the building regulations.

Lessons learned

Regulating green roofs should be approached with caution. While it is the most effective method by which to increase the amount of roofscape greened, it can also can be detrimental in the long run as mandatory green roofs may not be properly maintained. A neglected green roof can give the roof greening movement a negative image.

It is important that the building owner–developer perceive the green roof to be an asset as opposed to something that is simply being forced upon them. When the green roof is visible, or can be used, acceptance (and the likelihood of maintenance) is much higher.

Applicability to Canada

The financial incentive program and regulations for green roofs have had a profound effect on green roof development in Stuttgart. Furthermore, the city's commitment to greening public roofscapes has demonstrated its trust and belief in the technology.

Financial incentive programs

On the positive side of incentive programs, subsidies target parties who are genuinely interested in the idea and therefore more likely to properly maintain their green roofs. The incentive program can be targeted to specific areas or building types and can be used to meet various environmental needs. This type of program would work well for priority renewal or densely built areas as well as for retrofit projects.

On the other hand, financial incentives require a significant investment by the jurisdiction if the incentive is to be worthwhile. There should be a certain level of public awareness to ensure adequate interest in the program, which could be coupled with a marketing campaign. Municipalities should also be prepared to provide support to program applicants. This might include an initial consultation session, basic information on the benefits of green roofs, a list of local contractors and suppliers and so on.

Regulating green roofs

Regulating green roofs is an option in the face of budget constraints. In Stuttgart, this approach is used for new development, as it is not suited for retrofit projects. Regulations can be used to meet specific environmental goals by specifying the type of green roof that must be installed and is the most effective way of ensuring a target amount of roofscape is greened.

Demonstration projects

Canadian municipalities interested in promoting green roofs may consider greening public buildings to demonstrate their commitment to and trust in green roof technology. Accessible green roof demonstration projects are an excellent way to raise awareness and educate. An outreach and marketing campaign that directs media attention to the demonstration would help ensure adequate publicity. Campaigns could be targeted to different groups such as homeowners and developers, to address concerns specific to the group.

Guidelines — Green roof incentive program

1. Goals of the Subsidy Program

The goal of this program is to increase the aesthetic quality in densely populated and compact urban areas in Stuttgart, as well as to improve the climate and its urban ecology. To facilitate these goals, the City of Stuttgart will provide subsidies for the roof greening on private buildings within the limits of the budget set aside for this purpose.

2. Areas Eligible for Subsidies

The subsidy program applies to the entire city of Stuttgart.

B) Areas not eligible include:

- Areas designated for rehabilitation as designated in the urban development subsidy bylaw

3. Type of Support

A) Consulting services are available to building owners, tenants or other eligible persons.

B) Subsidy grants.

C) Approaching building owners in possession of buildings suited for roof greening.

4. Preconditions for the Grant of a Subsidy

A) Roof greening measures that consist of a growing medium-based, continuous structure are eligible for funding (i.e. container gardens are not eligible).

B) Not eligible for subsidies are:

- buildings that require green roofs as designated in the local development plan,

- plants in containers or pots or other similar measures,

- gravel layers, slabs, timber or other similar material for the construction of roof terraces

- measures that have been initiated before receiving grant approval.

C) Measures must not conflict with building regulations, building codes or with the bylaws for the protection of historical buildings. Any necessary documentation for the authorization of the measure must be submitted before approval of the grant.

D) Proof that financial resources, in addition to the grant, are available for the proposed green roof must be submitted.

E) Any measures funded may not be used as grounds to raise rents.

F) Property owners and other eligible persons must be committed to maintaining the subsidized green roof for at least 10 years after its installation.

G) Applicants must transfer all responsibilities associated with the subsidy to their successors in interest.

5. Amount of Subsidy

A) The subsidy will cover 50 per cent of the actual costs, but no more than 17.90 €/m^2 ($27.30 Cdn/$m^2$).

B) Sales tax will not be covered by the subsidy, if the applicant qualifies for advanced tax deductions.

Individuals or parties eligible for funding Include:

A) Property owners.

B) Those with legal rights to use the property.

C) Tenants with the approval of their landlords.

6. Priority will be given to:

A) Natural persons.

B) Those that demonstrate an acute need.

C) Measures especially capable of improving ecological conditions and the urban visual landscape in a sustainable manner.

D) Measures that are combined with others to improve environmental conditions.

7. Applications

A) Applicants must complete all required forms and submit the application to the Department of Parks and Cemeteries.

B) The following must be submitted with the application:

- Site plan at a scale of 1:500 (3 copies)

- A plan outlining the proposed design at a scale of 1:100. The plan must be accurate enough so that it may be used at a later date to determine whether the design of the green roof is in compliance with the guidelines.

C) Documents detailing the cost of the project.

D) Documentation from the land registry verifying ownership.

E) Proof of authorization or legal rights to the use of the property in the event that the property owner is not submitting the application.

8. Application Approval Procedures

A) If the all the eligibility criteria have been met, provisional approval will be issued.

B) After the green roof has been installed and after all receipts haven been submitted, an appointment for the inspection of the green roof must be made with the Department of Parks and Cemeteries.

C) Receipts must be submitted to the department of parks and cemeteries no later than three months after completion of the green roof.

D) After the green roof and receipts have been approved, final grant approval is issued.

E) Payment of the subsidy will be made according to the availability of funds in the order that the final grant approvals were made.

F) Advancements of up to 75 per cent of the grant amount as stated in the provisional approval can be issued upon presentation of proof of grant approval.

G) Representatives from the Department of Parks and Cemeteries may supervise the implementation of the green roof. The applicant must disclose all information requested by the supervisor upon inspection.

H) The subsidy must be repaid if the conditions of the grant are not met or if the regulations are violated. The subsidy must be repaid at the time of annulment of the final grant approval. The sum is subject to an interest rate three per cent above that of the current bank rate, with an annual rate of at least 7.5 per cent.

9. Exceptions

Exceptions to the technical section of these guidelines may be made, if they serve to enhance the goals of this subsidy program.

10. Effective Date

These guidelines come into effect a day after their publication (November 1986).

Contact information

Hermann Degen
City Planning and Renewal
City of Stuttgart
(07 11) 2 16-29 61
U610056@stuttgart.de

John Döveling
Department of Parks and Cemeteries
City of Stuttgart
(07 11) 2 16-53 21
U670005@stuttgart.de

Key literature

Green Roofs, But How? (2003). City of Stuttgart: Department of Parks and Cemeteries.
Evert, K-J. (2004) *Ökologisches Bauen mit Gründächern*. Presented at the International Green Roof Congress, Nürtingen, Germany.
Stender, I. (2002). *Why Spend Public Money on Green Roof Infrastructure?* Toronto, Ont.: Faculty of Environmental Studies – York University.

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Tokyo, Japan

Key motivators	Urban heat island		
Policy phase	5 — Program and policy development		
Champion	Municipal		
Longitude	35°N	**Latitude**	139°E
Average summer temperature	26°C (79°F)	**Average winter temperature**	4°C (39°F)
Average annual rainfall	1,500 mm (59 in.)		

Summary

The City of Tokyo went quickly into an advanced phase of green roof policymaking. Tokyo, with its temperate climate and plentiful rain, has been seeing an ever-increasing effect of rising temperatures from urban heat island effect. The rise in temperature is considered to be so serious issue that the Tokyo Metropolitan Government (TMG) has readily adopted policies requiring green roofs on buildings, without much time spent on phases 1 to 4 of policy development.

The TMG has mandated green roofs on a percentage of the area of every new building. Failure to provide green roofs results in a penalty for developers.

Roof gardens on buildings have always added high value to building where such spaces have been publicly accessible. However the mandatory requirement by the TMG has created a necessary reason to add green roofs on all new developments. It is estimated that in the first year after the passage of this law in 2001 the area of green roofs doubled.

Description

Tokyo is Japan's capital and the most populated metropolitan area in the world, with 12 million people. Tokyo proper has a population estimated at 8,100,000. It is at the head of Tokyo Bay, midway along the eastern coast of Honshu Island. The city occupies most of the southern part of the Kanto Plain, the largest area of flat land in Japan.

Canada

CMHC SCHL
HOME TO CANADIANS

The climate is temperate. There are frequent typhoons, with heavy rain, in September and October.

Tokyo Metropolis covers an area of about 2,200 km^2 (about 840 sq mi). The rest of Tokyo Metropolis is a large suburban area stretching to mountains in the west and two chains of small islands to the south in the Pacific Ocean.

Key motivators

In the last 100 years, the average temperature in Tokyo has increased by about 3°C, more than five times the increase in the world's average mean temperature. The effect of this urban heat island is an increase in smog alerts, energy consumption for cooling and heat-related illnesses and deaths.

Another factor related to the urban heat island effect and which affects Tokyo culturally is the earlier arrival of the cherry blossom season. Plant species native to tropical weather areas and never before seen in Tokyo have also emerged locally as a result of warmer weather.

Description of policy

Tokyo has at least two measures to promote green roofs on buildings:

1. As part of rooftop greenery measures, the TMG has passed an Ordinance on Natural Preservation, sometimes referred to as Ordinance on Environmental Preservation," that mandates that a certain portion of the roof on new developments be greened. Tokyo requires at least 20 per cent of a roof to be greened in new developments or extensions to existing developments larger than 1,000 m^2 (10,764 sq, ft.) for private developments and 250 m^2 (2,691 sq. ft.) for public developments. Failure results in a penalty of approximately 200,000 yen ($2,000 US).
2. As part of a green building program, TMG also has a voluntary measure in place that encourages new building developments to submit a project plan that states the environmental measures incorporated in the buildings. It also requires the assessment of the development in compliance with Tokyo's ordinance on environmental preservation.

Process to establish policy

Tokyo's severe urban heat island effect forced the municipal government to respond. Unlike European jurisdictions, the TMG instituted green roof requirements without much research or cost justification. The TMG was able to create regulations based on the pre-cautionary principles without the typical obstacles to policy development, such as research and public support.

A 2001 report by the Tokyo Environment Ministry confirmed the correlation between the high percentage of heat-absorbing surfaces and the city's warming. Widespread greening efforts, such as tree planting, park expansion and green roofs were considered potential mitigating solutions.

After a successful demonstration project, educational seminars targeting the development community and a subsidy trial in one ward, the TMG amended the Natural Conservation Ordinance to include among other measures, mandatory requirements for green roofs on new construction.

To promote the legislation the TMG also constructed a green roof demonstration project on the Tokyo Council Building and other facilities.

Effectiveness

In the first year after the passage of the law, total net area of green roofs almost doubled from 52,400 m^2 (564,000 sq. ft.) in 2000 to over 104,400 m^2 (1.1 million sq. ft.) by the end of 2001. At first glance, this success can be attributed to the low base requirement for coverage. However, actual implementation on some of the projects reveals that many developers invested in the creation of large roof gardens much larger than required by the law. The success of this initial regulation has motivated the city to raise target levels for rooftop greenery to nearly 12.5 million m^2 (130 million sq. ft.) as part of the effort to increase green space in the city.

The government of Japan is following Tokyo's lead on green roof legislation and in 2005 required greening of at least 20 per cent of roof areas of all new buildings.

Lessons learned

The documented evidence suggests that the TMG policy has worked well for new buildings. There does not appear to be any record of impact of the policy on existing buildings and it is not clear how the targets for greening will be achieved.

There is some anecdotal evidence that the policy may not be working as planned since on many new developments the penalty is small compared to the extra cost it would require to implement the green roof.

Contact information

Habuka, Yumi
Metropolitan Government
Bureau of the Environment
Tokyo, Japan
81-3-5388-3432

Makato, Murase
Department of Environmental Protection
Tokyo, Japan
81-3-3611-0573 or 81-3-5608-6209
murase-makato@city.sumida.lg.jp or
murase-m@jcom.home.ne.jp

Toshiko Chiba
Metropolitan Government
Tokyo, Japan
Toshiko_Chiba@member.metro.tokyo.jp

Predictions

Currently scientists at local universities are investigating how green roofs can most effectively be applied to mitigate the urban heat island effect. This retroactive research may affect future regulations and government investment in green roof development.

Key literature

Akagawa, H. (2003, April). *Greening of Buildings in Japan-Recent Developments*. Presented at the Australian Institute of Landscape Architects' Greening Cities a new Urban Ecology Conference, Australia. Retrieved March 2005, from http://www.aila.org.au/nsw/greeningcities/default.html

Brooke, J. (2002, August 13). *'Heat Island' Tokyo is in Global Warming's Vanguard*. New York Times. Retrieved March 2005, from http://www.greenroofs.com/pdfs/archives-nyt_brooke_heat_island_tokyo.pdf

City of Tokyo, Bureau of the Environment. (2003). *The Environment in Tokyo*. Retrieved March 24, 2005, from http://www.kankyo.metro.tokyo.jp/kouhou/english2003/index.html

Mikahami, T. (2005). *Tokyo: Cooling Rooftop Gardens*. In Earth Pledge, Green Roofs: Ecological Design and Construction (130-134). New York, New York: Schiffer Publishing Ltd.

Shobhakar, D. (2003). *Assessment of local strategies for countering greenhouse gas emissions: Case of Tokyo. Japan*: Urban Environmental Management Project, Institute for Global Environmental Strategies (IGES). Retrieved March 2005, from http://www.iges.or.jp/en/ue/pdf/dhakal/dhakal_tokyo.pdf

12-10-06

Part 3 — Additional case studies

Canada

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Calgary, Alberta

Longitude	51°03'N ,	**Latitude**	114°05'W
Elevation	1,084 m (3,556 ft.)		
Average summer temperature	15.2°C (60°F)	**Average winter temperature**	4.4°C (40°F)
Average annual rainfall	320.6 mm (12.6 in.)	**Average snowfall**	126.7mm (5 in.)
Area	722 km2 (279 sq. mi.)	**Population**	930,000

Description

Calgary, at the junction of the Bow and Elbow Rivers, is Alberta's largest city. The city's high elevation and position on the leeward side of the Rocky Mountain foothills gives Calgary a unique climate. Its best-known weather feature is the Chinook winds — Pacific-warmed systems that develop over the Rockies — which settle over the city 10 to 20 times each winter and can raise temperatures more than 20°C in a few hours. They often melt all the snow cover and their strong, dry winds desiccate the landscape. Winter returns suddenly and unprotected plants often die.

In the summer, Calgary has little precipitation. The number of days with minimal precipitation is 111 and the number of days with measurable sunshine is 332. With an average of 2,314 hours of sunshine, Calgary has been dubbed the Sunshine City.

The extreme summer and winter temperature swings and low precipitation are a major challenge for green roofs. With experience from green roof installations, roofing manufacturer Soprema recommends at least 153 mm (6 in.) of growth medium to help hold moisture.

The growing season averages 112 frost-free days, short even when compared with other Alberta centres. The soil in and around Calgary is typically an alkaline, clay-based composition, which can result in poor drainage and poor nutrition for plants. Although clay is rich in nutrients, the alkalinity of the soil, increased by watering with potable water, binds the nutrients and makes them unavailable for the plants. It is fair to say that gardening is challenging in Calgary.

Contact information

Liliana Bozic
Water Quality Research Engineer
Waterworks and Wastewater,
City of Calgary
(403) 268-2186
lbozic@calgary.ca

Kerry Ross
Sustainability Coordinator,
CPV Group Architects & Engineers,
Calgary
(403) 220-0542
kr.st@shaw.ca or kerryr@cpvgroup.com

Sinisa (Sonny) Tomic
Senior Urban Designer
Planning, Development and Assessment Department
City of Calgary
(403) 268-5921
sonny.tomic@calgary.ca

Laura Weckman
Planner
Planning, Development and Assessment Department
City of Calgary
(403) 268-2919
Laura.Weckman@calgary.ca

Canada

CMHC SCHL
HOME TO CANADIANS

The city, known as Canada's energy capital, is growing rapidly and recently overtook Edmonton as the largest city in Alberta. The main industry today is oil and gas, which drives a thriving economy and attract many high-tech industries. Agriculture is a key industry in the surrounding areas.

Key motivators

The motivators are stormwater management, green building practices and smart growth, as urban sprawl is an issue because of the city's rapid growth. There is also a desire to make the inner city more liveable and attractive.

There is a push for green roofs in the city core and Beltline District (which borders the downtown), directed by the City Centre Plan as a way to revitalize and develop green space.

Description of the policy

The City is considering a number of public benefits as being eligible for incentives and bonuses. The City Centre Plan may include green roofs as a public amenity for increased urban green space. Other public benefits might include open space, streetscape or "lanescape" improvements, heritage resources, redevelopment of key sites, affordable housing and other community development initiatives.

Process to establish policy

Several activities could encourage more green roof construction.

Kerry Ross, a Calgary resident and architect, championed a local green roof development workshop, co-hosted by Green Roofs for Healthy Cities, in 2003. She was inspired by the potential of green roofs after working on a green roof design for a building in Banff and attending a similar workshop in Vancouver.

The City of Calgary and CMHC supported the workshop. Although there as been no coordinated follow up or action on creating the Workshop's suggested city task force to further green roofs, Green Roofs for Healthy Cities and CMHC organized a Green Roof 101 course in October, 2004.

The City has taken some action to promote green roofs as a way to mitigate stormwater runoff, monitor the climatic effects on plants and create public amenity space. Sonny Tomic and Liliana Bozic of Calgary's city staff are working with a developer on a mixed-use residential, inner-city project that they hope will feature green building practices and a green roof.

Calgary Technologies Inc. (CTI), a high-tech focused, non-profit organization, offered its building as a test site. CTI is working with Ms. Ross, Soprema Canada, Studio T Design Ltd. and Alberta's Climate Change Central.

The project is about 279 m^2 (3,000 sq. ft.) of roof, which is visible from many vantage points in the building, outside a public link between two wings of the CTI building. Environment Canada's EcoAction, Shell Environment Fund, Climate Change Central and other private sector donors contributed enough funding to proceed with the first phase of construction in September, 2005. Soprema, a major supporter, donated green roof components.

Phase 2, which will go ahead when funds are available, will be a monitoring and data acquisition system. The City of Calgary will monitor the stormwater runoff. The demonstration roof will test growth mediums of 101, 152 and 203 mm (4, 6 and 8 in.) with different plants in each plot. Windward and leeward roofs will enable the monitoring of wind and buffering. The demonstration project is essential to determine how well green roofs tolerate Chinooks, to monitor watering requirements for native plant species and to find the optimal depth of growth medium.

Other recent events and City reports show some consideration of green roofs as a way to control stormwater and create green space in the city core and Beltline District. In particular, the city has created a sustainable building policy that proposes a LEED Silver rating as a requirement for new facilities and additions larger than 465 m^2 (5,000 sq. ft.)

A 2004 urban structure plan, which examined the redevelopment of areas of downtown Calgary, identified green roofs as one way of bringing green space into the city core.

In 2004, the city launched imagineCALGARY, a two-year visioning initiative. This is an initiative to create a long-term sustainability vision and will result in a 100-year vision with strategies to reach 30-year targets. The city plans to present the long-range community vision and plan at the United Nations World Urban Forum in Vancouver in June, 2006.

Effectiveness

Until a demonstration green roof is built and monitoring equipment installed there will be a lack of climate-specific data for Calgary. Interest in and uptake of green roofs in Calgary has primarily been led by building practitioners, owners and developers. Several recently built green roofs are in housing developments (single-family houses and MURBS), community-focused and mixed-use buildings.

City projects with green roofs include the Water Centre and the Pine Creek Water Treatment Facility. The Water Centre is a 13,000 m^2 (140,000 sq. ft.) office building for departments associated with water and waste water. Its environmental goal is to meet and exceed a LEED Silver rating as mandated by the City of Calgary for municipal buildings. It will have a green roof over its truck maintenance wing.

The Pine Creek Water Treatment Facility will be built over many years. A water research centre is planned with participation from the University of Calgary and other stakeholders. Green roofs are planned for a number of buildings on the site.

Lessons learned

Engagement of the City, developers, builders and the public requires concentrated effort before they consider green roofs as a means to mitigate stormwater runoff and provide urban green space.

The future

Success is anticipated for the demonstration green roof and the green vision that will evolve from the ImagineCALGARY and City Centre Plan initiatives. The growing grass-roots awareness of the environmental benefits bodes well for a bright future for green roofs in Calgary.

Literature

City of Calgary. (2000). *Stormwater Management and Design Manual*. Retrieved from http://www.calgary.ca/docgallery/bu/wwd/stormmanual.pdf

City of Calgary. (2004, March). *Urban Structure Plan*. Presented at Urban Structure Plan Workshop. Fort Calgary, Alta. Retrieved from http://www.calgary.ca/DocGallery/BU/planning/pdf/usp_e_zine_2.pdf

City of Calgary. (n.d). *ImagineCalgary*. Retrieved from http://www.imaginecalgary.ca/index.php

The Calgary Horticultural Society. (1996). *The Calgary Gardener*.

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Halifax, Nova Scotia.

Longitude	63°34'W	**Latitude**	44°39'N
Average summer temperature	17.4°C (63°F)	**Average winter temperature**	-3.2°C (26°F)
Average annual rainfall	1,356 mm (in.)	**Average snowfall**	151.8 cm (in.)
Area	79.2 km2 (15,444 sq. mi.)	**Population**	400,000

Description

Halifax, on the Atlantic coast of Nova Scotia, is situated on a protected bay. The municipality has a wide variety of industries, such as shipbuilding and shipping and support to the offshore oil industry. Halifax is also the regional hub for the provincial government and banking industry.

Weather patterns are extreme and can vary by 30 or more degrees in 24 hours. The coast is occasionally subject to hurricane winds. Overall though, the climate is moderate, with lots of cloud cover and fog that disperses the sunlight.

Key motivators

Halifax Regional Municipality (HRM) is working on a 25-year environmental plan that covers a variety of topics.

Green roofs are seen as a way to reduce commercial air conditioning costs and stormwater runoff. HRM is considering the promotion of sustainable construction and LEED requirements for new buildings. Green roofs would help meet those standards. Kendall Taylor, a local champion for green roofs, notes that developing a long-term environmental plan creates greater awareness of other environmental issues and solutions at different levels and sectors.

Contact information

Stephen King
Manager–Senior Adviser
Sustainable Environment Management Office
Halifax Regional Municipality
(902) 490-6188
kings@region.halifax.ns.ca

Jeremy Lundholm, PhD
Assistant Professor,
Biology Department/Environmental Studies Program
Saint Mary's University
(902) 420-5506
jeremy.lundholm@smu.ca

Kendall S. Taylor MRAIC
CaGBC Director
LEED-Accredited Professional
(902) 441-4329
ktaylorarchitect@eastlink.ca

Canada

CMHC SCHL
HOME TO CANADIANS

Description of the policy

HRM has initiated discussion, within the 25-year plan, to encourage green roof construction. A recent green roof workshop discussed the idea of using incentives. Now, the drive to encourage green roofs comes from the private sector with support from the HRM, which was fully involved in the green roof workshop.

Process to establish policy

Kendall Taylor is a LEED-accredited architect and a director with both the local and national Canada Green Building Council. Mr. Taylor attended the 2003 Green Roof Conference in Chicago and returned excited about the benefits green roofs could bring to Halifax. He initiated the idea of hosting a local Green Roofs for Healthy Cities (GRHC) workshop and with the HRM's support hosted the event with about 45 attendees in April, 2005.

Another champion is Professor Jeremy Lundholm, of St. Mary's University, who presented at the 2005 Green Roof Conference. Prof. Lundholm and Mr. Taylor have applied for funding to create a research centre to study the ability of native Nova Scotia plants to survive on rooftops. Prof. Lundholm proposes reducing the weight of green roofs by reducing the growth medium and using native plants. The hope is that reduced weight and cost will provide greater opportunities for existing and new buildings to include green roofs in their designs or retrofits.

Effectiveness

Effectiveness is not measurable at this time, but Mr. Taylor notes that the BIO Energy Centre in Halifax is the first Canadian government building with a green roof.

Lessons learned

The green roof movement is just starting in the Halifax area so there are few lessons learned.

The future

If the funding for St. Mary's University green roof research centre is approved, then within two years research will determine if native plants can survive in a lightweight medium on a roof. There are about 12 intensive green roofs in Halifax (the famous Citadel in downtown Halifax is a green roof) but as far as is known, there is only one extensive green roof.

Though it has been a slow process to date, Mr. Taylor feels that progress will be made very quickly when evidence points to the success of using native plants and shows that green roofs can help meet some of the goals of the HRM environmental plan.

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Ottawa, Ontario

Longitude	75°42'W	**Latitude**	45°25'N
Average summer temperature	19.7°C (67°F)	**Average winter temperature**	-8.5°C (17°F)
Average annual rainfall	733.2 mm (28.8 in.)	**Average annual snowfall**	202.7 cm (79.8 in.)
Area	2,796 km² (1,157 sq. mi.)	**Population**	800,000

Contact information

David Miller
Senior Environmental Planner
City of Ottawa
(613) 580-2424, ext. 21447
David.Miller@ottawa.ca

Description

Ottawa, the nation's capital, is located at the juncture of the Ottawa and Rideau Rivers and the Rideau Canal. With the City of Gatineau in Quebec, it is part of the federal National Capital Region. Only 9.1 per cent of the city's area is urbanized. The urban form in Ottawa includes a central developed area, older suburbs, a green belt area owned by the National Capital Commission (federal government) and four growing suburban and town centres beyond the green belt. A significant research capacity exists in the capital region, including the National Research Council, which has a green roof research facility.

The local topography of the area plays an important role. The valley created by the Gatineau Hills and the Ottawa River can trap pollutants and create temperature inversions. Surface winds are frequently less than 0.18 km/h (0.11 mph). This exaggerates the urban heat island effect within the City's developed portion.

Key motivators

Ottawa has not identified specific key motivators, but a green roofs workshop in May, 2004 identified potential benefits, including mitigating the urban heat island, managing stormwater and the amenity value of green spaces in urban areas (promoting "smart growth"). Helping alleviate concerns over the loss of green space, garden plots or community amenities as a result of infill projects is also a potential motivator.

In January, 2005, Ottawa City Council approved an air quality and climate change management plan that established a target of 20 per cent reduction in GHG emissions and cited green buildings and green roofs as one of the implementing mechanisms.

As a newly amalgamated city, Ottawa set out to create a future vision and update key strategic documents. Ottawa 2020 was a two-stage planning initiative that resulted in seven key principles including a green and environmentally-sensitive city. As part of this process, a new official plan and an environmental strategy were passed in 2003. This strategy establishes a firm urban boundary and is designed to encourage development within this boundary to maximize public investments and minimize the broader environmental impact of growth.

Description of the policy

There is no policy to encourage green roofs, though the City's Green Roofs Task Force has identified this issue. One developer was successful in having the city waive development charges as recognition, in part, of green building measures including a green roof.

The city is considering the use of local improvement charges (LIC). This entails a selection of measures off a prescribed list for which the city will provide incentives or assistance for hard costs. This "loan" is paid back through taxes. Green roof technology can be appropriate for this technique as the capital costs are associated with the building property, rather than the current builder who may sell the property upon completion of construction. (For more information, see "Local improvement charges", p. 17)

The city is also exploring a partnership with Natural Resources Canada to help facilitate projects under the Commercial Building Incentive Program (CBIP). Green roofs could be one acceptable energy-saving measure. A community development plan for a new community, Riverside South, encourages green roofs and green building in the community core, mixed-use area. Ottawa is now developing an internal city sustainable building policy for green building construction and for which green roofs could be a tool.

Process to establish policy

Several groups are pursuing a green roofs policy, including the Ottawa Environmental Advisory Committee. This committee of volunteers advises Ottawa council on a variety of environmental issues. It encourages green roofs and has participated in the efforts noted below.

The city has also worked with the local chapter of the National Capital Green Buildings Council (NCGBC), which has held sessions on LEED, green buildings and a Green Roofs Design 101 course delivered by Green Roofs for Healthy Cities (GRHC).

GRHC first contacted the city about a local green roof development workshop in 2003. The GRHC workshop in May, 2004 resulted in the formation of a local Green Roofs Task Force (including the Environmental Advisory Committee). This task force has met twice. Although the task force set many short- and long-term goals, policy development being one of them, it has had difficulty moving forward because of a lack of resources and financial support. Efforts are underway to initiate a green roof inventory once a source of funding is found.

On Aug. 23, 2005, Ottawa City Council directed staff to develop a green roof strategy for consideration by Council.

Effectiveness

Despite the absence of formal policy or specific regulatory requirements, new public projects are actively considering and constructing green roofs. In fact, private developers appear to be leading. One private developer, Windmill Developments, asked the city to waive development charges for its green building design, which includes a green roof.

Lessons learned

The province's *Planning Act* and building code do not lend themselves to a regulatory approach and there is no obvious legislation permitting a municipality to prescribe green roofs, except on its own buildings.

An integrated approach is critical for encouraging green roof development, especially as part of LEED certification. The city needs the ability to screen development approvals so that green roofs can be promoted during the design stage.

Ottawa benefits from having many federal government departments and agencies located in the city. For instance, The new Canadian War Museum has installed a green roof, part of the sustainable measures of the federal Greening the Government policy. Federal greening initiatives provide some opportunities and could positively influence more local developers' attitudes about green building construction and green roofs.

The future

Both LEED and the Go Green program of the Building Owners and Managers Association (BOMA) of Canada encourage local developers to build green for public image and marketing benefits. Green roofs fit well with these initiatives. David Miller, an environmental planner with the City of Ottawa, notes that green roofs must become a routine part of a green building package and be conceived as the right thing to do as part of an integrated design process.

Literature

Overtveld, J.C. (1990). *The Application of "Green Roof" Legislation to the City of Ottawa Official Plan.*

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Québec City, Quebec

Longitude	71°14'W	**Latitude**	46°49'N
Average summer temperature	18.3°C (65°F)	**Average winter temperature**	-15°C (5°F)
Average annual rainfall	415.6 mm (16.36 in.)	**Average annual snowfall**	110.6 cm (43.5 in.)
Area	2,796 km² (1,080 sq. mi.)	**Population**	173,000

Contact information

Marie Anne Boivin
Soprema
(450) 655-6676
maboivin@soprema.ca

Véronique Jampierre
Vivre en Ville
vjampierre@vivreenville.org

Description

In 2008, Québec City, one of the oldest cities in North America, will celebrate its 400th anniversary. The city is situated on the St. Lawrence River, northeast of Montréal.

Key motivators

The green roof movement in Québec City has been gathering momentum, led by Vivre en Ville, a non-profit organization that promotes sustainable development.

While Vivre en Ville has identified many key motivators and considered green roofs for improving biodiversity, it appears that most important motivator is related stormwater management.

Description of the policy

Québec City is expected to move into Phase 5 — Program and Policy Development through its partnership with Vivre en Ville to examine policies for promoting green roofs.

Process to establish policy

Québec City can be considered a leader in modern day green roofs in Canada. In 1994, the Horticulture Research Centre of Laval University started a pioneering research program to adapt European green roof technology for extensive and semi-intensive green roof systems and rooftop gardens to a Canadian climate. This research project was carried out by Marie Anne Boivin under the direction of Professor Blanche Dansereau.

In November, 1994, a green roof was installed on two roofs of different exposures and levels on the service building of the Agricultural and Food Sciences Faculty of Laval University. Several green roofs — listed in the following table — have been installed (or planned) since that time in Québec City.

Québec City has moved successfully through the introduction and awareness stages and is now in the community engagement phase, the action plan and implementation phase and the technical research phase.

Vivre en Ville is leading the effort through a demonstration project that highlights the use of plants on building walls and roofs.

In 2002, Vivre en Ville, along with Conseil regional de l'environnement-Capitale Nationale, made a submission to Québec City for a strategy to preserve local biodiversity with green roofs as one way to improve biodiversity.

Since then a partnership has evolved, led by Vivre en Ville, to promote green roofs through its demonstration project. Vivre en Ville explored various possibilities for the demonstration, including working with City buildings and those owned by the municipal housing department. In the end, Vivre en Ville teamed with the Centre for the environment and purchased two buildings, named "Centre culture et Environnement Frédéric Back." These buildings are linked. Their age and designation as heritage buildings posed a challenge in determining the type of green roof that could be installed.

The objectives of the two-phase project are:

Phase I

- Study the application of green roofs and green walls on two buildings in the context of northern climate.
- Measure the energy savings
- Measure stormwater retention

Project	Built	Area — m^2	Comments
Pavillon de services, Food and Agriculture Department, Laval University	1994	250	Accessible rooftop garden on flat roof
Pavillon d'accueil, Arboretum Domaine Maizerets	1996	200	Inaccessible roof on 30% slope
Coproprietes Manrèse	1996	215	Garden terrace over garage
Coopérative Jardins d'habitation Chloé	1996	80	Garden terrace over wood deck in residential building
Lofts Laliberté	1999	130	Rooftop garden over wood deck in residential lofts
Coproprietes Jardins Manrèse III	1999	234	Garden terrace over parking garage
Les Jardins St. Sacrement	1999	100	Rooftop garden terrace in a residential home for older people
Edifice René-Lévesque	2000	80	Accessible terrace
Centre culture et environnement Frédéric Back	2004	700	Demonstration green roof and wall by Vivre en Ville
Charlesbourg Library	2006	3,300	One of the largest accessible green roofs in Canada. It is connected to adjacent ground

- Demonstrate the feasibility and advantages of the green roofs and walls to the housing market and to the maintenance and renovation of institutional and public buildings.

Phase 2

- Widely disseminate the results of the project and attract more partners to the project.
- Demonstrate the need for similar studies on different types of buildings.
- Demonstrate the community benefits.

Community involvement

One of the major contributions of this project towards green roof policy making and green roof promotion was community involvement. At one level, Vivre en Ville was able to establish funding partners with a vested interest in the outcome of the project. At another level, it established a technical and advisory committee. Members of the technical committee are

- Marie-Anne Boivin, green roof specialist
- Gilles d'Amour, Architect with l'Agence de l'efficacité énergétique du Québec
- Jean-Pierre Finet, Manager of Fonds en efficacité énergétique du Québec
- Stéphan Gilbert, Architect with Émile Gilbert, Brière + architectes
- André Potvin, Architecture Professor at l'Université Laval
- Gabriel Thibault, Sales director with Composts du Québec
- Véronique Jampierre and Jérôme Vaillancourt, Vivre en Ville.

The project partners are:

- L'Agence de l'efficacité énergétique du Québec (Quebec's Energy Efficiency Agency)
- Le Centre de l'Environnement (The Environment Centre — a non profit organization)
- Le Fonds en efficacité énergétique du Québec (Quebec Energy Efficiency Fund)
- Le Fonds d'habilitation municipal vert — part of the Federation of Canadian Municipalities (FCM) Green Municipal Enabling Fund
- Ville de Québec (Québec City Municipal Government) voted unanimously to finance part of the project and had representation from the department of environment, department of infrastructure and property management department.
- Canada Mortgage and Housing Corporation
- Students, academics, consultants, designers, suppliers and contractors contributed to the project
- Funding was procured from the Environment Canada EcoAction 2000 program.
- Chantiers-Jeunesse (a non profit organization) participated in the installation.

Lessons learned

The biggest challenge was to implement a green roof on an existing building with limited structural capability. This involved removing a roof layer and using a lightweight green roofing structure (19 lbs./sq. ft.).

Also the city requires a new cornice consisting of a frame for training vine from the rooftop to appropriate the building's original appearance.

Selecting a new roofing system for an inadequate structure has provided useful insights, suitable for dissemination.

Research and measurement program

The demonstration roof will be monitored for thermal and water runoff performance. Temperature measurements of the old roof were taken before the green roof was installed. Water and temperature readings will continue for another year.

The amount of water collected by the roof will be compared with the rainfall collected at city facilities to show water retention due to the green roof.

Public awareness and demonstration

Already the project has lead to significant public awareness of green roofs. Information transfer began with project partners and participants and included the building's tenants and users. The local chamber of commerce organized a meeting to challenge participants on the use of green roofs. Press releases and bigger events were planned for the project's official launch in October, 2005.

The future

The greening sets the stage for public awareness and demonstration. There are now further plans for additional green roofs and walls by the Centre for the Environment.

The Charlesbourg Library will provide Québec City with one of Canada's largest publicly accessible green roofs in 2006.

Literature

Projet de recherche de l'Université Laval, http://www.greenroofs.org/misc/projects.htm#laval

Les Toits Verts et ses avantages http://www.rona.ca/webapp/wcs/stores/servlet/ContentServlet?assetId=7972&langId=-2&parentAssetId=22&parentAssetId=4

Vivre en Ville (2004, Novembre) Rapport d'étape du Programme de végétalisation de bâtiment, Passons a l'action, projets encours, toitures et murs végétaux, http://www.vivreenville.org/action_projets.html

Vivre en Ville (2002, Avril) Stratégie québecoise sur la diversité biologique: une avancée pour le maintien de l'intégrité biologique du territoire

Vivre en Ville (2005, novembre) Manuel d'installation de toitures et de murs végétaux

CMHC (2006) Rapport final du Programme de végétalisation du bâtiment et cahiers des annexes

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Winnipeg, Manitoba

Longitude	97°09'W	**Latitude**	49°53'N
Elevation	239m		
Average summer temperature	26.1°C (79°F)	**Average winter temperature**	-23.6 °C (-10°F)
Average annual rainfall	504 mm (20 in.)	**Average annual snowfall**	114.8 cm (45 in.)
Area	465.16 km² (180 sq. mi.)	**Population**	650,000

Contact information

Centre for Indigenous Environmental Resources (CIER)
(204) 956-0660
info@cier.ca

Rodney McDonald
McDonald & Hardess Sustainability Group Inc.
(204) 478-0598
rmcdonald@mhsg.ca

Description

Winnipeg, on the banks of the Red and Assiniboine Rivers, is surrounded by prairie. Winnipeg is known for its cloudless winter skies and frigid temperatures. Winnipeg has the sunniest winter in Canada, with an average of 99 hours of sunshine in December, 120 in January and 140 in February. Summers can be quite hot but short, limiting the growing season. With the consistent cold weather, snow tends to stay for the entire winter, which offers some protection to plants from freezing temperatures.

There is a wide mix of industry in predominately low, flat buildings in industrial parks, which provides opportunities to retrofit green roofs. There are few tall buildings in Winnipeg and new construction activity has been slow.

There are several well-known green roofs in Winnipeg. One of the first is the award-winning Ducks Unlimited Oak Hammock Marsh Interpretive Centre, built in 1990. The roof has two tiers, one with shallow-rooted native prairie grasses and the other with stress-tolerant Kentucky Bluegrass.

Another well-known Winnipeg green roof is the Mountain Equipment Co-op (MEC) building. This new building used more than 95 per cent reclaimed materials from the original buildings on site. It has been awarded LEED-Gold certification and features a green roof on a portion of the roof. A cistern in the basement collects rainwater. This rainwater is mixed with a small amount of compost tea from the building's composting toilets to irrigate the rooftop garden through a solar-powered irrigation system.

Red River College recently completed a downtown campus that includes a small green roof that students enrolled in the turf management program will maintain.

Key motivators

Stormwater management is the main identified motivator: the City has combined sewer districts and is close to two rivers. A potential motivator is electrical energy savings from less use of air conditioning. A third motivator is the benefit of green roofs as a public amenity, such as community gardening.

Description of the policy

Winnipeg has not yet established a program, incentive or policy to encourage green roof development.

Process to establish policy

The Centre for Indigenous Environmental Resources (CIER) became interested in building a green roof on its downtown building. When that wasn't possible, CIER investigated funding from the Federation of Canadian Municipalities (FCM) Green Municipal Fund to conduct a green roof feasibility study for the City of Winnipeg. FCM grants require matched funding, so CIER collaborated with the City to meet that requirement.

In 2003, CIER and Tetr*ES* Consultants researched the benefits of the green roofs for stormwater management. Controlling stormwater is a major problem for the City, especially in the Combined Sewer District. From May to October each year, there are typically 18 stormwater overflows in which municipal storm sewers spill raw sewage into local waterways. The study showed that in the combined sewer-stormwater areas, there is structural capacity to support extensive green roofs on most of the buildings because they were originally designed to have upper floors added. Other partners in the study included the province of Manitoba (Conservation, and Transportation and Government Services); Syverson Monteyne Architecture; Altmitra Engineering Ltd. and ATLIS Gematics Inc.

The preliminary study findings show that green roofs can provide important social, engineering and monetary benefits. In particular, the study verified that green roofs in the City of Winnipeg could:

- Enhance stormwater management in the core area, especially areas with inline storage. (This complemented the stormwater-management program currently planned by the City.)
- Provide cooling benefits for buildings.
- Extend the life of a roof.
- Trap and treat hazardous air-pollutants.
- Sequester carbon where building structures allow for intensive plantings.

Urban heat island effect is not an issue in Winnipeg and was not considered. The study also identified the need for further initiatives by the City of Winnipeg to investigate and promote green building technologies, especially green roofs.

Effectiveness

Although there has been very little action by the City of Winnipeg in response to the green roof study, it is felt that the report overall contributes to the body of knowledge for the local context. The full report is on CIER's website at www.cier.ca/GRSReport.pdf.

Lessons learned

Barriers that CIER met in the feasibility study included the general lack of awareness and understanding of what a green roof is comprised of and its potential benefits, in particular for stormwater management. The study noted that civil engineers consider more and bigger pipes as the main way to deal with stormwater, not alternative measures such as vegetated rooftops that can reduce the need for expensive infrastructure.

Rodney McDonald, formally of CIER, adds that stormwater has "no public face," so it is difficult to engage the public when it can't easily see and understand the environmental impacts of stormwater.

The future

Mr. McDonald hopes that the City of Winnipeg will eventually encourage and promote green roofs as a way to deal with stormwater. More research is needed to prove that green roofs can work in Winnipeg's climate. More demonstration projects will allow people to experience them from an esthetic perspective and allow the city to verify their benefits in mitigating stormwater runoff. The recent MEC project is considered an inspiration for other green roofs.

The movement towards green building construction will help, though Winnipeg is not as active as other areas in new construction.

More research on a holistic perspective — benefits to the building, the city and the community at large — is definitely needed. More research is also required to examine incentives that the City can offer to developers, builders and building owners. And finally, more research is needed to prove the benefits and cost-effectiveness for Winnipeg's predominantly retrofit market. The costs are relatively low for adding a green roof to a new building, but it may be more difficult and expensive to retrofit a roof.

New developments include the launch of the Manitoba Chapter of the Canada Green Building Council and the formation of a volunteer City Civic Environment Committee with a green building subcommittee. This committee recently recommended that new recreational facilities be required to attain a LEED Silver rating. This is the first time a LEED rating has been recommended for municipal buildings in Manitoba.

Manitoba Hydro's new downtown building (construction started in 2005) will be the largest LEED building in Canada and one of the greenest buildings in the world. The building design includes a green roof.

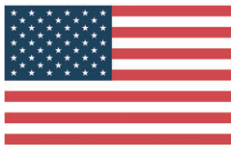
Mr. McDonald says that the best motivator is for decision-makers and others is the realization that there is a public cost to a flat, impermeable roof and with management of the roof's stormwater runoff. If the cost of managing stormwater is transferred to building owners, there will then be a financial incentive for green roofs.

Literature

CIER and TetrES Consultants Inc. (2003). *Development of Green Roof Strategy for the City of Winnipeg*, Man. (Report to Federation of Canadian Municipalities). Winnipeg, Man. Retrieved from www.cier.ca/GRSReport.pdf

12-10-06

United States of America



GREEN ROOFS POLICIES WORLDWIDE

Case studies

Atlanta, Georgia

Longitude	84°23'W	**Latitude**	33°45'N
Elevation	308 m (1,010 ft.)		
Average summer temperature	26.1°C (79°F)	**Average winter temperature**	7.2°C (45°F)
Average annual rainfall	1,219 mm (48 in.)		
Area	342 km² (132 sq. mi.)	**Population**	425,000

Contact information

Janet Faust
JDR Enterprises Inc.
(770) 442-1461
jfaust14@earthlink.net.

Ben Taube
Environmental Manager
(404) 330.6752
btaube@atlantaga.gov

Description

The City of Atlanta is part of Metropolitan Atlanta, which has a population of about 3,850,000. Although Metropolitan Atlanta continues to grow and expand faster than the City, the City of Atlanta retains its position as the hub of the entire region.

Notable physical characteristics within the city are the rolling, hilly topography, numerous streams and an extensive tree canopy.

At the base of the Blue Ridge Mountains, Atlanta is the meeting point for 10 stream and watershed basins supplying two distinct river basins – the Chattahoochee and Ocmulgee Rivers. It is now one of the top five land-consuming metro areas in the U.S. Hurricanes can severely modify the moderate climate and rain can be heavy in major storms.

Key motivators

There are three primary motivators for green roofs in Atlanta. Urban heat island has been identified as one. In 1996, a NASA (National Aeronautics and Space Administration) Science Investigation Project focused on an urban heat island experiment in Atlanta that "sought to observe, measure, model and analyze how the rapid growth of the Atlanta metropolitan areas since the early 1970s has impacted the region's climate and air quality." NASA thermal infrared photography showed that temperature in downtown Atlanta is often 10°F warmer than the surrounding areas.

Poor air quality, related to the urban heat island, is another important issue in Atlanta. The city has a serious ozone problem, and the 10-degree temperature difference doubles ozone production. In October, 2001, NASA, in collaboration with Cool Communities (Georgia), began a federally funded project to quantify the impact of land cover and land-use changes on air quality, particularly on ground-level ozone. The results of this report were not available in late 2005.

Also related to land-use changes and practices, Atlanta has erosion, sedimentation and stormwater management problems, partly caused by over-burdened sewer systems.

Atlanta is exploring green roofs as one of several ways to mitigate the effects of higher urban temperatures, degradation of air and water quality, overflowing sewer systems and loss of green space.

Description of the policy

The City of Atlanta is promoting green roofs through a demonstration project.

The City of Atlanta also requires city projects to conform to LEED Silver standards. Green roofs are expected to be considered as part of this requirement.

The City is considering an incentive program for commercial, residential and industrial green roof projects. Such incentives may become increasingly popular, since the city is working on creating stormwater fees that will base fees on impervious surface calculations. There are no planned dates for implementation of these policies and programs.

Process to establish policy

In December, 2003, the City of Atlanta installed a green roof on its City Hall as a demonstration pilot project, claimed to be the first such project in the U.S. southeast. The City expected to generate reliable technical data for temperature reduction, energy efficiency, stormwater retention, effect on roof life and determination of which plants work best in the shallow soil of a green roof. It also hoped to show Atlanta's business community a working green roof as a model for similar projects.

Green roofs are expected to help improve Atlanta's air quality. In Atlanta, air quality, particularly high levels of ground-level ozone, has been designated a "severe" non-attainment area by the U.S. Environmental Protection Agency (EPA). In 2002, the city exceeded federal ozone standards on 38 days, up from 20 days in 2001. This, along with the expectation that green roofs will play a significant role in mitigating stormwater problems, led to the demonstration project.

Effectiveness

The green roof pilot project is not moving forward as planned. The green roof is currently only being promoted as one approach to meet the environmental needs of Atlanta. The roof is not being monitored as expected and the City ordinance is not necessarily resulting in green roof activity on City-owned buildings.

Although there are serious stormwater issues in Atlanta, there are no incentives for developers for green roofs. However, the benefits of green roofs as demonstrated by the City Hall project are being noted. Some developers are designing to LEED standards and considering green roofs on their projects. Southface Energy Institute, a local non-profit organization, is working with developers and the community to consider adopting green roofs as part of sustainable practices.

Lessons learned

The Atlanta City Hall demonstration project represented a relatively minor expenditure, primarily because, with outside bidding starting at $163,000, the city focused on in-house program management, construction and maintenance. The City received

approximately $55,000 in donated products, a construction grant of $18,000 from the State of Georgia and a matching grant of $18,000 from the city Department of Watershed Management. The project cost a total of $110,000, but after deducting the donations and grants it cost the City only $19,000. The city parks and recreation department is providing what little maintenance the roof is expected to require.

Lack of funds has postponed the monitoring of the green roof. On the other hand, involvement in the project has allowed non-profit groups to educate developers on the merits of green roofs. This is leading to voluntary implementation of green roofs on non-municipal projects.

The future

For City-owned buildings, green roofs may be considered part of the requirement to meet sustainable design standards. It is likely that Atlanta will move towards a fee for stormwater based on the amount of impervious area on a building site—probably in 2007. Green roofs would be one measure to decrease imperviousness when such a new, fee-based structure is implemented. In the meantime, the role played by non-profit organizations such as Southface will lead to more green roofs being considered by private developers.

Literature

City of Atlanta. (2003). *Sustainable Development Design Standards.* Retrieved March, 2005

Taube, B. & Ward, J. (2004). *A Cool Roof in a Hot City: The Southeast's First Municipal Greenroof.* Retrieved in March, 2005, from http://www.greenroofs.com/archives/gf_mar04.htm

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Minneapolis-St. Paul, Minnesota

Longitude	93°21'W	**Latitude**	44°59'N
Elevation	254 m (833 ft.)		
Average summer temperature	29°C (85°F)	**Average winter temperature**	-32°C (-25°F)
Average annual rainfall	693 mm (27.3 in.)	**Average annual snowfall**	91.4 cm (36 in.)
Population	2.5 million		

Contact information

Karen Jensen
Senior Water Resource Planner/Environmental Engineer
Metropolitan Council Environmental Services
(651) 602-1000
environment@metc.state.mn.us

Corrie Zoll
Greenspace Partners Program Director
The Green Institute
(612) 278-7100 or (612) 423-2048
czoll@greeninstitute.org or
info@greeninstitute.org

Description

The Twin Cities of Minneapolis-St. Paul have a climate similar to Winnipeg's. The region is subject to frequent winds and throughout July and August, hot temperatures, coupled with little to no precipitation, make plant choices for green roofs difficult.

The cities are at the juncture of three major rivers — the Mississippi, Minnesota and St. Croix. The old cities are on bluffs overlooking the Mississippi.

Each municipality has a separate elected council. Both cities require the approval of a metropolitan council for building development planning. The current mayor of Minneapolis supports more green roofs. The Green Institute, one of the first green roofs in Minneapolis, was erected on the Phillips Eco-Enterprise Centre property.

Key motivators

The Metropolitan Council approves all new development, waste water treatment plants, drinking water treatment plants, transportation systems, housing, sewer systems, water resource protection and stormwater management in seven counties. Currently, stormwater quantity and quality concerns the Metropolitan Council because of the number of aging and deteriorating sewers discharging untreated sewage (combined sewer overflow) into the Mississippi River after a rainfall.

Fixing this problem would cost about $100 million, which is not available. This has spurred the development of alternative stormwater management plans to reduce stormwater runoff, improve infiltration and protect river water sources at less cost. An *Urban Small Sites Best Management Practice (BMP)* Manual has been published for use in the Metropolitan region by engineers, architects and other planning professionals. The manual includes detailed information on 40 best management practices, including a strong description of green roofs, their environmental benefits, construction details, plant recommendations and more.

Description of the policy

The City reports that the use of best management plans, such as green roofs, will improve a building owner or manager's eligibility for a reduced stormwater utility fee. These monthly fees, established in 2005, are based on a formula that incorporates roof area, parking lot area and any other impervious surface area that generates stormwater runoff. This stormwater utility fee is an incentive for building owners to consider using green roofs and other stormwater management tools. For more information on this stormwater utility fee, see www.ci.minneapolis.mn.us/stormwater/

Process to establish policy

In 2003, the Green Institute co-hosted a one-day, green roof market development seminar with Green Roofs for Healthy Cities. More than 100 people attended, including the mayor of Minneapolis and several city councillors. From this seminar, a volunteer Twin Cities Green Roof Council was formed to which architects, engineers, developers and others interested in market development were invited. A steering committee now meets monthly and full meetings are organized quarterly. Buildings with green roofs are featured and highlighted at the quarterly meetings.

In 2004, the Green Institute hosted the Green Roof Design 101 course presented by Green Roofs for Healthy Cities.

The Twin Cities Green Roof Council is seeking to develop a thoughtful commentary on the City's stormwater utility fee. The collected funds are expected to help upgrade urban infrastructure and prevent further combined sewer overflows into the river.

The City now separates strategies used by building owners and developers that affect water runoff quality from those that affect water runoff quantity. Green roofs are now eligible to provide a credit of up to 100 per cent towards reducing a building or a property's stormwater utility fee.

The Green Roof Council is exploring the use of development bonuses for people employing green strategies (such as a green roof) as well as programs or policies that make them mandatory for City projects .

Use of best management practices and related new technologies, coupled with the efforts of local professionals who are keen to learn more about green roofs, has had a steady effect on raising the profile of green roofs across the Twin Cities and the Metro region.

Effectiveness

There are about two dozen green roofs in the Twin Cites with some unique offerings, beginning with one built in the 1920s. Another provided a lawn bowling area. Since 2004, many new condominium projects have included green roofs as part of their early development plans. Corrie Zoll, Green Space Coordinator at The Green Institute, suggests that this is due to increased education and awareness, coupled with the stormwater utility fee and an appreciation for green amenity space by condo buyers.

Lessons learned

Few green roofs were installed before 2003, and they were positioned more as amenities than as strategic environmental tools to improve air quality and stormwater runoff. As such, these older green roofs are difficult to locate and study. The files outlining design factors, themes, costs, materials and plant choices have been difficult to locate. Nonetheless, the Green Roof Council is cataloguing green roofs. Mr. Zoll says that since more attention has been given to green roofs over the past two years there has been increased interest in them.

Currently, few green roofs monitor stormwater runoff parameters, urban heat island and other environmental benefits. However, the Green Institute is now able to monitor outputs from its highly visible green roof, which it will add to a critical local body of knowledge. The University of Minnesota's water resources centre is working with the School of Architecture's Center for Sustainable Building Research on this and other projects.

The future

A Metropolitan Council stormwater engineer predicts that the Twin Cities, along with other U.S. urban areas, will be acutely interested in the effect that stringent stormwater management requirements and utility fees will have on business, building owners and developers. Already, a number of major American cities are using these fees to their advantage in terms of supporting stormwater best management practices, water research and new infrastructure planning.

Similarly, surface water regulations upheld by the federal National Pollutant Discharge Elimination System program, which formerly applied only to big cities, is now being applied to smaller municipalities.

Green infrastructure, in the form of green roofs, will help offset the future stormwater utility fee. This, with increased understanding of the technology, will result in more green roofs in the Twin Cities area.

Literature

Metropolitan Council. (2003). *Environmental Services.* Retrieved from http://www.metrocouncil.org/environment/environment.htm

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Pittsburgh, Pennsylvania

Longitude	80°0'W	**Latitude**	40°26'N
Elevation	350 m (1,148 ft.)		
Average summer temperature	28°C (82.5°F)	**Average winter temperature**	-6°C (20.8°F)
Average annual rainfall	928.7 mm (36.6 in.)	**Average annual snowfall**	(43.1 in.)
Population	330,000		

Contact information

Joan Blaustein
Project Manager
3 Rivers Wet Weather Inc.
(412) 578-8375
jblaustein@achd.net

Charlie Miller
Roofscapes, Inc.
(215) 247-8784
cmiller@roofmeadow.com

Description

Pittsburgh is the largest inland port in the U.S., providing access to the 9,000-mile inland waterway system. Three rivers—the Monogahela, Allegheny and Ohio—converge in the city. Pittsburgh is the major city in Alleghany County, which has a population of 1.2 million. The three rivers are part of a vast watershed of more than 30,000 miles of rivers and streams. The geography is one of plateaus and hillsides along narrow valleys and rivers.

Key motivators

Before 1972, industry and mining runoff polluted Pittsburgh rivers. The *Water Pollution Control Act Amendments* brought this situation into the American spotlight and stringent controls on industrial pollution helped reduce effluent discharges. Decades of vigilance and increased public and legislative attention on the Western Pennsylvania watershed have dramatically improved water quality. Dozens of agencies and organizations have missions that focus on protecting the rivers. In addition, most of the polluting heavy industry is gone.

The 3 Rivers Wet Weather (3RWW) program is a non-profit program that seeks to improve the quality of Pittsburgh region water resources by helping communities address issues such as combined sewer overflows and stormwater runoff. To promote the most cost-effective, long-term, sustainable solutions, 3RWW benchmarks sewer technology, educates the public, funds green roof demonstration projects and advocates for inter-municipal partnerships that support stormwater technology. 3RWW receives federal funding through the U.S. EPA as well as private funding for its green roof demonstration projects. For more information see http://www.3riverswetweather.org/f_resources/f_green_roof.stm

There are now about 40 buildings, totalling about 465,000 m^2 (5 million sq. ft.), either certified or registered under the U.S. Green Building Council's LEED rating system. The David L. Lawrence Convention Center in Pittsburgh claims to be the largest green building in the world. Pittsburgh's green building advances have occurred over the last four years (since the creation of LEED) and it helps support the green roof movement in the region.

Description of the policy

Pittsburgh has more than investigated the merits and environmental benefits of green roofs. The 3RWW program champions green roofs and has set the stage for further exploration and integration of green roofs in the area. For this reason, Pittsburgh is in Phase 3 — Action Plan Development.

Process to establish policy

The federal *Water Resources Development Act*, HR 5428, funds Army Corps of Engineers-related projects. Recent amendments to the Act include water-quality projects, such as sewer construction, stream restoration and environmental infrastructure. 3RWW is working with the Pittsburgh District of the U.S. Army Corps of Engineers and the regional authority to investigate options for reconfiguring the combined sewer discharges.

Similarly, the 3RWW has been funded under the Act to build stormwater best management practice (BMP) demonstration projects that focus on lot-level or low-impact development (LID) projects. LID was established as a highly effective strategy for controlling urban stormwater runoff in Pittsburgh.

The two primary goals of LID design are to

1. reduce runoff volume through infiltration, retention, and evaporation
2. to find beneficial uses for water rather than exporting it as a waste product down storm sewers.

Structural stormwater BMPs fall into three main categories

1. runoff volume control that is infiltration-oriented
2. runoff volume control that is non-infiltration oriented (vegetated roofs and rain barrels)
3. runoff quality control that is non-infiltration oriented.

For the Pittsburgh region, volume control is the primary consideration, given the age and deteriorated condition of the sewers, in addition to the soil structure and topography which limit infiltration.

Therefore, 3RWW demonstration projects focus on runoff volume control that is not ground-infiltration oriented, such as provided by vegetated or green roofs. The state of Pennsylvania has since created stormwater management guidelines that include green roofs as a best management tool.

Effectiveness

In November, 2003, 3RWW asked for proposals for green roof demonstration projects. By February, 2004, the 3RWW had received eight proposals totalling $2.6 million and had provided about $1 million in grant funding.

The following green roof projects have been awarded grants:

- Shadyside Giant Eagle (Pittsburgh). Renovation and expansion of an existing commercial building. Extensive green roof with five-inch growing medium using non-invasive, drought-resistant plants. Excess stormwater will be captured in cisterns and provide greywater for other uses. 3RWW funding: $240,000
- Hammerschlag Hall/CMU (Carnegie Mellon University) (Pittsburgh). Renovation of an existing building on the CMU campus. An extensive green roof will collect discharge from the adjacent main roof area; Pennsylvania native plants are to be used where possible. 3RWW funding: $25,250

- Terminal Buildings (Pittsburgh) Retrofit of one section of roof on an existing industrial building. 3RWW funding: $55,000
- 213-215 E. Eighth Avenue (Homestead). Renovation of a commercial-residential building on the main street of Homestead. Extensive green roof for residents of upper floors. The second side of the attached building provides a control roof for compaison. 3RWW funding: $66,000.

In addition, 3RWW is funding the development of monitoring protocols and programs that will provide uniform evaluation standards. The engineering departments of the University of Pittsburgh and Carnegie Mellon University are working on this monitoring project. The project identifies current European and U.S best practices for monitoring stormwater quality, retention and diversion on green roof projects, and for assessing their suitability for use in Pennsylvania. The recommended practices will be applied to all green roof projects in Pittsburgh.

Lessons learned

Developers need to be involved from the beginning as any perceived or actual added cost to a project can deter a project such as a green roof. Funding for demonstration projects has helped promote green roofs.

The future

Local experts do not predict development of a green roof policy in the near future. Pittsburgh is a region with very little growth and a declining population. As long as developers perceive any type of green requirements as a risk or a penalty, there will not be the political will to make green roofs happen. However, Pittsburgh is a leading city for green buildings and LEED-certified buildings and this initiative may encourage more green roof installations.

Literature

3 Rivers Wet Weather Demonstration Program. (nd). Retrieved from http://www.3riverswetweather.org/

Miller, C. (nd). *Roofscapes Inc. – Green Technology for the Urban Environment.* Retrieved from http://www.roofmeadow.com/

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

Seattle, Washington

Longitude	112°20'W	**Latitude**	47°36'N
Elevation	4 m (13 ft.)		
Average summer temperature	28°C (82.5°F)	**Average winter temperature**	-6°C (20.8°F)
Average annual rainfall	890-970 mm (35-38 in.)		
Population	569,101		

Description

The Pacific Northwest's largest city, Seattle lies between Puget Sound and Lake Washington, about 180 km south of the Canada-U.S. border. The City is in a metropolitan population of 3.7 million. The climate is mild, with temperatures moderated by the sea and the Olympic mountains protecting the city from winds and storms. The "Rainy City," as it is known locally, receives less precipitation a year than most major Eastern Seaboard cities. However, Seattle is cloudy an average of 226 days a year, compared to 132 for New York City. Because Seattle is in the rain shadow of the Olympic mountains, most of the precipitation falls as drizzle or light rain. The temperature and weather are similar to that of Vancouver, B.C.

Key motivators

Washington was the first U.S. state to require new publicly funded buildings larger than 465 m^2 (5,000 sq. ft.) to meet LEED Silver certification. The law, passed in April 2005, is expected to affect billions of dollars of construction projects over the next few years. High-performance green building with green roofs will be eligible for a reduction in stormwater utility fees, which seek to protect local rivers and the ocean from polluted stormwater runoff. Protection of waterways, coupled with core urban values for "green" and sustainable development, drive green roof development in Seattle.

Contact information

Lucia Athens
Chair of the City of Seattle Green Building Team, LEED Accredited
(206) 684-4643
Lucia.Athens@Seattle.Gov

Patrick Carey
Hadj Design
Director, Ecobuilding Guild
(206) 721-0084
pkc@hadj.net

Miranda Maupin
Seattle Public Utilities
miranda.maupin@seattle.gov

Canada

CMHC SCHL
HOME TO CANADIANS

Description of policy

No green roof policy as yet.

Process to establish policy

While there is no direct policy supporting green roofs in Seattle, green roofs receive support indirectly though Seattle's "City Sustainability Building Policy." This initiative, coupled with the now mandatory support for LEED-certified buildings, is bringing green roofs into the design and planning stages for building professionals. While each building requires a separate assessment for earned credits, green roofs can contribute up to 11 credits toward LEED certification in some cases. More experience with green roofs may change these credits toward LEED certification

The City supports green roofs in the private sector through the Northwest Ecobuilding Guild Project. A director from the guild, Patrick Carey of Hadj Design, is both designing and installing green roofs on commercial and residential buildings and reports that 30 green roofs have been installed since August, 2004.

Similarly, the city's *Flow Control Requirements Manual* for stormwater management currently provides for a reduction credit in the impervious surface fee for building owners with a green roof.

The Seattle Office of Sustainability and the Environment recently received a grant to encourage green roofs in new and retrofitted buildings and is considering awarding funds to several green roof projects in Seattle. Seattle Public Utilities (the city's water, drainage and solid waste utility) is examining a variety of drainage strategies that could be encouraged through changes to regulations, cash rebates or revised utility fee rates. Overall, green roofs appear to be a mainstay of the green building movement in Seattle.

Effectiveness

In February, 2005, Seattle celebrated the fifth year of its landmark policy requiring a LEED Silver rating on city-funded buildings. In April, 2005 King County Council (home of Seattle) unanimously adopted an ordinance that requires future county projects to seek the highest LEED certification possible on new building projects. This green construction law received strong support among councillors, despite opposition from developers fearing higher upfront financial costs. Statewide, 90 green public and private building projects are in the works, 16 of which have already received LEED certification.

In the Seattle area, the law and policy supporting LEED certification has sparked interest for 32 city-owned projects that must aim for some level of green certification. Seattle's City Hall and Justice Center are two buildings in the city with green roofs. Other buildings in Seattle with green roof projects include the Ballard Library, a Parks project and the Pint Defiance Zoo.

Lessons learned

According to Lucia Athens, chair of the City of Seattle Green Building Team of the Seattle Public Utilities Sustainable Building Program, one of the challenges has been obtaining solid and reliable green roof performance data for Seattle. Several recent projects underway include monitoring of green roofs by the Northwest Ecobuilding Guild and by Magnusson Klemencic Engineers, to add more geographic- and city-specific data. Patrick Carey reports that a partnership with Evergreen State College, Pommegranate Centre and Seattle Public Utilities to institute more green roof monitoring sites (10 test panels on 10 green roofs) will support the need for more local data. With more Seattle-based performance data, Ms. Athens suggests that a stronger business case can be made for including green roofs in green building initiatives.

The future

Policy makers in the Seattle area seem convinced that the higher upfront costs of going green (be it green roofs or green buildings) will balance out in the long run — thanks to lower stormwater and energy bills and maintenance costs. Seattle may also regulate measures to improve indoor air quality and improve health of employees.

Seattle developer Gregory Broderick Smith, among other architects and real estate developers, traveled to Sweden in 2004 to tour the Green Roof Institute and the Augustenborg Botanical Roof Gardens in Malmo. Mr. Smith now predicts that while it's going to take a while for the private sector to embrace green construction, it will happen. Mr. Smith is aiming for LEED Gold on his latest project — the Redo Building in Pioneer Square. This office building will feature a green roof, solar panels, operable windows, exposed timbers and perhaps a small rooftop wind turbine.

> "After having viewed the eco-roofs in person, I am convinced it is the roof of the future. It is attractive, long-lasting, cost-effective and over the long term it is both socially and environmentally the correct application. I plan to install them in my properties."
>
> Gregory Broderick Smith

Public schools in Seattle are relative newcomers to green building construction — but are expected to be a major force for green roofs. The state is planning to partner with local school districts and build, on average, more than 140,000 m^2 (1.5 million sq. ft.) of school space every year for the next few years, and some will have green roofs.

Others predict that the next frontier is residential development in Seattle where single-family homes will feature green roofs, rain barrels and more. Hadj Design in Seattle is providing seminars for do-it-yourselfers so owners can install green roofs themselves.

Literature

City of Seattle. (2000). *Sustainable Building*. Retrieved from http://www.cityofseattle.net/sustainablebuilding/

12-10-06

GREEN ROOFS POLICIES WORLD WIDE

Case studies

Washington D.C and Chesapeake Bay Area

Longitude	77°2'W	**Latitude**	38°54'N
Elevation	88 m (288 ft.)		
Average summer temperature	25°C (77°F)	**Average winter temperature**	2.7°C (37°F)
Average rainfall	1,034.4 mm (40.7 in.)	**Average snowfall**	42.16 cm (16.6 in.)
Area	17,920 km² (6,920 sq mi) (Metropolitan area)	**Population**	560,000

Contact information

Jessica Blackburn
Alliance for the Chesapeake Bay
(804) 775-0951
jblackburn@acb-obline.org

Dawn Gifford
D.C. Greenworks
(202) 518-6195
dawn@D.C.greenworks.org

Description

Washington, D.C., is a federal district with a population of 560,000. The Washington Metropolitan Region, with a population of 5,090,000, contains 24 counties in the surrounding states of Maryland, Virginia and West Virginia and has an area of 17,920 sq km (6,920 sq mi).

The City is located at the confluence of the Potomac and Anacostia Rivers and is flanked by the states of Maryland and Virginia. Washington's climate is hot and humid in the summer and cool and damp in the winter.

Separate stormwater sewer systems serve about two-thirds of the District and a combined sewer system serves the remaining third, or about 5,115 ha (12, 640 acres) — areas primarily developed before 1900.

Key motivators

Over the past 30 years Washington D.C. has lost 64 per cent of its heavy tree cover and its stormwater runoff has increased by 34 per cent.

The Anacostia, Potomac and Rock Creek Rivers within the District of Columbia do not meet federal water quality standards. To meet the standards, the District is investing $1.9 billion in a long-term control plan to manage combined sewer overflows by building three underground stormwater tunnels.

Similarly, D.C. is not meeting federal air quality standards for ground level ozone and particulate matter. This alone jeopardizes about $120 million of annual federal highway funding to D.C. The District reports the highest asthma rate in the United States, at 6.5 per cent for children and five per cent for adults.

The key motivators for green roof development include reducing combined sewer overflow events and the need to improve air quality and, by extension, the health and quality of life of its citizens.

Description of policy

Current incentives that support green roofs in Washington, D.C. include an expedited review and permit process for green roofs, increased floor-area ratios (FAR), tax benefits (reduced property taxes) and stormwater management plan credits for green roofs.

Process to establish policy

Several projects that support green roof infrastructure development include Casey Trees Endowment Fund with Limno-Tech, Inc.; D.C. Water and Sewer Authority; Chesapeake Bay Small Watershed Grants Program; National Fish and Wildlife Foundation, The District of Columbia Health and Watershed Protection Division; and, the U. S. Environmental Protection Agency.

History of funding for green roofs in D.C.

In 2003, the U.S. Department of Justice, the EPA and a coalition of citizen groups reached a partial settlement under the *Clean Water Act* in litigation against the Washington D.C. Water and Sewer Authority (WASA). Their effort launched an extensive program to reduce illegal discharges of untreated sewage into the Anacostia and Potomac Rivers and Rock Creek. The settlement required WASA to pay a $250,000 penalty for past violations and undertake or fund $2 million in stormwater pollution prevention. Of the $2 million, $300,000 was to be placed in a fund for the development of roof gardens. The interim measures to be taken by WASA include steps to limit combined sewer overflows. This may also result in the promotion of green roofs as a strategy for source control.

Chesapeake Bay Foundation

In 2005, the Chesapeake Bay Foundation (CBF) gave $200,000 in grants to three corporations: JBG Companies., Akridge Real Estate Services and Anacostia Economic Development to create environmentally sensitive, landscaped roofs on office buildings.

Half of the grant money was designated for a 6,317 m^2 (68,000 sq. ft.) vegetated roof at the new headquarters for the U.S. Department of Transportation along the Anacostia River.

The rest will be used to install a 929 m^2 (10,000 sq. ft.) roof in downtown D.C. and in historic Anacostia.

D. C. Greenworks

D.C. Greenworks is a non profit organization that provides assistance in implementing low impact development (LID) technologies. The LID program helps owners of commercial, multi-residential or single-family residential property in the D.C. area to install green roofs, rain gardens or rain barrel systems to save energy, cut maintenance costs and improve the quality of life.

In the state of Virginia, a grant competition is promoting green roofs by awarding a grant of $28,000 for a green roof on a non-residential project. The Alliance for Chesapeake Bay is promoting the grant competition.

Effectiveness

The Mayor of Washington D.C., Anthony A. Williams, referenced the Vision for a Comprehensive Plan for Washington, D.C, in his remarks at the 3rd annual Greening Rooftops for Sustainable Cities Conference in May, 2005. This plan includes an environmental agenda, a desire to clean up the local rivers such as the Anacostia Waterfront Initiative and the long-term control plan for stormwater improvements.

In 2004, there was less than 929 m^2 (10,000 sq. ft.) of green roof coverage in D.C. More than 18,581 m^2 (200,000 sq. ft.) is planned for 2005–2006. Most of these green roofs are being supported by funding for a portion of the incremental costs of the green over a conventional roof. The Casey Trees Endowment Fund proposes continued grant funding programs and other incentives for re-greening Washington D.C. The Fund's vision includes a "20:20:20 vision" — where in 20 years, 20 per cent of the roofs in Washington will be greened, representing 20 million square feet (1.8 million m^2)of green roof coverage.

The District government is showing leadership by directing that all new District government buildings be LEED Silver certified or the equivalent.

Lessons learned

According to a 2003 report by the U.S. Department of Energy, Energy Efficiency and Renewable Energy Network, Center for Sustainable Development, buildings in Washington D.C consume:

- 12 per cent of D.C.'s consumption of fresh water
- 35 per cent of total energy use
- 40 per cent of raw materials
- 65 per cent of electricity use
- 88 per cent of potable water supplies

and generate 30 per cent of the District's greenhouse gas emissions

Strategies to reduce these figures through the installation of green roofs will be a positive step.

The future

Advocates of green roofs suggest that hydrologic modelling of stormwater reduction, water quality benefits, heat-island modelling and energy savings for Washington D.C. will further improve the general understanding of the environmental benefits. The vision for greening D.C. includes green roofs as one strategy among many to improve stormwater runoff quality and improve air quality. There is optimism among green roof advocates that green roofs will find their way into the planning documents proposed for the many new buildings predicted for Washington D.C in the next decade.

Literature

Alliance for the Chesapeake Bay. (2004). *Want to Replace your Roof? Save Some Green and Make it Green!*. Retrieved April 2005, from http://www.alliancechesbay.org/pressrelease.cfm?id=195

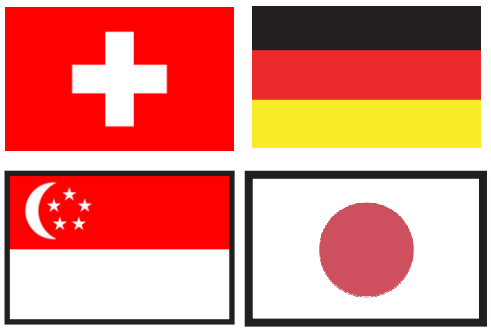
Alliance for the Chesapeake Bay. (2004). *Green roof promotional contest for Central Virginia*. Retrieved April 2005, from http://www.acb-online.org/pubs/projects/deliverables-240-2-2004.PDF.

D. C. Greenworks. (nd). *Current and Completed Projects*. Retrieved April 2005, from http://www.D.C.greenworks.org/LID/LIDprojects.html

Van Zee, J. (2004, September). *An international cross-cultural exchange 1999 to 2004* (43-46). Presented at the International Green Roof Congress, Nurtingen, Germany.

12-10-06

International



GREEN ROOFS POLICIES WORLDWIDE

Case studies

Berlin, Germany[1]

Longitude	13°25'E	**Latitude**	52°30'N
Elevation	49 m (161 ft.)		
Average summer temperature	25°C (77°F)	**Average winter temperature**	-2°C (28°F)
Population	3.4 million		

Description

Berlin is the federal capital of the reunited Germany. Berlin is one of three German city-states, combining the functions of city and state, with a senate having the executive function.

Fresh new approaches to urban design have been and continue to be applied in Berlin for relatively large and important projects. The unique opportunity to develop the vast central area after reunification provided a testing ground for innovative, large-scale projects. The oasis of green urban planning is largely a result of the Landscape Program for Berlin 1984–1994 with its four master plans (for the protection of nature and wildlife, natural resources, landscape, and recreation areas). They defined the high value placed on nature.

Key motivators

Berlin has been concerned with the increasing effects of urbanization, such as a lack of green space and stormwater management, since the 1970s. Densely developed land is severely limited in its function by:

- a high degree of impermeable ground cover
- inadequate replenishment of groundwater resulting from rapid runoff of rainfall into the sewage system
- lack of humidity and excess warming of air
- a constant decrease in plant and animal habitat due to inadequate green space.

[1] Used with permission from "Tools for Encouraging Sustainable Design" (2004) by Goya Ngan. Minor modifications from the original document have been made. The document can be found online at www.gnla.ca.

Description of the policy

Berlin established a Biotope Area Factor (BAF or BFF for *BiotopFlächenFaktor*) in the 1980s in the western sector before reunification. It resembles other urban planning instruments such as floor space ratio. The BAF contributes to standardizing the following environmental goals:

- safeguarding and improving the microclimate and atmospheric hygiene
- safeguarding and developing soil function and water balance
- creating and enhancing the quality of the plant and animal habitat especially wild species
- improving the residential environment.

The BAF is required in areas with a legally binding landscape plan. There are about 13 such areas in Berlin. Outside these areas, the BAF is voluntary and can be used as a guideline for environmental measures when changes to the existing building structures are proposed.

Calculating the BAF

The BAF expresses the ratio between the ecologically effective surface area and the total land area.

For each type of urban form, planners set a particular BAF target value. For example, new residential structures have a BAF target of 0.60 and new commercial structures have a BAF target of 0.30. For renovations, the BAF target may fluctuate depending on the existing degree of coverage. For instance, a residential renovation with a degree of coverage of more than 0.50 has a BAF target of 0.30.

Each type of surface on the proposed plan is measured and assigned a measure of relative importance according to its ecological value (see following table).

BAF=ecologically effective surface/total land

Weighting factor per m² of surface type	Description of surface type
Sealed surfaces—**0.0**	Surface is impermeable to air and water and has no plant growth. (that is, concrete, asphalt, slabs with a solid sub-base)
Partially sealed surfaces—**0.3**	Surface is permeable to water and air; as a rule, no plant growth (that is, clinker brick, mosaic paving, slabs with a sand or gravel sub-base)
Semi-open surfaces—**0.5**	Surface is permeable to water and air; infiltration; plant growth (that is, gravel with grass coverage, woodblock paving, honeycomb brick with grass)
Surface with vegetation, unconnected to soil below—**0.5**	Surfaces with vegetation on cellar covers or underground garages with less than 80 cm (31.5 in.) of soil covering
Surfaces with vegetation, unconnected to soil below—**0.7**	Surfaces with vegetation that have no connection to soil below but with more than 80 cm (31.5 in.) of soil covering
Surfaces with vegetation, connected to soil below—**1.0**	Vegetation connected to soil below, available for development of flora and fauna
Rainwater infiltration per m² of roof area—**0.2**	Rainwater infiltration for replenishment of groundwater; infiltration over surfaces with existing vegetation
Vertical greenery up to a maximum of 10 m (32.8 ft.)—**0.5**	Greenery covering walls and outer walls with no windows; the actual height, up to 10 m (32.8 ft.), is taken into account
Greenery on rooftop—**0.7**	Extensive and intensive coverage of rooftop with greenery

Berlin's (BAF) Biotope Area Factor

Process to establish policy

Berlin has a long history of green roof policy. In the 1970s, researchers from the Technical University of Berlin began examining the ecology of the city's green roofs. At the same time citizens began pressing for the support of more environmentally friendly cities. Many projects were implemented, driven by the environmental movement.

Between 1983 and 1996, a Courtyard Greening Program aimed at adding green space in the form of green roofs, green facades and backyard community gardens to the most densely sealed areas of the city. Through the program approximately 65,750 m^2 (707,727 sq. ft.) of extensive green roofs were subsidized. The program reimbursed residents for about half of their installation expenses. Berlin has since had deficits and no longer offers direct financial incentives.

Berlin also has a stormwater fee, administered by the Berlin Water Corporation, a corporation 50.1 per cent publicly owned. The stormwater fee for 2004 is 1.407 €/m^2/yr, based on impervious surfaces. Green roofs do not earn a discount. However, if the runoff is not connected to the drain, the roof area is not counted. Green roofs are sometimes integrated into local land-use plans, either as source-control measures or as nature-compensation measures. This is administered by the boroughs.

Effectiveness

The goals of this policy are numerous and aimed at improving the general quality of the urban landscape. There are so many factors involved that accurately quantifying all the benefits is not possible.

City planners have received positive feedback from architects and property owners who like the BAF because it is easy to use and there are immediate visual improvements as well as energy savings. In addition, it leaves designers and property owners with room for individuality, creativity and flexibility. City planners appreciate that it follows the same logic as other planning indices and ratios. The BAF also works well in existing neighbourhoods where there is a lack of green space.

Lessons learned

There are no specific design requirements or performance goals for green roofs. They must simply conform to industry standards. That said, technical issues are extremely important. In the early days, when standards were not well developed and workers lacked knowledge and experience, there were problems, such as erosion of substrates, leaks in the waterproofing and inadequate maintenance, which resulted in the growth of unwanted plant species whose roots sometimes damaged the waterproofing.

Training city staff for the BAF is fairly straightforward because of the BAF's similarity to other German planning instruments. However, a shortage of staff has made it difficult to check for compliance. Several years may pass before a green roof is inspected.

12-10-06

GREEN ROOFS POLICIES WORLDWIDE

Case studies

London, United Kingdom

Longitude	0°5'W	**Latitude**	51°32'N
Elevation	49 m (161 ft.)		
Average summer temperature	15.5°C (60°F)	**Average winter temperature**	4.4°C (40°F)
Average annual rainfall	754.3 mm (29.7 in.)		
Area	1,580 km² (620 sq. mi.)	**Population**	6,767,500

Contact information

Mathew Frith
Peabody Trust
mathew2@peabody.org.U.K.

Dusty Gedge
Green Roof Consultant
dustygedge@yahoo.co.U.K.
http://www.livingroofs.org

Description

The overall climate in England is temperate maritime — mostly mild. It is also damp and subject to frequent changes in weather. The Atlantic Ocean, and the warming of its local waters by the Gulf Stream, provide a temperate climate.

Key motivators

A key motivator is the protection of the black redstart *(Phoenicurus ochruros)*, an endangered bird that breeds and nests in urban brownfield sites in the Greater London Area.

In London, the Mayor's Biodiversity Strategy supports green roofs, saying that "by providing suitable substrates on roofs will allow wasteland flora and fauna to colonize naturally." It also mentions the physical and psychological benefits that are afforded to London's residents by greater contact with green spaces.

In addition, the Mayor's Biodiversity Strategy reinforces the Urban Taskforce's findings on the benefits of green spaces. The greatest endorsement of green roofs specifically comes under the heading of "wasteland biodiversity." This policy document says

> "where wasteland habitats are lost to development it is important that mitigation and compensation should concentrate on provision of similar habitats…such as creating wasteland habitats on roofs."

Description of the policy

There are now no planning or building codes to encourage the design and implementation of green roofs in Britain. National planning policy neither directly refers to green roofs nor implicitly includes them. There are no government incentives or support for green roofs. The first Urban White Paper in the U.K. in over 20 years — a report that calls for the renaissance of urban design quality and deeper community capacity-building — does not mention green roofs.

Process to establish policy

Current planning legislation allows local authorities in the Greater London Area to prepare "supplementary planning guidance" (SPG) on matters of relevance to their location. Some authorities are using the SPG to improve thermal efficiency, energy and water use, drainage and construction materials. London's Westminster City's SPG (2003) makes reference to green roofs. Similarly, Lewisham Council's revised unitary development plan (2002) contains a specific green roof policy. The most support for green roofs goes to references in the British Council for Offices' (Corporation of London) research advice note on green roofs (2003), which has been taken very seriously by planning and related professionals.

The government's £22 billion Sustainable Communities program, launched in February 2003, sets out a program of action to address a range of fundamental infrastructure issues within the context of the shortage of housing across the U.K. A demand for 4.4 million new homes is predicted by 2021. Green roofs are appearing as just one of a fairly complex recipe of sustainability features to meet increasingly rigorous environmental impact criteria; however, Mathew Frith, landscape regeneration manager of the Peabody Trust, warns that with complexity comes confusion among developers and clients about the importance of green roofs. Mr. Frith notes that while there are no policies in support of green roofs, there are none that detract from green roofs either.

Optimism for green roofs now springs from the role of London's Mayor, Ken Livingstone, who heads the Greater London Authority (GLA). His duties and powers include the preparation of strategies for London to express economic development, biodiversity, energy savings and many others while in keeping with the principles of health, equalities and sustainable development. According to Mr. Frith, the Mayor holds a unique position to help green roofs go mainstream. The GLA is the strategic planning authority for London and has published the London Plan. Surrounding boroughs' plans must be in keeping with the London plan such that

> "Wherever appropriate, new development should include new or enhanced habitat, or design (e.g. green roofs) and landscaping that promote biodiversity and provision for their management."

Effectiveness

According to Livingroofs.org, green roofs have been appearing more frequently throughout the U.K. since 2003. Livingroofs.org is a non-profit organization established to promote, advise upon and seek research into green roofs and similar structures within the context of urban and rural regeneration. It does not provide green roof products but provides:

- Professional, independent advice on green roofs through its contacts with consultants and the green roof industry.
- Independent consultants for specific projects/themes.
- Strategic reports on how green roofs can play a real role in terms of sustainability in urban regeneration areas, local and regional authority plans, etc.
- An online resource for researchers, planners, developers, regeneration professionals, ecologists, engineers and others.
- An online resource of current and past research documentation on green roofs.
- A portfolio of successful green roof projects, with information on their cost and construction.
- Signposts to key green roof system manufacturers, products and green roof resources.
- Tours of green roofs in London (in particular the Canary Wharf area) for interested parties.
- Speakers at conferences and events regarding green roofs and similar features in terms of urban regeneration and sustainability.

According to Mr. Frith, much of the green roof activity in the U.K. has been in the commercial sector where the focus is on protecting brownfield biodiversity in inner urban areas. This is the protected breeding and nesting ground of the black redstart.

The largest green roof in the U.K.—40,000m² (430,556 sq. ft.)—was recently installed on the new Rolls Royce factory in Chichester, West Sussex. (Rolls Royce is owned by BMW in Germany, where BMW sites have green roofs.) In the West Midlands, the Walsall Bus Garage, Wolverhampton University and Birmingham Hospital have green roofs. The new Fort Dunlop development in Birmingham includes a green roof in the development plan, in part because of concerns about conservation of the black redstart.

Over the last 40 years, many well-known citizens in the U.K. have included green roofs on their homes. Some recent housing developments include green roofs in their planning. Other housing authorities and co-operatives have also installed green roofs, including Acton Housing Association, Co-Housing Limited, East Thames Housing Association, Hedgehog Self-Build Co-Op, Hockerton Housing, Notting Hill Housing Group and Peabody Trust.

The government's Housing Corporation, (the agency regulating U.K. housing associations) has published a sustainability strategy and established an innovation and good practice grant fund. This strategy commits the housing sector to raise its environmental standards in new developments and to score credits on a rating system called Eco-Homes. Eco-homes is the housing version of BREEAM (Building Research Establishment Environmental Assessment Method) which is similar to LEED in North America. Credits on the Eco-Homes rating scale are granted for sustainable inclusions, such as reduced energy and water use and ecology. Very little work has been done on the inclusion of green roofs for Eco-Home credits. Some suggest that credits may be lost for a green roof as it adds more materials in construction. Thus far, BREEAM has not been a likely incentive for green roofs.

A unique green living developments in the U.K. is the BedZED (Beddington Zero-Emission Development) in the London Borough of Sutton. The 82 home and work units are designed to be highly energy-efficient and eco-friendly. The units are capped with a curved green roof of sedum mats to reduce surface water runoff and provide green space for residents. The green roof has become very popular with the residents.

Lessons learned

Aside from the capital costs, there are a number of perceived problems regarding green roof installation. A study in London in 2002 identified a number of these perceived problems by interviewing a number of professionals (architects, engineers, landscape architects) and interested parties. The London study asked participants to agree with the statement: "the physical structure of the many buildings prevents the establishment of green roofs." These were the responses:

Occupation	% Agreed
Environmentalists	67
Architects	40
Planners	33
Engineers	27
Developers	92
Ecologists	13
Other	50

Another perceived barrier illuminated by the survey was that the costs associated with maintaining a green roof are prohibitive. In the U.K., green roofs are expected to add about £1 per square metre per year to the operating costs of the building. The study indicated that many design professionals are keen to see more green roofs in the U.K., however many cited the lack of technical guidance, education and government support as a barrier.

Livingroofs.org responds to this survey by networking with political decision makers, providing technical advice, supporting research in the development of technical standards and certification, attending conferences and providing tours and seminars about local green roofs.

The future

Currently, enthusiasm for green roofs is limited to a few design companies, some professionals and other related enthusiasts. According to Frith, the installation of green roofs on housing projects, as of late, has been dismissed as the work of "hair-shirted hippies." However, the work at BedZED project, among others, is setting a new standard and turning some heads in the U.K.

Similarly, good work has leveraged the research and implementation successes shown in Basel, Switzerland; Malmo, Sweden; and Germany. Still however, the understanding and importance of green roofs is limited to individual companies and a few enthusiasts. The creation of a website, www.livingroofs.org, has focused on the policy deficits in the U.K. The organization is also working on the development of British design standards.

The British at present rely upon German FLL Standards to guide green roof installation. However, only manufacturers are monitoring the green roofs. While the desire for green roofs is predicted to grow exponentially over the next few years, there is a need for minimum industry standards and certification.

In June 2005, some manufacturers, the GLA, Livingroofs.org and other interested parties met at the British Standards Institute to start work on establishing codes of practice and standards for green roofs.

The Construction Industry Research and Information Association is working on *Buildings and Biodiversity*, a guide that includes a significant section on green roofs. This book will published in 2006 and will be the first major industry guide in the U.K.

Literature

Dunnet, N. & Kingsbury, N. (2004). *Planning Green Roofs and Living Walls* (254). Portland, Oregon: Timber Press.

English Nature Report. (2001). *Green roofs: their existing status and potential for conserving biodiversity in urban areas.* Retrieved from www.blackredstart.org.uk

Gedge, D. (2003, May). *From Rubble to Redstarts…Black Redstart Action Plan Working Group.* Presented at the Greening Rooftops for Sustainable Communities Conference, Chicago, Illinois.

Livingroofs.org. (2003). *Green Roofs Benefits and Cost Implications - A report for Groundwork Birmingham Sustainable Eastside.*

GREEN ROOFS POLICIES WORLDWIDE

Case studies

North-Rhine Westphalia, Germany

Contact information

Christof Mainz

Ministry of Environment, Consumer Protection, Nature Conservation and Agriculture

christof.mainz@munlv.nrw.de

Description

The state of North-Rhine Westphalia (NRW) is a highly industrialized region. It has more than 18 million inhabitants, making it Germany's most heavily populated state. The state contains the heavily industrialized Ruhr River region, and includes the cities of Essen, Dortmund, Duisburg and Bochum, Düsseldorf, Cologne and Bonn.

While it once depended heavily on the coal and steel industries, today 66 per cent of the NRW workforce is employed in the service sector. Many energy producers and suppliers have their headquarters in NRW; it is also a prime location for the large-scale power plant industry and the chemical industry. The state also hosts many innovative firms active in environmental protection, making it one of Europe's foremost centres of environmental technology.

Key motivators

With two major rivers and ample rainfall, stormwater management and improving water quality are the key motivators for green roof policies. Source controls can reduce and delay stormwater runoff. This in turn reduces sewer overflows, reduces the load at water treatment plants, reduces flooding and allows certain areas to be disconnected from the sewer system.

Description of policy

Launched in 1996, the Ecological and Sustainable Water Management Initiative is the first state-level subsidy program for green roofs in Germany. The €20 million program was developed by the NRW Ministry of Environment, Consumer Protection, Nature Conservation and Agriculture (MUNLV). The program applies to a variety of stormwater management initiatives. Funding is derived from waste water fees set by the *Wastewater Charges Act*. The fees must be used to improve water quality.

Municipalities in the NRW administer the program through their engineering, tax, or environmental departments (see Münster, page 69.) Typically, the municipalities have a qualified representative on staff and have information on their websites.

Subsidy

The program subsidized four types of stormwater management:

1. Removal of impervious surfaces: €15/m² of removed surface
2. Infiltration systems: €15/m² of infiltration surface
3. Green roofs: €15/m²
4. Systems that re-use rainwater: up to €1,500 per system.

The program applies to existing urban areas. New developments are usually required to implement some form of stormwater control and are therefore not eligible for the subsidy. Initiatives that are required as an ecological compensation measure also do not qualify. The subsidy may be used with the stormwater fee discounts.

Green roofs

Subsidies for green roofs are available for both new and retrofitted buildings. The green roof must have a runoff coefficient of 0.3 or less, meaning that it must retain about 70 per cent of stormwater. This level can be attained by installing an extensive green roof with a growing medium depth of 10 to 15 cm (4 to 6 in.). Furthermore, the green roof must be at least 34 m² (366 sq. ft.). Some municipalities have their own incentive programs for smaller green roofs, which are typically installed on carports.

To apply for the subsidy an application must be submitted containing the size of the proposed green roof, the depth of the components, the portion affected by stormwater delay, the runoff coefficient and whether the load-bearing capacity has been approved.

Process to establish policy

The incentive program was developed by MUNLV in 1995 after the Green Party took office.

Effectiveness

From 1996 to 2004, the program paid €16,551,595 on green roof subsidies to 4,138 applicants. When the removal of impervious surfaces and the installation of stormwater source controls are added to these numbers, total expenditure by the MUNLV equals €75 million. This has resulted in approximately 6 million m² (65 million sq. ft.) of surface area that could be disconnected from the sewer system.

Lessons learned

The financial incentive was key in motivating home and property owners to implement stormwater source-control measures. The incentive also led to a rethinking of how to design and build green roofs and homes.

The incentive played an important role in stimulating the green roof market, with small-and medium-sized businesses profiting the most. These businesses were also encouraged to seek out and develop new technologies to meet the increasing demand.

The future

There was a change of government in May 2005, which has left the future of the program unknown.

Literature

MUNLV. (2005). Antwort: Nachhaltig und ökologische Wasserwirtschaft aus Mitteln der

Abwasserabgabe. Nordrhein-Westfalen

12-10-06

Resources

Books–Publications	
Title	**Planting Green Roofs and Living Walls**
Authors	Nigel Dunnet and Noel Kingsbury
Publisher	Timber Press (2004)
ISBN	088192640X
Title	**Roof Gardens: History, Design and Construction**
Authors	Theodore H. Osmundson
Publisher	W. W. Norton and Company Inc. (1999)
ISBN	0393730123
Title	**Green Roofs: Ecological Design and Construction**
Authors	Earth Pledge, foreword by William McDonough, Editor Marisa Arpels
Publisher	Schiffer Publishing Limited (2005)
ISBN	0393730123
Title	**Green Roofs**
Authors	Katrin Scholz-Barth
Publisher	Federal Energy Management Program (FEMP), Federal Technology Alert, No. DOE/EE-0298
ISBN	http://www.nrel.gov/docs/fy04osti/36060.pdf
Title	**Green Roof Systems: A Guide to the Planning, Design and Construction of Building Over Structures**
Authors	Susan Weiler, Katrin Scholz-Barth
Publisher	John Wiley and Sons
ISBN	0471674958
Title	**The Green Roof Infrastructure Monitor**
Authors	Several
Publisher	Green Roofs for Healthy Cities
ISBN	www.greenroofs.ca
Organizations promoting green roofs	
Name	**Green Roofs for Healthy Cities (GRHC) North America Inc.**
Description	GRHC based in Toronto is a non-profit industry association consisting of public and private organizations and individuals.
Website	http://www.greenroofs.org/
Name	**Greenroofs.com**
Description	Greenroofs.com is the international green roof industry's resource and online information portal. Greenroofs.com serves an important role as the information database and clearinghouse for the green roof movement worldwide. The website contains a compilation of information and is easily the first stop for green roof information.
Website	http://www.greenroofs.com/
Name	**LivingRoofs**
Description	U.K. based organization promoting green roofs. It is a non-profit organisation established to promote, advise upon and seek research into green roofs and similar structures within the context of urban and rural regeneration.
Website	http://www.livingroofs.org

Name Description Website	 The objectives of the institute are to promote an increased use of green roofs in Scandinavia, to provide evidence for the positive impact of green roofs on urban ecology, and to provide background material for legislation, building standards, instructions, loan regulations and state grants. It is home to the Scandinavian Green Roof Journal. http://www.greenroof.se/
CMHC green roof resources	
Title Author Available from	**Design Guidelines for Green Roofs** Steven Peck and Monica Kuhn http://www.cmhc.ca/en/inpr/bude/himu/coedar/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=70146
Title Author Available from	**Greenbacks from Green Roofs: Forging a New Industry in Canada** Steven Peck, Monica Kuhn, Chris Callaghan, Brad Bass http://www.cmhc.ca/en/inpr/su/waco/alstmaprrepr/alstmaprrepr_001.cfm
Title Author Available from	**Waterfall Building Green Roof Case Study, Vancouver, B.C.** NA http://www.cmhc.ca/en/inpr/bude/himu/inbu/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=58783
Title Author Available from	**Merchandise Loft Building Green Roof Case Study, Toronto, ON** NA http://www.cmhc.ca/en/inpr/bude/himu/inbu/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=58788
Title Author Available from	**Green Roof Herb Garden Case Study, Fairmont Waterfront Hotel, Vancouver B.C.** Aysa N. September, Steven Peck http://www.cmhc.ca/en/inpr/bude/himu/inbu/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=58800
Title Author Available from	**Soka-Bau Green Roof Case Study, Wiesbaden, Germany** Goya Ngan http://www.cmhc.ca/en/inpr/bude/himu/inbu/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=60458
Organizations promoting sustainable buildings	
Name Description Website	**United States Green Building Council (USGBC)** The home of LEED. The U.S. Green Building Council is the nation's foremost coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work. http://www.usgbc.org/
Name Description Website	**Green Resources Links including Canadian Funding Opportunities** Part of the Canadian Green Building Council website http://www.cagbc.org/green_resources/links.php
Name Description Website	**Canadian Green Building Council (CGBC)** The Canadian home of LEED. Canadian counterpart of the U.S. Green Building Council. http://www.cagbc.org/
Name Description Website	**International Initiative for a Sustainable Built Environment (IISBE)** Energy and Environmental Issues in the Building Sector: to advance the energy and environmental performance of buildings through the creation, exchange and application of appropriate and timely information. Provides many Canadian case studies of green buildings. http://greenbuilding.ca/

Visit our home page at www.cmhc.ca

65255

03/11/2006