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# Economic Benefits and Cost of Green Roof

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**ABSTRACT**
Reflections Green roofs are a well known example of environmentally friendly building. Many scholars have explored the financial benefits of green roofs.This chapter begins with a thorough examination of the benefits and costs of green roofs. The lifecycle costs of green roofs from cradle to grave were evaluate, and quantitative estimations of individual and public benefits of green roofs were undertaken. Individual benefi ts, public benefits.

**KEYWORDS:** Green roof; economics , environment , cost effective.

## I. INTRODUCTION

Green roofs are well-suited for urban areas because they offer exceptional value for money at both the individual and public levels when compared to other green or grey infrastructure currently available. The substantial initial investment necessary for green roofs, on the other hand, operates as a market barrier. Individual green roof benefits include reduced energy use for heating and cooling.

The extensive construction of green roofs in a typical urban mixed-use neighbourhood was evaluated using a life-cycle evaluation. To assess private and social costs and benefits, Green roofs are currently not financially effective on a private cost basis, but when social benefits are considered, multifamily and commercial building green roofs are competitive. Green roofs on multifamily and commercial buildings are also viable options for lowering greenhouse gas emissions and storm-water runoff. Green roofs, on the other hand, are not the most cost-effective methods of energy conservation.

## II. INDIVISUAL BENIFITS OF GREEN ROOFS

### ENERGY REDUCTION IN HEATING AND COOLING

Through shading, evapotranspiration, insulation, increased thermal mass, and reduced heat loss through radiation, green roofs reduce energy consumption in space heating. When compared to conventional roofs, green roofs can be more effective at preventing heat loss in the winter.

### MEMBRANE LONGEVITY

Green roof technology protects a building's roof against diurnal changes, UV radiation, and thermal stress, extending its lifespan. Green roofs have been shown in studies to extend the lifespan of roofing membranes up to 40-50 years. whereas a conventional roof's lifespan spans from 10 to 30 years . The cost of replacing a traditional roof when it reaches the end of its useful life is estimated to be roughly 12204.20per square metre . The expense of installing a conventional roof 20 years from now is a benefit ofputting an a green roof.

### ACOUSTIC INSULATION

Green roofs improve a building's soundproofing and reduce sound refraction by enhancing absorption .The sound insulation generated by green roofs can be especially beneficial for buildings located near very loud sources of noise, such as nightclubs, motorways, or flight lines. Nature-Based Strategies: Social, Economic, and Environmental Benefits .Nature-Based Strategies: Social, Economic, and Environmental Benefits There are no accurate estimations of the economic worth of the sound insulation benefit of green roofs in the literature. Applying an extra layer of plasterboard to the ceiling is a standard way to improve noise insulation. Because green roofs include more than one layer, the noise insulation benefits obtained by them are comparable to or greater than those obtained by such an additional ceiling feature Installation and materials.

### AESTHETIC BENIFITS

Aesthetics are the most intangible advantage, and because assessing aesthetics in monetary terms is difficult, they are frequently left out of cost-benefit evaluations. The willingness of an individual to pay a greater price can be used to assign a monetary value to qualitative attributes like attractiveness. According to the London Commission for Architecture and the Built Environment, the price of a building or house will

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rise by 6% if there is a park nearby, and by 8% if the property has a direct view of the park. Green roofs, especially when spread out over a greater region, serve the same purpose as a neighbourhood park. As a result, 2 percent 5 percent and 5 percent 8 percent of property value increases have been assumed for extensive and intensive green roofs, respectively . The vast green roof may increase the value of the home.

**LEED CERTIFICATION BONUS**

LEED certified buildings are becoming increasingly popular as a result of cheaper operating costs, higher employee performance (in commercial and industrial buildings), enhanced public relations, improved health standards, and other community advantages . The most appealing feature for owners is that it improves financial availability. The average return-on-investment of LEED certified buildings increased by 19.2 percent for green retrofit projects in existing buildings and 9.9 percent for new green construction projects, according to estimates. Green roof installations earn one point for stormwater management and one point for minimising heat island effect under the Canada Green Building CouncilLEED programme if the roof covers at least 50% of the building. Another advantage of green roof technology is that the plant and soil medium of green roofs are environmentally friendly.

**2.6 ROOF LONGITIVITY**

When compared to conventional and white roofs, properly fitted green roofs provide more than twice the number of years before a roof needs to be replaced.

## III. PUBLIC BENEFITS OF GREEN ROOF

**REDUCTION OF STORMWATER RUNOFF**

Green roofs can have an impact on a building's storm water retention capacity. Most crucially, rainwater that falls onto roof surfaces drains into sewers at a slower pace when green roofs are present, as green roofs can absorb water. Green roofs can reduce sewer system capacity requirements by holding up to 50% of annual rainfall precipitation, depending on regional climate .According to a city of Portland investigation, 2,288,329,500 million per year1 is required to manage storm water that falls on impervious areas that do not absorb rainwater (City of Portland, 2008). Based on the above-mentioned retention performance of green roofs, green roofs will be able to save $1528 m2 per year by lowering public infrastructure management fees.

**IMPROVEMENT OF AIR QUALITY**

Green roofs are widely known as a solution for improving air quality. By actively absorbing numerous pollutants and passively filtering and directing airflows, vegetation minimises air pollution. In Toronto, Canada, it is projected that 109 ha of green roofs can remove eight metric tonnes of unclarified air pollutants each year . According to another study conducted in Chicago. The cost of a green roof's air quality benefit is evaluated by taking into account the pollutant's negative effects on health, the environment, infrastructure, and climate change. Due of the impact on a larger number of people in urbanareas, the cost would be much higher.

**MITIGATION OF URBAN HEAT ISLAND EFFECT**

Vegetation has been mostly replaced by impermeable and gloomy surfaces in metropolitan areas. Dark surfaces absorb more energy and reflect less solar light. The urban heat island effect is caused by a lack ofvegetation and the prevalence of dark surfaces. A modelling study in New York found that if 50% of the roof area is covered by vegetation, the average roof temperature can be reduced by as much as 0.8C. The temperature of a green permeable surface might be 4C lower than the existing paved roof in Venice, according to field observations and calculations .

**INCREMENT OF URBAN BIODIVERSITY**

Green roofs can assist improve local biodiversity by providing home for a variety of animal species such as birds and insects. A research conducted in Switzerland discovered that a single green roof supported 79 beetle and 40 spider species, 20 of which were threatened .Another study conducted in England on green roofs that imitate circumstances seen in derelict buildings indicated that black redstart, a rare bird species in the United Kingdom, prefers these places. However, as compared to other quantifiable benefits, the development of an animal habitat is viewed as a bonus. It is difficult to measure the increase in biodiversity and assess the costs and benefits associated with it using a standard methodology.

**JOB GENERATION AND ECONOMIC DEVELOPMENT**

Green roofs can provide both professional and untrained people with long-term employment prospects. They can also provide building owners and developers with a variety of services. Buildings with green roofs are more marketable than those

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without. According to some data, higher It's possible that rental occupancy, purchase prices, and faster sales may all improve as a result of a green roof's presence.

## IV. GREEN ROOF COST AND BENEFITS

Green roofs on commercial and public buildings provide the following environmental benefits:

- Improved water quality due to reduced storm water runoff and fewer combined sanitary and stormwater sewage system overflows.
- Increased habitat for biodiversity.
- Lower temperatures for building roofs and the air above them in most climates.
- Reduced energy consumption in some climates.
- Improved sound absorption in upper floors of buildings.

The cost of installing and maintaining green roofs on commercial and public buildings is included in theeconomic costs.

The following are some of the financial advantages of building green roofs:

- Lower energy costs due to the cooling effect of plant respiration as well as the insulation, shade, and thermal mass of the plant and soil layers.
- Less frequent roof replacements than conventional roofs due to better durability .
- Lower storm water management expenses.
- Job creation in roof construction and maintenance, as well as in the developing industry of urbanagriculture.

Green roofs have a payback period of about 6.2 years (based on a 50-year average annual savings) nationally (internal rate of return of 5.2 percent) and 6.6 years in Washington, DC (internal rate of return of
4.2 percent), with a conservative estimate of 40 years for a green roof versus 17 for a conventional roof.

If green roofs were to replace conventional roofs on all 54 million square feet of real estate in the National Capital Region (an estimated 5.9 million square feet of roof area), the cost-benefit analysis predicts a 50- year NPV of $22.7 million, or $0.42 per square foot of building area.

In the National Capital Region, community or public benefits might total over $180 million, or $3.30 per square foot of building area. As installation and maintenance charges decline, energy costs rise, and storm water rules tighten, these financial benefits are anticipated to grow.

## V. LIFE CYCLE COST OF GREEN ROOF

### INITIAL COST

Green roof prices vary significantly depending on criteria such as kind and size, location of green roofs, and country. The present cost of a conventional extensive green roof in British Columbia, Canada ranges from$130 to $165 m2, while the cost of a standard intense green roof begins at Economic Benefits and Costs of Green Roofs $540 m2 (Bianchini and Hewage, 2011). The cost of installation is influenced by a number of factors, including personnel and equipment expenses. Green roof prices in Singapore range from $40 to $65 per square metre, depending on the type of green roof and the foundation structure (Wong et al., 2003). The typical price of an agreen roof in China (Jia and Wang, 2011; Liu and Hong, 2012) is between $48 and $76 m2 (Jia and Wang, 2011; Liu and Hong, 2012).

Green roof prices in a mature market like Germany range from $15 to $45 per square metre.

Green roof prices in Germany are reduced as a result of two decades of research and development, as well as market penetration. There are no economies of scale in nascent markets, and competition is minimal.

Because to the lack of knowledge and the desire to employ unique design solutions, labour is also more expensive. Adopting low-cost approaches pioneered by mature markets is one way to lower the initial costof green roofs. Once the industry has established itself, the cost of green roofs often drops by 33% to 50%.

### OPERATION AND MAINTENANCE

The performance of green roofs determines their economic and environmental benefits. As a result, maintaining and operating vegetative roofs is vital to ensuring their positive effects. The cost of maintenance is also affected by the size of the green roofs, the building's attributes, the complexity of thegreen roof system, the type of vegetation, and the market O&M pricing. Green roofs are projected to cost between $0.7 and $13.5 per square metre per year in the United States (Bianchini and Hewage, 2012**).**

### DISPOSAL COST

At the end of their useful lives, green roofs can be disposed of in a variety of ways. Materials can be disposed of in the landfill, repurposed, or recycled. At the conclusion of the green roof's lifespan, the water retention layer, drainage layer, and root barrier layer can all be recycled. Many cities, on the other hand, lack the

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requisite recycling infrastructure. Landfill costs are determined by a variety of factors, including technology, location, facility size, and a municipality's available landfill capacity. According to a study, land filling operations and maintenance costs average $56 per tonne of trash discarded without including energy recovery (Chang and Wang, 1995). Another European report examined the cost of green roof disposal in detail, including inert material waste, sanitary landfill, and incineration with energy recovery.

An whole green roof is anticipated to cost $1120 ton1(h784 ton1) to dispose of (Peri et al., 2012).

The cost of removing green roof materials, according to Bianchini and Hewage (2012), is between $0.03and $0.2 million.

## VI. RELATIVE COST AND IMPACT BY BUILDING TYPE

| | MATERIAL (%) | CONSTRUCTION (%) | DIRECT ENERGY (%) | HEAT ISLAND ENERGY (%) | STORM WATER (%) |
|---|---|---|---|---|---|
| **COST** | | | | | |
| Single family | -33 | -45 | 1.2 | 19 | 3.4 |
| Multifamily | -35 | -35 | 1.7 | 24 | 1.7 |
| commercial | -27 | -43 | 3.1 | 25 | 1.5 |
| All categories | -30 | -43 | 1.8 | 19 | 2.8 |
| | | | | | |
| **Energy use** | | | | | |
| Single family | -0.07 | 0 | 6.4 | 92 | 0.72 |
| Multifamily | -0.06 | 0 | 6.5 | 92 | 0.26 |
| commercial | -0.06 | 0 | 11.1 | 87 | 0.20 |
| All categories | -0.06 | 0 | 7.6 | 91 | 0.54 |
| | | | | | |
| **StormWater reduction** | | | | | |
| Single family | | | | | 84 |
| Multifamily | | | | | 04 |
| commercial | | | | | 10 |
| | | | | | |
| | | | | | |
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The negative value shows the cost, emissions generated, or energy used.

These findings show that green roofs can help cities become more environmentally sustainable, although that function may be limited to commercial and multifamily buildings in specific regions. Green roofs appear to be more effective in areas with higher than average power rates, multi story building stock, and climates that may easily demonstrate heat island reductions when green roofs are installed. It's worth noting that this model doesn't modify material and construction pricing based on the number of building floors, which could limit the results and conclusions. recommend that urban sustainability solutions be evaluated using at least three metrics: initial cost, annualised cost effectiveness, and total effectiveness. The annualised cost effectiveness should reflect the intervention's running expenses or savings. Physical limits should be reflected in complete

efficacy. When it comes to green roofs.

## VII. CONCLUSION

Green roofs provide both personal and social advantages. The lifecycle costs of green roofs may be foundin most marketplaces across the world, according to the cost benefit analyses. In established markets and markets with average beginning expenditures, payback periods are shorter than the lifespan of green roofs. Green roofs' societal advantages will skyrocket if they are used on a wider scale. Governments should play a vital role in supporting green roof building by offering tax breaks, direct cash rebates, low-interest loans, and other incentives to transmit social benefits to private investors. Green roofs will also benefit the public and have a lower lifecycle cost as a result of these incentives.

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