# Green Roofs on Public Schools: An Exceptional Infrastructure Investment

*Aggregate Cost-Benefit and Job Creation Analysis of the Proposed Public School Green Rooftop Program Legislation (H.R. 1863)*

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GREEN INFRASTRUCTURE FOUNDATION

GREEN ROOFS FOR HEALTHY CITIES

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**About Green Roofs for Healthy Cities**
Green Roofs for Healthy Cities is a non-profit 501(c)(6) professional industry association working to grow the green roof and wall industry throughout North America since 1999. GRHC's activities including the publishing of the Living Architecture Monitor Magazine, and online training through the Living Architecture Academy

**About the Green Infrastructure Foundation**
The Green Infrastructure Foundation (GIF) is the charitable, 501(c)(3) arm of Green Roofs for Healthy Cities. GIF partners with communities to shape healthy, resilient, and sustainable places using living green infrastructure.


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**Cover Photo:**
*P.S. 6 Eric Dutt Eco Center. 2014 GRHC Award of Excellence Winning Project: MKM Landscape Architecture P.C.* The intensive green roof on Manhattan's P.S. 6 functions as an outdoor classroom, offering numerous hands-on learning opportunities for students, and serving as a model for all schools on how to optimize productive and educational programs on otherwise under-utilized roofs.

## About the *Green Roofs for Public School Buildings* Legislation

In 2021, Congresswoman Nydia Velázquez of New York introduced legislation entitled *Public School Green Rooftop Program*[1] (H.R. 1863). The legislation proposes $500 million over four years as follows: $100 million for planning, $300 million for installation, and $100 million for maintenance.

The bill, would bring numerous benefits to students, school districts, local economies, and the community at large, including:

- Providing educational and physical activity opportunities for students
- Reducing Urban Heat Island impacts which disproportionately impact lower income Americans. According to The Guardian[2], *"Researchers have found that poorer areas of US cities, with more residents of color, can be up to 20°F hotter in summer than wealthier, whiter districts, impacting children as they grow"*
- Extending lifespans of roofing systems from an average of 17 to an average of 40 years, saving school districts and taxpayers money[3]

*The green roof on Eastdale Collegiate Institute works as part of a social enterprise in partnership with non-profit organization FoodShare. The roof provides a valuable educational tool and raised over $18,000 in revenue in 2014. Photo: FoodShare*

- Reducing energy use buildings and extending the life of HVAC systems, saving school districts and taxpayers money
- Reducing air pollution through the capture of pollutants and particulate matter by plants
- Reducing impacts on stormwater systems, water pollution, and providing stormwater management services
- Providing access to local, healthy foods and education through urban agriculture programs
- Providing neighborhood stabilization benefits, improving property values and addressing inequities
- Reducing GHG emissions by reducing energy use and sequestering carbon
- Providing habitat for a diverse array of migratory birds, pollinators, and wildlife
- Creating meaningful, living-wage green jobs and offering workforce development opportunities in communities across the country

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[1] Press Release (2021, March 16). Velázquez Reintroduces Bill to Bring Green Rooftops to Public Schools. https://velazquez.house.gov/media-center/press-releases/velazquez-reintroduces-bill-bring-green-rooftops-public-schools

[2] Milman, O. (2021, February 16). The life-altering effects heat is having on American children. *The Guardian.* https://www.theguardian.com/us-news/2021/feb/16/the-life-altering-effects-heat-is-having-on-american-children

[3] US General Services Administration (2011). The Benefits and Challenges of Green Roofs on Public and Commercial Buildings. https://www.gsa.gov/cdnstatic/The_Benefits_and_Challenges_of_Green_Roofs_on_Public_and_Commercial_Buildings.pdf

## Why this Analysis

While the many benefits of green roofs are well known and documented extensively in a range of contexts, these benefits are often not valued, and this valuation not applied to decision-making. When a robust business case is not completed, quality investments are often missed, policy does not achieve its intended outcomes, and resources are misallocated.

The Green Infrastructure Foundation conducted this aggregate cost-benefit and job creation analysis in order to paint a complete picture of the costs and benefits of green roofs on public schools, and to help guide elected officials and other decision-makers as they make investments like this and others.

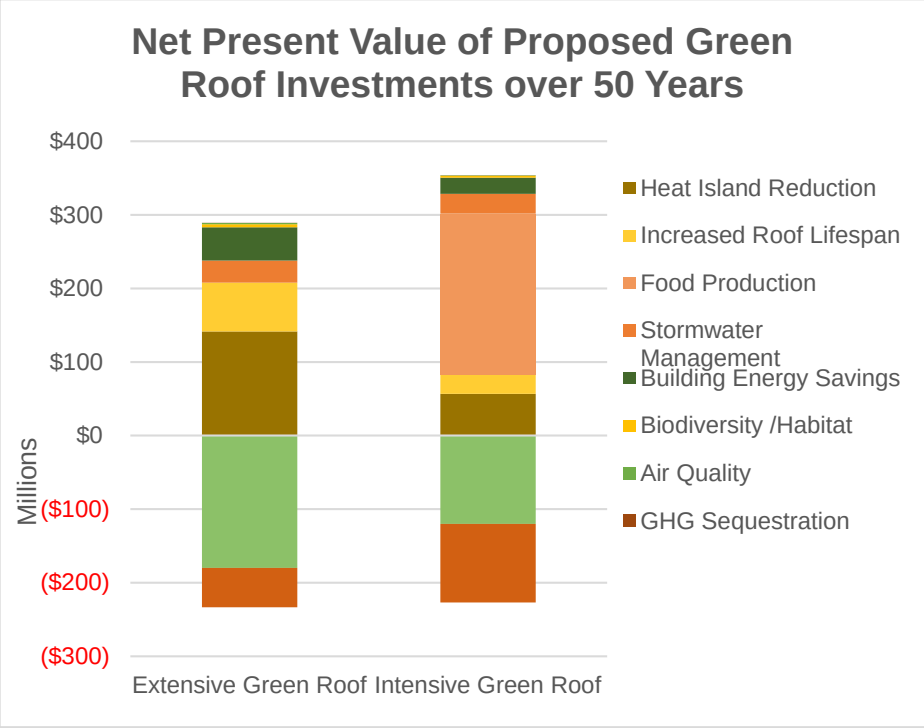
## Cost-Benefit Analysis of Proposed Legislation

The *Green Infrastructure Cost-Benefit Matrix* was developed by Green Roofs for Healthy Cities and the Green Infrastructure Foundation to help political leaders and other decision-makers understand the costs and benefits of green roofs and other forms of green infrastructure, and help analyze policies, programs, and proposed developments.

It is based on several steps of data aggregation and simplification, and the values that the Matrix uses are averages, reflecting large-scale implementation rather than being project-specific – ideal for analyzing the impacts of the *Public School Green Rooftop Program* (H.R. 1863) legislation. We used the Green Infrastructure Cost-Benefit Matrix to conduct an economic analysis of the proposed legislation, making a number of assumptions[4].

Based on these assumptions, the green roof investments proposed as part of the *Public School Green Rooftop Program* legislation would have a significant positive return, while retaining an estimated 154 million gallons of stormwater, sequestering 537 tons of carbon, and saving 10.7 million kWh of electricity every year.

Over 50-year period, the $300 million capital investment in green roof installation would have a positive return of **$183 million** (in 2021 dollars), and a combined rate of return of **7.3%**.[5]




[4] See Appendix: Cost and Benefit Assumptions for further information.
[5] Rate of return includes expenditures by the federal government, and benefits accrued by school districts and communities.

## Highlights of Analysis

- $300 million in capital investments would lead to the implementation of 14 million sf of green roof (10 million sf of extensive, 1 million sf of intensive, food producing, 3 million sf of intensive, non-food producing)
- $160 million (2021 dollars) in maintenance costs over a 50-year period
- $183 million (2021 dollars) in net benefit over a 50-year period
- A rate of return of 7.3%
- 154 million gallons of stormwater retained annually
- 537 tons of carbon sequestered annually
- 10.7 million kWh of electricity consumption reduced annually
- $378 million in benefits to school districts from reduced building energy use, increased roof lifespan, and rooftop food production over 50 years
- $264 million in community benefits from improved stormwater management, urban heat island reduction, improved air quality, increased biodiversity, GHG sequestration over 50 years
- This does not include many other valuable benefits, like opportunities for environmental education and workforce development, improved health/well-being, increased green space, improved productivity and reduced absenteeism for staff, improved resilience to climate change impacts, increased property values for surrounding properties, and increased tax revenue from added jobs and improved property values.
- Because our analysis captures all costs, but many benefits are left out, it is extremely conservative. A more detailed analysis that attempts to capture some of these additional benefits will likely find an even stronger case for large scale green roof investments on our nation's schools.

*Students on P.S. 41's green roof in New York City*
*Photo: Vicki Sando*

For more information about the Green Infrastructure Cost-Benefit Matrix, including detailed methodology, read the Green Infrastructure Charrette Program reports at greeninfrastructurefoundation.org/resources

## Job Creation Analysis

As we move towards an economic recovery from the impacts of the Covid-19 pandemic, there is an opportunity to invest in sustainable technologies that can provide benefits to taxpayers and the community, and also create meaningful, living-wage green jobs. At a weighted average cost for green roofs of $21.40 per square foot (of which $10 is labor), the $300 million in grants for green roof installation represents over $140 million for labor costs on the projects, - more if the grants leverage other funding for projects. With labor rates of $25-75 an hour for green roof crews, or

about $1,400 per day for a four-person crew, the legislation will support over 3 million labor hours, or 1,593 construction job-years[6].

Jobs will also be created from the need to maintain more green roofs, jobs which will be most needed in the first two years of a new green roof, but will continue for the useful life of the green roof systems. At a weighted annual maintenance cost of 43 cents per square foot for maintenance, and an average, all-in wage rate of $44 an hour, 5.7 full-time permanent maintenance jobs will be created for every 1 million square feet of green roof space. This legislation will result in an additional 14 million square feet of green roof over four years and will create nearly 80 new and permanent maintenance jobs each year – 3,977 job-years over the 50-year study period. Based on these figures, the total number of direct job-years created as a result of this legislation is 5,570, over the 50-year study period.

However, it is important to consider that economists and researchers have determined that jobs have an 'employment multiplier', additional indirect and induced jobs created for each direct job created. This figure ranges from 2.26 in construction, to 9.57 in utilities[7]. A team from LSE estimated that this economic multiplier for green jobs is 4.2[8].

*Green roofs provide meaningful, living-wage jobs in the 21st century green industry, while supporting local suppliers and manufacturers. Source: LiveRoof*

Based on this multiplier, in addition to the 5,570 direct job-years created over the 50-year study period, over 23,000 indirect and induced job-years would be created.

Workforce development programs in the communities these schools are in could help identify, train, and support the installation and maintenance workforce for green roofs. Educational programming on green roofs for students could include career exploration and skills training to create the next generation of green roof workforce.

## Conclusion

The Covid-19 pandemic has resoundingly demonstrated the need for safe outdoor spaces where we can gather while maintaining safe distances, while school closures have had disproportionate impacts

[6] A job-year represents one person employed full-time for one year.
[7] Economic Policy Institute (2019). Updated employment multipliers for the U.S. economy. https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/
[8] Vona, F., Marin, G., and Consoli D. (2018). Measures, drivers and effects of green employment: evidence from US local labor markets, 2006–2014. Journal of Economic Geography 19:5, pp 1021-1048.

on students of color and those living in poverty. Green Roofs can provide opportunities for outdoor classrooms that can help students keep learning through this pandemic and the next one.

“Besides the wide range of educational opportunities our green roof has offered, it has been vital in providing emotional support and access to nature for both teachers and students during the COVID-19 pandemic. Additionally, our green roof has created a thriving wildlife habitat while passively reduced the school’s energy consumption by 27.8%, which is critical for tackling our climate emergency,” said Vicki Sando, STEM Teacher and Green Roof Founder of P.S. 41 in New York City.

The many benefits of green roofs to mitigate heat islands, reduce pollution, and stabilize neighborhoods will be most pronounced in many of our urban core neighborhoods, where students of color make up the majority of the school population. The *Public School Green Rooftop Program* Legislation will be a tool to improve many of these urban schools and communities, while addressing our next big challenge: climate change. When combined with STEM learning and career exploration, it can also create pathways for a more diverse green infrastructure workforce and a more equitable sharing of the benefits of green roofs.

The legislation has the potential to transform neighborhoods in every community in the nation, while generating $183 million in benefits to school districts and the public, providing a rate of return of 7.3% and generating 14,700 FTE jobs. The legislation also promises to offer untold opportunities to our nation’s public school students, connecting environmental technology and sustainability to their education, and providing opportunities to be trained as part of the next-generation green workforce.

“There is no better place to begin teaching our children about conservation than our public schools,” argues Congresswoman Velázquez. “However, their education does not need to be confined to the classroom. These roofs allow students to directly engage with sustainable practices and see for themselves the impact that environmentally conscious initiatives can have on their hometowns and neighborhoods. By exposing them to these ideas early on in their education, we forge a path to a cleaner, healthier community.”

## Appendix: Cost-Benefit Analysis Assumptions

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|---|---|
| Installation spending over four years | $300 billion |
| Green roof installation costs | $18/sf for extensive, $30/sf for intensive |
| Green roof annual maintenance costs | $0.20/sf for extensive, $1/sf for intensive |
| Funding split | 60% of investments to extensive green roofs, 30% of investments to intensive green roofs that do not produce food, 10% of investments to food-producing green roofs |
| Discount rate | 4.4% |
| Inflation rate | 1.6% |
| Benefits accruing to school districts | Reduced building energy use, increased roof lifespan, and rooftop food production |
| Benefits accruing to the community | Improved stormwater management, urban heat island reduction, improved air quality, increased biodiversity, and GHG sequestration |
| Stormwater | Based on average rainfall in the continental US, assuming annual retention rates of 50% for extensive green roofs and 80% for intensive green roofs |
| Energy | Based on a weighted average of values derived for one example location in each Census Bureau designated region using the Green Roof Energy Calculator[9] |
| Carbon Sequestration | Based on Getter et al (2009)[10] |
| Monetary values of benefits | Benefit values are based on a weighted average of values per square foot of green roof from a literature review, normalized for time and currency.[11]<br>Benefit values are designed to reflect national averages and are not project specific. Given additional resources, a more detailed analysis could account for differences in benefit values by region and context. |

[9] The Green Roof Energy Calculator was developed by Portland State University, University of Toronto, and Green Roofs for Healthy Cities, now available at Arizona State University at https://sustainability.asu.edu/urban-climate/green-roof-calculator/

[10] Getter, K. L.; Rowe, D. B.; Robertson, G. P.; Cregg, B. M.; Andresen, J. A. (2009). Carbon sequestration potential of extensive green roofs. Environmental Science and Technology 43, 7564−7570

[11] References for cost-benefit values can be found on page 108 of GIF's 2020 Report, *Green Infrastructure for Climate Adaptation: Visualization, Economic Analysis, and Recommendations for Six Ontario Communities* at https://greeninfrastructurefoundation.org/s/GI_for_Climate_Adaptation_WEB.pdf