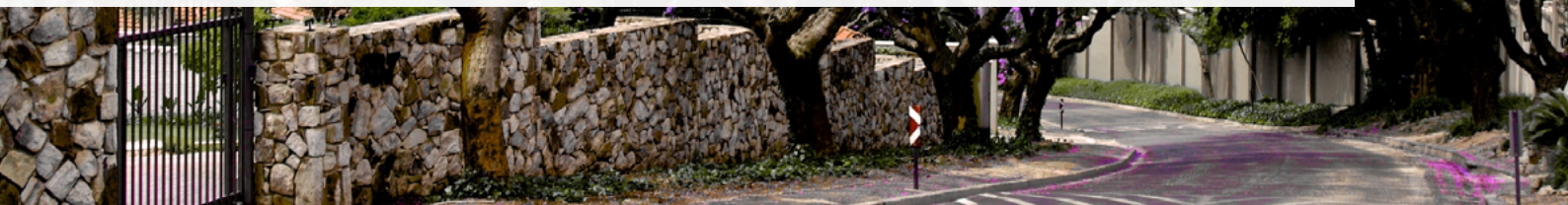


# Johannesburg: Schools as the centre of learning about the Nexus



ICLEI Case Studies

Updated in July 2021

## Food-Water-Energy Nexus in Johannesburg

“Johannesburg is the largest city in South Africa and part of a growing city-region within Gauteng Province of more than 12 million people, including Ekurhuleni to its East, Tshwane to the North and Mogale City to the West. Johannesburg has a long history of bringing or welcoming migrant workers from across the country and continent, which now contribute to a thriving financial and cultural center on the continent. Johannesburg is also well known for housing one of the largest artificial forests in the world. Yet, as is characteristic of many South African cities that experience the legacy of pre-apartheid, apartheid, and post-apartheid planning, the access to green space is unevenly distributed, as shown in Figure 2. Johannesburg’s built environment makes up just over 30% of its administrative area, with about 13% of its land as cultivated agriculture, and the rest made up of various, green and blue infrastructures. There have been strong efforts to mainstream biodiversity and the use of green infrastructure throughout Johannesburg. However, it is suggested that while the concepts of green infrastructure are understood, there are political or administrative limitations to the implementation of green infrastructure in lieu of grey infrastructures. This case study suggests a similar experience may be true for nexus: while the promise of nexus is understood, its implementation is currently limited.



## Facts & Figures

### Population

4,434,827 [1]

### Annual population growth rate

3.18%

### GDP per Capita

USD 2100,35 [2]

### Population Density

2696 persons/km<sup>2</sup>

### Land area

1645 km<sup>2</sup>

As with many large cities, Johannesburg is dependent on wider environmental hinterlands for its food, water and energy. For food, however, availability is not the main limitation, but rather, access to nourishing foods. In this way food security in Johannesburg, which ranges from an average of 27% to 44% in low-income parts of the city [4], is strongly aligned with income levels [5]. In 2013, galvanised by a study which showed that many citizens of Johannesburg were going hungry on a consistent basis, the City of Johannesburg (CoJ) established the Food Resilience Unit. This Unit first aimed to deliver food parcels to those experiencing food insecurity [6], before shifting to a more structural approach of providing citizens with land for cultivation. These efforts are praised for building and sharing urban farming skills, improving the proximity of produce to informal markets, raising incomes and improving food security, and providing wider health benefits for participants [4]. Endorsement and buy-in from other CoJ departments, as well as support from provincial government has been noted as vital to continuing these efforts [4]. New efforts are being focused on developing food gardens on rooftops in the central business district [6].

Similarly, Johannesburg is dependent on water that arrives in the Vaal River system naturally and from other provinces through two transfer schemes: The Tsekela-Vaal Transfer Scheme and the Lesotho Highlands Scheme [7]. It has come close to experiencing severe water shortages a number of times, including in 2015 and 2019, and the city is currently using more than its municipal water allocation from Rand Water [8], the region's bulk water service provider. However, there do not seem to be

effective systemic responses to improve water resilience. Rather, the focus is on demand-side management, with Rand Water recommending water restriction levels and increased costs for different user types.

The dominant energy consumption sector in Johannesburg is transport (61%), followed by industry and commerce (20%) and domestic use (17%) [9]. Because of this, liquid fuels represent the largest energy carrier in the city; however, due to a high reliance on coal-generated electricity, electricity is responsible for 66% of energy-related carbon emissions [9]. About 90% of the population has access to electricity in Johannesburg, so improved access is not as critical a development priority; however, many households choose to make use of other energy sources due to electricity cost or preference [10], so affordability should be considered. The two levers for shifting to sustainable energy are, therefore, changing the mobility and transport paradigms, and finding alternative sources for electricity generation. The first is potentially more manageable at a municipal level through strong regulations which could be led by the Climate Action Plan that is currently in development [11]. The latter poses more difficulty, as the city is dependent on the national electricity grid, and has minimal leverage to compel a shift to more renewable sources. Instead, decentralized installation of renewables by businesses and individuals who can afford to install these technologies shows potential. Additionally, it should be noted that renewable sources of energy are cost competitive and have been effectively used in implementation of low-income housing [10].



Figure 1 – Distribution of Green Space in Johannesburg [3]



However, the magnitude of the shift required is immense: currently, decentralized renewable energy generation (that is registered in the city) contributes 46 GWh of electricity to a mix which is dominated by 1150 GWh of coal-generated electricity [10]. Nevertheless, the effective implementation of decentralized innovations holds promise for community resilience, particularly if combined with other service offerings (such as those proposed by the nexus).

While there is potential to align priorities for food, water and energy sustainability in Johannesburg, there does not seem to be a strategy which intertwines the sectors [12]. Rather, each issue is addressed separately in planning, which acknowledges the importance of other sectors. As part of an exercise to identify the drivers of environmental challenges within CoJ, stakeholders from each of the departments and entities within CoJ came together for a workshop

to articulate and prioritize these specific challenges. 65 challenges were articulated, which were merged where necessary into 49 specific issues that were grouped under 16 themes.

The stakeholders present voted for the three issues that they believed were most pressing to improve environmental and social sustainability. This was useful, firstly, to note how many issues were articulated per theme, as well as where the city officers believed action would be most effective. The themes and leverage points are summarized in Table 1. It should be noted that votes articulate points of intervention with widespread co-benefits, and not the importance of the theme to the city. For example, inequality, a theme which received no direct votes, is an ever-present priority for the city and here, is encapsulated within other specific themes, such as informal settlements, food insecurity, waste management, and infrastructure planning.

Table 1 – Themes relating to environmental unsustainability in Johannesburg, with associated issues and urgency of leverage points

Row Labels	Specific Issues Articulated within this Theme	Key Leverage Points within this Theme (Votes)
Climate Change	3	7
Crime & Safety	1	
Failing Infrastructure	8	11
Food Security	2	
Health & Wellbeing	2	
Inequality	2	
Informal Settlements	1	3
Jobs, Unemployment & Human Resources	5	5
Lack of Awareness	1	2
Open Space	5	4
Pollution & Ecological Degradation	7	13
Population	2	
Urban Sprawl	3	3
Waste Management	3	13
Water Quality	2	4
Water Security	2	2
Total	49	67

After the exercise, the specific issues which were first organized into core themes were assigned related themes and connected to other issues using co-occurrences of these themes. For example, food supply, while organized under the food security theme also shared links to the themes of open space, jobs, unemployment & human resources, health & wellbeing, and climate change, and was therefore connected to each specific issue that also shared these themes. Using Gephi, an open source social network analysis software, a network map was created. What resulted was a dense network of 49 issues (nodes) and 563 connections, visualized in Figure 2. The nodes are colored by

overall theme and sized by the number of votes that the specific issue received. What is clearly visible is that waste management, increase in illegal informal settlements, climate change, and food supply are central features of this map. Key levers articulated by the stakeholders include addressing illegal dumping (12) ageing, dilapidated and unsafe infrastructures (8), improving climates change (5) responsiveness and reducing environmental pollution (5). This aligns with priorities articulated by CoJ's Environment and Infrastructure Services Department (EISD), who are grappling with illegal dumping and are in process of developing a Climate Action Plan [11], [12].

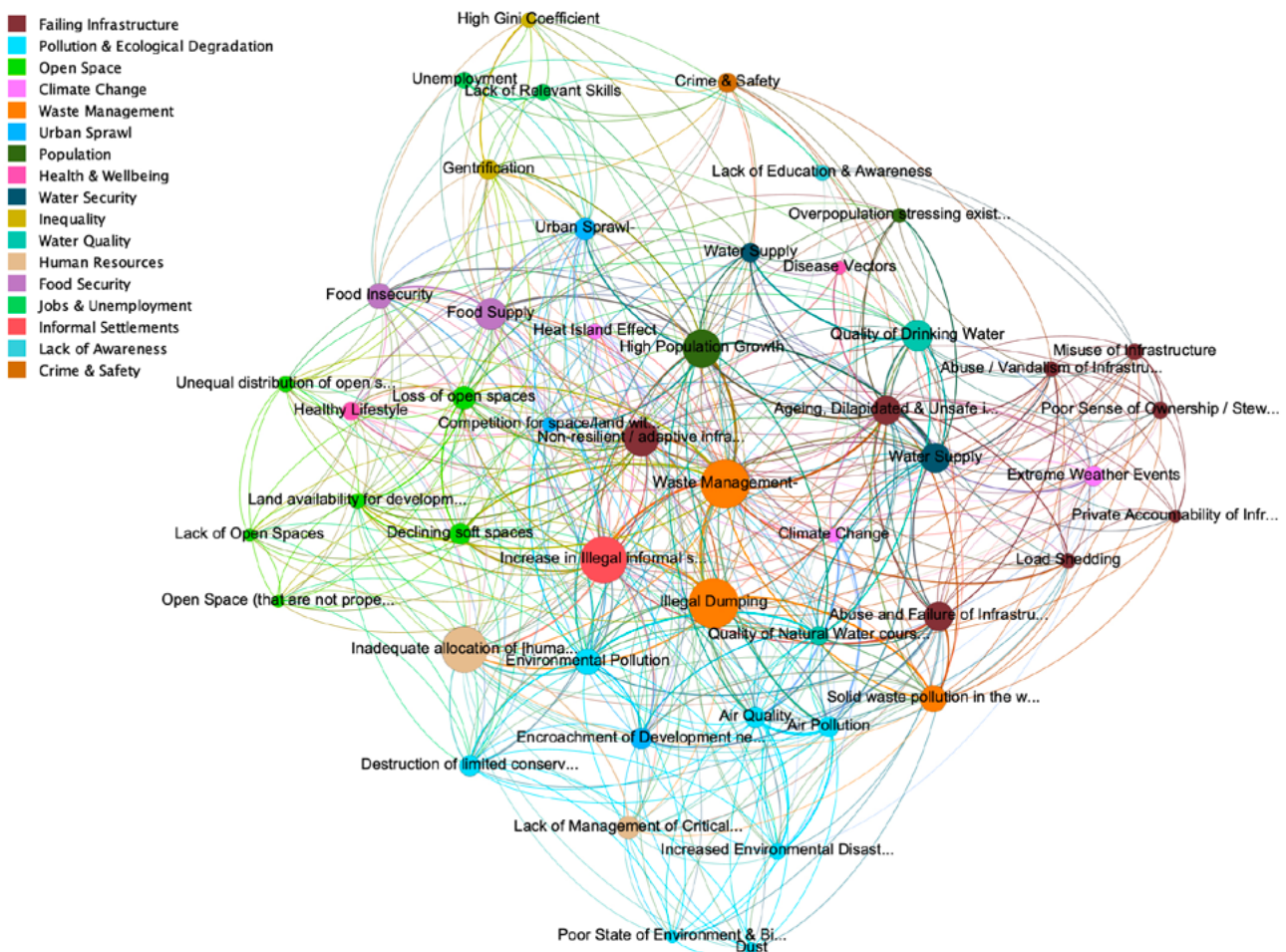


Figure 2 – A network map of interrelated social and environmental issues in Johannesburg



Figure 3 – Johannesburg City Chambers and the Civic Centre

## Story of the Innovation

The nexus project under investigation in this case is the School Greening Project, also referred to as the School Climate Proofing project in one annual iteration. The city of Johannesburg Environmental Education and Awareness Strategy [13] identifies three forms of environmental education, which are each supported in the implementation of the School Greening Project:

1. **Education about the environment**  
(information on environmental phenomena to develop awareness, knowledge and understanding of the environment);
2. **Education in the environment**  
(experiential and activity based learning encourages knowledge through contact with the environment);
3. **Education for the environment**  
(environmental improvement, specific actions to improve environmental quality).

This project is a great example of each of the aims articulated above, providing a platform in which educators and learners could interact with various technologies and facilities, learn about alternative food, water, energy and waste infrastructures, and contribute directly to environmental and social development objectives.

The project ran annually from 2013 to 2017 as part of the city's Environment and Infrastructure Services Department's (EISD) environmental education and awareness campaigns. Over these four years, the project was implemented in 41 schools<sup>1</sup> selected in vulnerable communities within Alexandra, Cosmo City, Eldorado, Ivory Park, Orange Farm, Riverlea, and Soweto. Key stakeholders involved in the project, and their associated roles are listed in Table 2.

1 Boepakitso Primary, Cosmo City Secondary 1, Cosmo City West Primary, Delrado Primary School, Drake Koka, Ekukhanyisweni Primary, Eldorado Park Secondary, Equisweni High School, Far North Secondary, Freedom Park Primary School, Harry Gwala Primary School, Hoernle Primary School, Isaacson Primary School, Iphutheng primary school, Ithute Primary School, Kliptown Primary School, Molalatladi Primary School, Musenga Vhadzimu Primary, Nancefield Primary, Nandi Primary School, Nkhohli Primary, Ponelepele Oracle Secondary School, Qhakazani Primary School, Raymond Mhlaba Primary School, Rebone Primary School, Rebonwe Primary, Riverlea Primary School, Sediba Thuto Primary, Sefika Primary School, Sgodiphola Secondary, Skeen Primary School, Tshebedisano Primary, Tshedimusho Primary School, Tshepana Primary School, Tshepisong Primary School, Vukuzenzela Higher Primary, Vulindlela Primary School, White City Skills School, Wilhelmina Hoskins Primary, Wiseman Primary, Zonkizizwe Primary School



Table 2 – Stakeholder roles in the School Greening Project

Stakeholder	Role
<b>City of Johannesburg</b>	Funder and project coordinator
<b>Provincial Government Departments</b>	Providing support and resources as needed or articulated by schools
<b>Service Provider</b>	Implementing Agent, facilitating the procurement and delivery of technologies to schools, the selection and upskilling of EPWP youth participants, and the coordination of project implementation
<b>EPWP Participants</b>	Trained in the installation and operation of each technology or process, the participants of this program were responsible for engaging the school principals, teachers and learners about the technologies, for providing environmental education using the technologies, and offering a hand-over when the project period completed
<b>School Champions (Teachers &amp; Principals)</b>	Depending on their interest and capacity, these champions oriented some of the school curricula around the facilities and technologies, using them as learning instruments for environmental sustainability, or even as learning platforms for biology, mathematics, geometry and other subjects; where champions were not interested or had limited capacity to engage, the projects were not mainstreamed into the school
<b>School Learners</b>	Depending on the level of engagement by EPWP participants and school champions, the learners could be deeply involved, participating in an eco-club, contributing to school gardens, following recycling principles, and learning about the other technologies; if there is minimal momentum at the school, then learners could be completely ignorant of, or disinterested in, the facilities
<b>NGOs</b>	Other environmentally-focused organizations have relationships with schools which enhanced implementation and receptivity of the project technologies and facilities

The equipment and facilities that were provided by the project included:

- Biogas Digester
- Food Garden
- Landscaping
- Outdoor Classroom
- Rainwater Harvesting Tanks
- Solar Water Heater
- Trees
- Waste Recycling

In this way, waste was a key addition to the food, water, energy nexus, particularly through the installation of a biogas digester and recycling bins. The success of recycling was entirely dependent on whether recycling pick-up services were offered in the neighborhood. Nevertheless, the presence of bins shifted many schools away from burning waste, a predominant issue beforehand.

In addition to offering alternative platforms for learning and engagement, one of the most innovative aspects of the project approach was the upskilling and employment of youth in the vicinity of the beneficiary schools, through the National Expanded Public Works Program (EPWP). This meant that, through the implementation process, unemployed youth received an opportunity for skills development and a period of employment. This was aimed at improving their ability to gain further employment. Indeed, a number of participants in this program are now employed within the CoJ, or continuing with environmental work elsewhere [12], [14].

These EPWP participants were responsible for installing the technologies or facilities, for training school champions, and for facilitating a number of environmental awareness engagements, making direct use of the facilities. Different levels of success were demonstrated in each school, due primarily to the presence of a champion teacher or principal who ensured that



these technologies were maintained and used as engagement tools for the learners. Where the champions did not exist or graduated, the longevity of the project was undermined. Of all the facilities, the food gardens were the most present and used learning aids, drawing learners in to cultivate vegetables after school, and inspiring community members to start their own gardens, where space allowed.

The best examples of nexus in this project are the relationships between the food gardens, the rainwater harvester, which provided irrigation, and the school kitchens, which benefited from the additional produce in their feeding programs. In theory, the biogas digester could have completed this nexus well by providing energy for cooking. However, in practice the stability of the technology was difficult to maintain over time. Here, the importance of a strong social foundation to any technological implementation is visible.

## Enabling Environments & Capabilities

This is a notable nexus project in that it emerged from internal drivers, and not as an externally conceptualized and funded project. Internal funding by the City of Johannesburg was mobilized for a holistic approach to environmental education, with the aim to provide direct benefits of subsidized water, energy and food, beautification, and recycling infrastructures. A detailed overview of the project was completed as part of an evaluation for CoJ. Key enablers of project delivery identified in this evaluation are described in Table 4, organised by knowledge, institutional, social, ecological, technological and economic enablers. Novel enabling aspects of this project include alignment with a national Extended Public Works Program (EPWP), in which temporary employment is created to support public services and infrastructure building or maintenance. Thus the project supported indirect benefit beyond specific implementation at each school.

Table 3 – Enablers for implementation of the Schools Greening Project

Knowledge	Institutional	Social	Ecological	Technological	Economic
Technological and environmental systems knowledge - the service provider was trusted to know which novel technologies could improve the efficiency of the schools. Participants in the project were tasked with educating learners and school staff about the benefits of each facility/ technology. Knowledge uptake and sharing differed based on engagement by school staff (e.g. some teachers more engaged than others). An evaluation of the project after 5 years of implementation has provided new process learnings which can improve future implementation	<p>Impetus for the project had strong motivation by City of Joburg to improve environmental awareness and actions</p> <p>There was linear delivery from city to learner - areas of improvement include iterative/ reflexive components in future implementation</p> <p>The project was aligned institutionally with EPWP, and drew in provincial departments and city entities to contribute to delivery</p> <p>Buy in from each school differed; many schools were unclear on which government department was responsible for what</p>	<p>Success was driven heavily by personal buy-in of a school champion or EPWP participant</p> <p>Project invested in social upliftment through EPWP</p> <p>Where EPWP participants had strong social ethos and invested in building relationships with school staff and learners, projects were most successful</p> <p>Where school staff viewed the environment as important, the projects lasted</p>	<p>Depending on the size of school grounds, there were opportunities for ecological interaction and learning</p> <p>Availability of land for food gardens and for planting trees</p> <p>Where there was abundant space, many community members requested to cultivate food gardens on school land, inspired by school gardens</p>	<p>Retrofitting and building technologies across schools: lighting, biogas digesters, solar water heaters, farming canopies or tubes, rainwater tanks, recycling bins (different colours for different material streams), trees, food seeds, landscaping, outdoor classroom</p>	<p>Internally funded from city budget</p> <p>Invested half in technology, and half in human resources</p> <p>No maintenance budget limited the project sustainability</p> <p>EPWP is a nationally-funded program</p>

A key challenge articulated during project implementation was the holistic nature of the project, which attempted to install all technologies at once. Upon reflection by the CoJ Team, slower implementation over time, and based on stronger monitoring of school buy-in, would have allowed the school stakeholders and learners to properly assimilate and look after each of the technologies [12], [14]. This is a case in which a key limiter was a mismatch between desired implementation process and the short budget period of the City financial year. It would be important to find mechanisms to support implementation over a longer period, giving time for the facilitators to effectively excite and educate school participants about the facilities, and to enable continuous engagement with the schools to reinforce learnings year-on-year. Timing is also an important consideration for maintenance of the facilities, particularly as school holidays resulted in a gap in maintenance of the food gardens, biogas digesters and other technologies.

## Synthesis

There is interest in attempting to address the issues of open space and failing infrastructure, through the use of green and blue infrastructures. But as articulated in GCRO, there appear to be jurisdictional limitations to the widespread application of this approach in the city [3]. This resonates with a number of interviewee perspectives [8], [11], which suggest that systems approaches

in CoJ may remain somewhat accidental and tend to be champion-led and project-based. The findings of this case study concur with this perspective, particularly as the innovation related to the School's Greening Project was not initially articulated as a nexus approach, yet it leveraged the interlinkages between different technologies, facilities and approaches and attempted to implement a holistic approach to environmental education for the learners in these schools.

In conversation with city officials, we asked how a programmatic, institutionalized approach to nexus or systems thinking could be implemented in the city. The first suggestion is a widespread inclusion of Key Performance Indicators that require cross departmental interaction and participation in projects. However, this is perceived to be top down, and difficult to measure. The other approach is to increase systems thinking capabilities among champions in the city and improve the enabling environments in which accidental cross-pollination of ideas and cross-departmental project development can occur. The EISD, with its recent Environmental Sustainability Strategy and Action Plan and upcoming Climate Action Plan, seems well poised to lead systemic action around a number of issues. These strategies provide a basis for engagement, but this will only work if the EISD takes on a convening role and draws the city's departments and entities into these processes. Future work with the Department through the IFWEN project aims to develop a process toolkit with this in mind.





## References

- [1] StatsSA, "Johannesburg Municipal Profile," 2016. [Online]. Available: [http://www.statssa.gov.za/?page\\_id=993&id=city-of-johannesburg-municipality](http://www.statssa.gov.za/?page_id=993&id=city-of-johannesburg-municipality).
- [2] City of Joburg, "Economic Profile," 2019. [Online]. Available: [https://www.joburg.org.za/about/Pages/About\\_the\\_City/About\\_Joburg/Economic-Data.aspx](https://www.joburg.org.za/about/Pages/About_the_City/About_Joburg/Economic-Data.aspx).
- [3] A. Schäffler et al., State of Green Infrastructure in the GCR. 2015.
- [4] FAO and MUFPP, "Food empowerment zones in johannesburg's farms," Johannesburg, 2018.
- [5] M. Rudolph, F. Kroll, S. Ruysenaar, and T. Dlamini, "THE STATE OF FOOD INSECURITY IN JOHANNESBURG," Kingston & Cape Town, 2012.
- [6] S. Motsusi, "Personal Interview," Social Development, CoJ. 2 June, Johannesburg, 2019.
- [7] Rand Water, "Where does our water come from?," 2013. [Online]. Available: <http://www.waterwise.co.za/site/water/purification/index.html>.
- [8] J. Eagle, "Personal Interview," EISD, CoJ. 1 August, Johannesburg, 2019.
- [9] City of Joburg, "City of Johannesburg state of energy report," vol. 1, no. 0, p. 133, 2008.
- [10] City of Johannesburg, "Joburg Energy Usage," no. 18, 2019.
- [11] L. Molefe, "Personal Interview," EISD, CoJ. 22 June, Johannesburg, 2019.
- [12] L. Serobatse, "Personal Interview," EISD, CoJ. 22 June, Johannesburg, 2019.
- [13] City of Joburg, "Building Towards a Greener, more Sustainable, Future: The City of Johannesburg's Environmental Education and Awareness Strategy," no. August, 2011.
- [14] G. Ramasunga, "Personal Interview," 24 June, Johannesburg, 2019.

SPONSORED BY THE



*This publication was developed based on the research conducted under the SUGI-IFWEN project, which was funded by the German Federal Ministry of Education and Research as part of its Social-Ecological Research funding priority, funding no. 01UV1802. The responsibility for the content of this publication lies with the authors.*

## Author

Paul Currie

## Contributor

Ryan Fisher

## Editor

Pourya Salehi

## Design

Olga Tokareva

## COPYRIGHT

© 2021 ICLEI - Local Governments for Sustainability e.V. All rights reserved. The ICLEI World Secretariat holds the copyright of this publication, including text, analyses, logos and layout designs. Requests to reproduce or to quote material in part or in full should be sent to [urban.research@iclei.org](mailto:urban.research@iclei.org). ICLEI encourages use and dissemination of this case study, and permission to reproduce this material without modification will usually be permitted without charge for non-commercial use.

ICLEI – Local Governments for Sustainability is a global network of more than 2500 local and regional governments committed to sustainable urban development. Active in 125+ countries, we influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development. Our Members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

## Contact Us

Kaiser-Friedrich-Str. 7  
53113 Bonn | Germany  
Tel. +49-228 / 97 62 99-00

